

## EFFECT OF THE INJECTION OF INTRARUMINAL VOLATILE FATTY ACIDS ON PLASMA CONCENTRATIONS OF GROWTH HORMONE AND INSULIN IN CATTLE

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### Introduction

The secretion of growth hormone (GH) is regulated by the hypothalamic-hypophysiotrophic hormone system. The nutritional status also plays a major role in determining the concentration of the circulating GH in ruminants. Oshibe et al. (1989) demonstrated that the secretion of GH is suppressed in inverse proportion to a dose of intraruminally injected propionate. However, to our knowledge, the changes in the plasma concentration of GH associated with other volatile fatty acids (VFA) injected intraruminally have not been investigated. The purpose of this study is to clarify the relationships between the doses of n-butyrate or acetate injected intraruminally and the changes in the plasma concentrations of GH and insulin.

### Materials and Methods

Three Holstein non-lactating and non-pregnant cows aged 64 months and weighing 547-548 kg were used as the experimental animals. The animals were fitted with permanent cannulas in the rumen. Each experiment was started 12 hr (at 10:00 hr) after feeding. Each injection solution was adjusted to pH 5.4 through the addition of NaOH. n-Butyrate or acetate was injected via the rumen cannula in doses of 2.5, 10 or 20 mmoles/kg body weight. Saline with an equivalent volume of 20 mmoles n-butyrate/kg was injected as the control. Each treatment was carried out with more than 2-day intervals. The jugular venous blood samples were obtained at 20 min intervals during the period from 20 min before to 180 min after the injection. The plasma concentrations of GH

and insulin were measured by radioimmunoassay. The areas under the GH response curves (AUC) for the 180 min period after the injection were calculated using the trapezoidal method and used as the index of the GH release in response to the injected solution. The T-test was used to assess the significance of the difference.

### Results and Discussion

Compared to the control, lower plasma GH concentrations were observed after the intraruminal injection of 10 mmoles n-butyrate/kg. Furthermore, the GH concentrations decreased significantly ( $p < 0.05$ ) at 20, 60 and 80 min after the injection of 20 mmoles n-butyrate/kg. The AUC after the n-butyrate injection decreased

TABLE 1. THE AREAS UNDER THE GH RESPONSE CURVES (AUC) AFTER THE INJECTIONS OF SALINE OR n-BUTYRATE AND ACETATE IN THE THREE COWS ( $\text{ng} \cdot \text{min} \cdot \text{ml}^{-1}$ )

Dose (mmoles/kg)	AUC
Saline	790 ± 155
n-Butyrate	
2.5	652 ± 102
10	439 ± 28
20	332 ± 11*
Acetate	
2.5	706 ± 210
10	1,071 ± 349
20	537 ± 57

The values are expressed as the mean ± SE. The asterisk indicates a significant difference ( $*p < 0.05$ ) as compared with the value of the saline injected cows.

as the dose was increased. The AUC in the 20 mmoles n-butyrate/kg was significantly smaller ( $p < 0.01$ ) than the control or the 2.5 mmoles/kg treatment (table 1). No significant difference was observed in GH concentrations after the 2.5 and 10 mmoles/kg acetate injection. However, it was significantly ( $p < 0.05$ ) lower at 20 min after the 20 mmoles/kg acetate injection. Compared to the control, no clear relationship was observed between the AUC and the dose of acetate (table 1). It is known that the growth hormone-releasing factor (GRF) stimulates the release of GH and that the arcuate nucleus is a primary source of GRF. In the present experiment, it was not elucidated as to whether the responses of the plasma GH to the intra-ruminal n-butyrate injections were caused by the direct action of this acid in the hypothalamus, since it remains to be determined

as to whether VFA levels in the peripheral blood were increased. Van Houten et al. (1980) identified a specific binding site for blood-borne insulin which was localized to nerve terminals in the median eminence and to the synaptic terminals in the adjacent hypothalamic arcuate nucleus in the rat. Posner (1987) has suggested that these axonal receptors may be hypophysiotropic terminals involved in mediating the effect of insulin on the secretion of GH. In this experiment, the plasma insulin concentrations increased immediately after the injections except for the control and the 2.5 mmoles/kg acetate treatment (table 2). It is possible that the increase in the insulin level in the peripheral blood results in the decrease of the GH secretion through a specific binding site for insulin in the hypothalamus.

(Key Words: Somatotropin, Butyrate, Acetate)

TABLE 2. PLASMA INSULIN CONCENTRATIONS IN THE THREE COWS INTRARUMINALLY INJECTED WITH SALINE OR n-BUTYRATE AND ACETATE ( $\mu$ U/ml)

Time after injection (min)	Saline	n-Butyrate (mmoles/kg)			Acetate (mmoles/kg)		
		2.5	10	20	2.5	10	20
0	23.8±4.6	23.2±1.5	27.1± 2.1	20.2± 2.0	26.0±3.7	37.6±7.3	29.4±3.3
20	24.2±3.5	41.3±1.8**	223.1±44.0*	384.1±71.1**	27.1±4.5	52.4±0.9**	59.4±2.2**
40	27.9±5.2	35.0±3.3	86.3±27.2	270.8±99.0	24.5±3.9	43.1±7.7	31.8±1.0
60	25.6±4.1	26.8±3.1	41.0±12.7	107.8±45.5	21.7±3.9	36.0±5.1	25.0±3.0

The values are expressed as the mean  $\pm$  SE. The asterisks indicate a significant difference (\* $p < 0.05$ , \*\* $p < 0.01$ ) as compared with the value of the saline injected cows.

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