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Behavioural and Growth Effect of Oral Administration of Rumen Protected Tryptophan on Weanling Beef Calves

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Introduction

Under modern livestock management, suckled animals are weaned when young, the age of weaning being dependent on the species and on the breed. Weaned suckled animals experience a variety of environmental changes such as new surroundings, separation from their dams, encounters with new groupmates and a new food supply. As a result, some animals show behavioural and physiological changes indicative of stress[2,4,6]. To obtain fundamental information for reducing weaning stress, reactions of the animals to environmental stress have been investigated[1,7,16,17].

In Japan, beef calves are weaned at a young age (usually 3-6 months), and therefore it appears that early weaning is stressful to these calves as it is to other farm animals. Recently it has been suggested that tryptophan, one of the precursors of serotonin (5-hydroxytryptamine; 5-HT) which functions as a neurotransmitter, regulates instinctive and emotional behaviours after passing through a blood-brain barrier[8,15]. Thus, it might be expected that tryptophan supplementation could alleviate weaning stress by helping weaned calves cope with their environment. However, changes in behaviour of early weaned calves after a dose of tryptophan have not been elucidated, and few advantageous effects of tryptophan supplementation have been reported for calf growth.

The aim of this study was to examine the effect of oral doses of rumen protected tryptophan on behaviour, growth rate and feed utilization of beef calves over 14 days following weaning at 3 months of age.

Materials and Methods

Animals and management

The present study was carried out at the Iriki Livestock Farm, Kagoshima University during June-August in 1995. A total of 22 naturally suckled Japanese Black calves were used. The suckled animals were kept together in a loose-housing creep pen as a cow-calf group from birth to 3 months of age. All calves were separated from their dams on Day 0 (1300 h) at 3 months of age (80-90 days). They were transferred from the loose-housing creep pen to indoor pens for weaning. They received 3 kg of formula feed per animal and Sudangrass hay *ad*

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libitum. Water and salt were also provided *ad libitum*.

Treatment

After balancing groups for sex and weaning weight, twelve calves in *Experiment* 1 and 10 animals in *Experiment* 2 were assigned to one of two treatments : oral tryptophan dose and no tryptophan as control. Both groups were housed separately in two adjacent identical pens (3.5m × 3.5m) which were bedded with sawdust on the concrete floor. Granules of rumen protected tryptophan were composed of 30% L-tryptophan, 30% vegetable fat and oil, and 40% dibasic and tribasic calcium phosphate (Plate 1). Tryptophan granules equivalent to 160 mg kg^{-1} of body-weight were individually administered with a small amount of water on preweaning day (Day -1), followed by 2 doses (80 mg kg^{-1} of BW each) on weaning day. An oral tryptophan dose was given once a day for 14 consecutive days following weaning in *Exp.*1, whilst it was done on alternate days after weaning in *Exp.*2.

Observations

Behavioural observation was made between 1300 h (weaning time) and 1900 h using a time-lapse video recording system on Days 0, 1, 2, 4 and 6 for *Exp.*1, and on Days 0, 1, 2, 4, 6 and 9 for *Exp.*2. Maintenance behaviour (eating, lying, standing, locomotion and exploration *etc.*) were recorded at 1-min intervals, and the number of occurrences of social behaviour (agonistic interactions, social licking, social investigation, vocalization, play and mounting *etc.*) were recorded continuously. Calves were weighed on Days -1 and 14 to determine average daily weight gain (ADG), and feed conversion during the postweaning period (14-day) was also calculated.

Statistical analysis

Daily percentage of time spent in each maintenance behaviour and total frequency of each social behaviour were analyzed by unrepeated 2-way layout ANOVA[14] for comparing

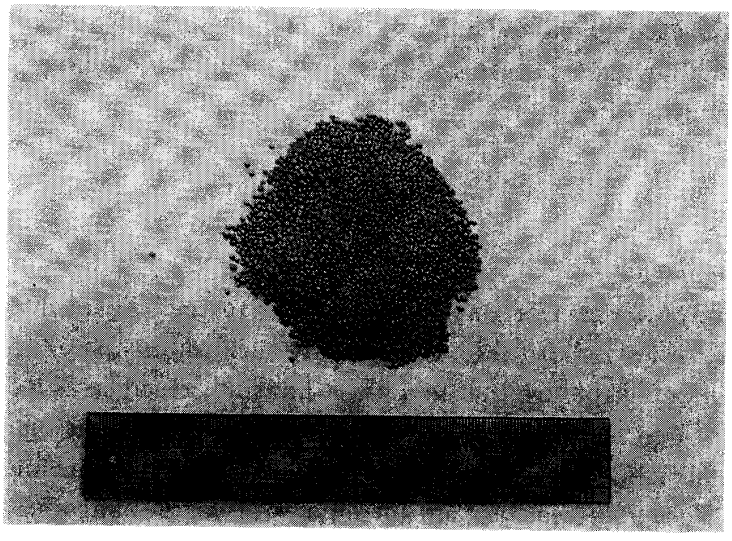

Plate 1. Granules of rumen protected tryptophan which consist of 30% L-tryptophan, 30% vegetable fat and oil, and 40% dibasic and tribasic calcium phosphate.

between-treatments as the main effect. As for ADG, a comparison was made between treatments for each experiment using the unpaired t-test[14].

Results

Experiment 1

Maintenance and social behaviours in calves after a dose of tryptophan (once a day for 14 consecutive days following weaning) are shown in Tables 1 and 2. There was no significant difference in mean time of eating and standing between control and tryptophan groups. On the contrary, tryptophan calves spent significantly more time lying than controls, and they were likely to spend less time in locomotion and exploratory behaviour. Agonistic behaviour, social investigative behaviour, vocalization, play (mostly mock fighting) and mounting were decreased by tryptophan doses. There was no significant difference in growth rate between treatments ($P>0.05$) nor in feed utilization even though the latter appeared to be higher in tryptophan calves than controls (Table 5).

Table 1. Time budget of maintenance behaviour in weanling calves during the daytime (1300-1900 h) after oral tryptophan administration in experiment 1

Behavioural type	Treatment		
	Control		Tryptophan
Eating(%)	15.9*[1]		17.5
Lying(%)*[2]	34.8	*	47.7
Standing(%)*[2]	17.7		24.0
Locomotion(%)	11.6	-	4.1
Exploratory behaviour(%)	13.4	-	4.8

* Mean of 5 observation days.
*[2] Including rest and rumination.
† $P<0.10$, *$P<0.05$ (ANOVA).

Table 2. Frequency of social behaviour in weanling calves during the daytime (1300-1900 h) after oral tryptophan administration in experiment 1

Behavioural type	Treatment		
	Control		Tryptophan
Agonistic interactions(no.)	103.8*[1]	**	65.6
Social licking(no.)	52.8		46.4
Social investigative behaviour(no.)	49.6	*	34.8
Vocalization(no.)	99.0	**	76.2
Play(no.)*[2]	49.2	*	31.8
Mounting(no.)	44.0	*	31.8

*[1] Mean of 5 observation days.
*[2] Including mock fighting.
* $P<0.05$, **$P<0.01$(ANOVA).

Experiment 2

Tables 3 and 4 show maintenance and social behaviours in calves when a dose of tryptophan was given on alternate days after weaning. The mean time of eating and lying was increased by oral tryptophan doses relative to no tryptophan, whereas locomotion and exploration were decreased. The manifestation of social behaviour was similar to that in *Exp.*1. Tryptophan calves had higher growth rate than controls (1.5kg vs. 0.8kg, $P<0.01$), but feed utilization was not significantly increased by the tryptophan dose (Table 5).

Discussion and Conclusion

In both experiments, the oral administrations of tryptophan significantly increased lying time. It is thought that brain serotonin (5-HT) plays an important role in inducing slow wave (non-REM) sleep and drowsiness in domestic animals[5,9,10]. As non-REM sleep and drowsiness occupy the majority of cattle recumbency[13], the increase in lying behaviour seems to be responsible for the buildup of brain serotonin synthesized by orally administered tryptophan. In contrast, moving behaviour including locomotion and exploration was apparently decreased by oral tryptophan administrations. Veissier *et al.*[16] noted that both an increase in the time spent lying and a decline in the time spent moving after weaning reflect higher adaptation to

Table 3. Time budget of maintenance behaviour in weanling calves during the daytime (1300-1900 h) after oral tryptophan administration in experiment 2

Behavioural type	Treatment		
	Control		Tryptophan
Eating(%)	11.2*1	*	15.2
Lying(%)*2	38.3	**	55.9
Standing(%)*2	16.1	†	20.3
Locomotion(%)	12.3	†	2.7
Exploratory behaviour(%)	11.4	**	3.2

*1 Mean of 6 observation days.
*2 Including rest and rumination.
† $P<0.10$, *$P<0.05$, **$P<0.01$(ANOVA).

Table 4. Frequency of social behaviour in weanling calves during the daytime (1300-1900 h) after oral tryptophan administration in experiment 2

Behavioural type	Treatment		
	Control		Tryptophan
Agonistic interactions(no.)	110.0*1	**	69.2
Social licking(no.)	47.4		42.8
Social investigative behaviour(no.)	34.2	*	24.2
Vocalization(no.)	84.8	*	66.6
Play(no.)*1	50.8	**	27.4
Mounting(no.)	60.4	**	41.0

*1 Mean of 6 observation days.
*2 Including mock fighting.
* $P<0.05$, **$P<0.01$(ANOVA).

Table 5. Average daily weight gain (ADG) and feed conversion in weanling calves during the 14-day period after oral tryptophan administration in experiments 1 and 2

	Treatment	
	Control	Tryptophan
*Exp.*1		
Initial body-weight(kg)	93.3±14.1	93.2±19.3
ADG(kg/day)	1.0±0.2	1.2±0.5
Feed conversion*[1]	3.3	2.3
*Exp.*2		
Initial body-weight(kg)	90.9±11.4	90.6±9.4
ADG(kg/day)	0.8±0.1[a]	1.5±0.3[b]
Feed conversion*[1]	3.3	2.0

*[1] Pooled data of all animals within each group.
[a,b] $P<0.01$ (t-test).

the new rearing conditions. The present findings indicate that the weaned calves habituate more rapidly to the new surroundings when the tryptophan dose is given than with no tryptophan. The inhibition of agonistic behaviour derived from the oral tryptophan administrations in this study is probably supported by the findings of Mabry and Campbell[11] who reported that the elevated 5-HT resulted in regulation of aggression in rats. As vocalizing is one of the emotional behaviours frequently exhibited by weaned animals[3,7], the weakness in the dam-young bond as indicated by a decrease in vocalizations is of practical importance in early weaning of beef calves. Therefore, it is noteworthy that oral tryptophan doses could reduce vocalizations in this study. A decline in mounting behaviour in tryptophan calves indicates that sexual behaviour may be regulated by brain serotonin depending on the animal species and on the sexual maturity, because it is suggested that hypersexuality was suppressed by the administration of 5-HTP, one of the precursors of serotonin[12]. A larger difference in growth rate between treatments was found in *Exp.*2 than in *Exp.*1. This may be due to a lower stocking density and/or a shorter period of restraint when tryptophan was given.

The oral administrations of tryptophan promoted lying behaviour in weaned calves and also had a significant sedative effect on agonistic behaviour. These altered behaviours are more likely to reflect a higher feed utilization. Further studies are needed to establish more rational techniques for oral administrations of tryptophan.

Summary

This paper examines the effect of orally administered tryptophan on behaviour, growth rate and feed utilization of beef calves during 14 days postweaning at 3 months of age. Twenty-two Japanese Black calves were used in the following two experiments ; 12 calves in *Exp.*1 and 10 animals in *Exp.*2. After weaning an oral tryptophan (160mg kg^{-1} of BW, including 30% L-tryptophan) was given once a day for 14 cosecutive days in *Exp.*1, whereas it was done on alternate days in *Exp.*2. In *Exp.*1, tryptophan calves spent significantly more time lying than controls ($P<0.05$) and they tended to spend less time in locomotion and exploration. Agonistic interactions, social investigation, vocalization, play (mostly mock fighting) and mounting were decreased by tryptophan doses ($P<0.05$). Average daily weight gain (ADG) and feed utilization of the tryptophan calves did not differ significantly from those of

controls. In *Exp.*2, eating and lying behaviours were increased by tryptophan doses ($P<0.05$). The social behaviour showed a similar pattern to that in *Exp.*1. The ADG of the tryptophan calves was greater than that of controls (1.5kg vs. 0.8kg, $P<0.01$). Feed utilization was not significantly increased by the tryptophan dose even though it appeared to be higher in tryptophan calves than controls. The present findings suggest that oral administrations of tryptophan have a significant sedative effect on agonistic behaviour and this may lead to a higher feed utilization.

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References

1) Dantzer, R. and Mormede, P. : Influence of weaning time on piglet behaviour and pituitary-adrenal reactivity. *Reprod. Nutr. Develop.*, **21**, 661-670 (1981)
2) Dantzer, R. and Mormede, P : Stress in farm animals : a need for reevaluation. *J. Anim. Sci.*, **57**, 6-18 (1983)
3) Fraser, D. : Vocalizations of isolated piglets. II. Some environmental factors. *Appl. Anim. Ethol.*, **2**, 19-24 (1975)
4) Gonyou, H. W. and Stookey, J. M. : Maternal and neonatal behaviour. in Price, E. O. (ed.), *The veterinary clinics of north America. Food animal practice.* p.231-249, W. B. Saunders Company, Philadelphia (1987)
5) Houpt, K. A. and Wolski, T. R. : Domestic animal behavior for veterinarians and animal scientists. p.67-95, The Iowa State University Press, Ames (1982)
6) Houpt, K. A. and Wolski, T. R. : Domestic animal behavior for veterinarians and animal scientists. p.151-188, The Iowa State University Press, Ames (1982)
7) Houpt, K. A., Hintz, H. F. and Butler, W. R. : A preliminary study of two methods of weaning foals. *Appl. Anim. Behav. Sci.*, **12**, 177-181 (1984)
8) Ito, S. : Hormones and behaviour. Kyoritsu-shuppan Co. Ltd., Tokyo (1978) (in Japanese)
9) Jouvet, M. : Biogenic amines and the states of sleep. *Science*, **163**, 32-41 (1969)
10) Kisara, N. : Amines and behaviour. in Kubota,K. and Ono,T. (eds.), *Handbook of physiological sciences*, vol.11. p.386-400, Igaku-Shoin Ltd., Tokyo (1989) (in Japanese)
11) Mabry, P. D. and Campbell, B. A. : Serotonergic inhibition of catecholamine-induced behavioral arousal. *Brain Res.*, **49**, 381-391 (1973)
12) Meyerson, B. J. and Eliasson, M. : Pharmacological and hormonal control of reproductive behavior. in Iversen, L. L. and Iversen, S. D. (eds.), *Handbook of psychopharmacology*, vol.8. p.159-232, Plenum Press, New York (1977)
13) Ruckebusch, Y. : The relevance of drowsiness in the circadian cycle of farm animals. *Anim. Behav.*, **20**, 637-643 (1972)
14) Steel, R. G. D. and Torrie, J. H. : Principles and procedures of statistics. McGraw-Hill Book Company, Inc., New York (1960)
15) Tanaka, C. and Kimura, M. : Serotonin (5-hydroxytryptamine). in Takagaki, G. and

Nagatsu, T. (eds.), *Neurotransmitters, amino acids and amines.* p.156-191, Kodansha Scientific, Tokyo (1982) (in Japanese)

16) Veissier, I., Le Neindre, P. and Trillat, G. : The use of circadian behaviour to measure adaptation of calves to changes in their environment. *Appl. Anim. Behav. Sci.*, **22**, 1-12 (1989)

17) Veissier, I., Le Neindre,P. and Trillat, G.: Adaptability of calves during weaning. *Biol. Behav.*, **14**, 66-87 (1989)