Fecal bacterial community and fecal organic acid profile in Holstein calves fed whole milk or milk replacer supplemented with cellooligosaccharide

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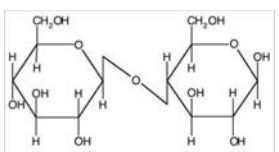
Introduction

Oligosaccharides have been added to calf milk replacers to reduce the potential growth of enteric pathogens and to promote the growth of "beneficial" bacteria and thereby to improve or stabilize enteric health of calves.

Cellooligosaccharide (CE), which consists mainly of cellobiose (Right), is a kind of oligo-saccharides. In a previous in vitro study, CE affected the fermentation of organic acids by mixed ruminal bacteria. CE has therefore a potential to improve growth performance via modification of the intestinal environment in calves.



Aim of this study ✈✈✈ To investigate the effects of type of liquid feed (milk or milk replacer) and administration of CE on the growth performance, the fecal bacterial community composition and the fecal organic acid profile in Holstein calves.

Experimental procedure

Animals and diets

--The present study was conducted at the research organizations of six prefectures (Toyama, Chiba, Aichi, Ishikawa, Ibaraki and Kanagawa).

--We made two trials:

	Trial 1	Trial 2
Liquid feed	Milk replacer (24% CP, 21% CF)	Whole milk
No. of calves	24 (female only)	14 (male/female)

--Calves were fed milk replacer or whole milk from 3d, in an amount necessary for a daily body weight gain of 0.3 kg in two daily feedings. They were weaned at 46d. The CE group was fed CE (Nippon Paper Chemicals) at 5 g/day by dissolving in the liquid feed.

--Commercial calf starter (18% CP and 2% CF) was offered. No antibiotics was included in MR nor calf starter.

--The animals' health and feed intake were monitored daily and body weight was measured weekly.

Fecal samples analysis

--Faecal samples were collected from calves by rectal stimulation on a day of week 4 and 7.

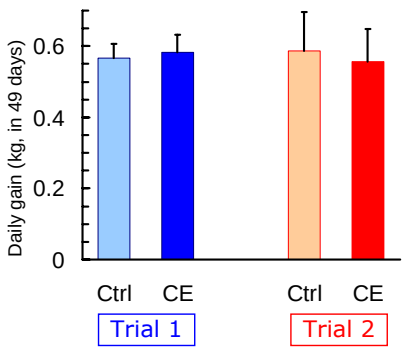
--A part of the sample was used for the determination of bacterial community composition by an RNA-based method **(sequence-specific SSU rRNA cleavage method)** (Uyeno et al, 2004).

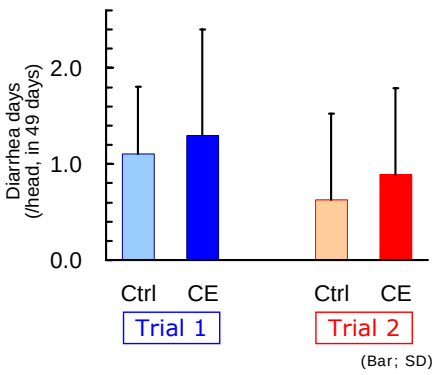
--Another part of the sample was suspended in 3x vol water and centrifuged. The supernatant was used for analyzing short-chain fatty acids and lactic acid by HPLC (Shimadzu LC-20 model).

--pH of the suspensions ranged 6.3 to 6.8.

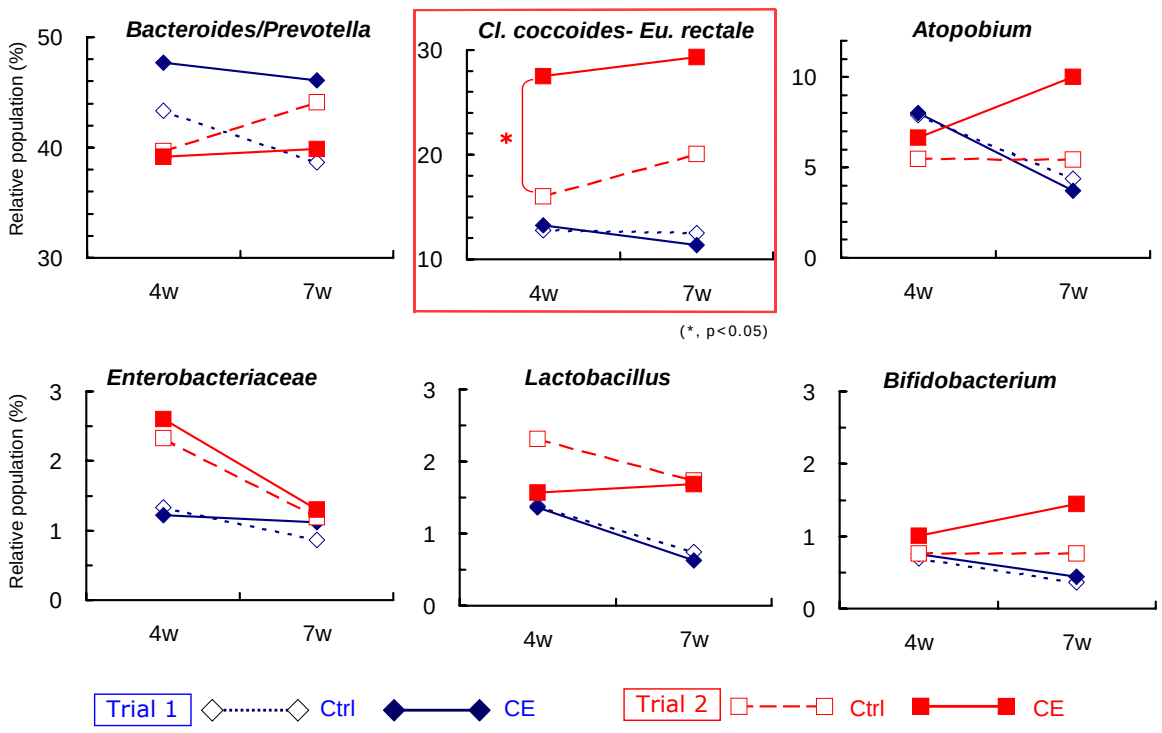
Results

Health & Performance

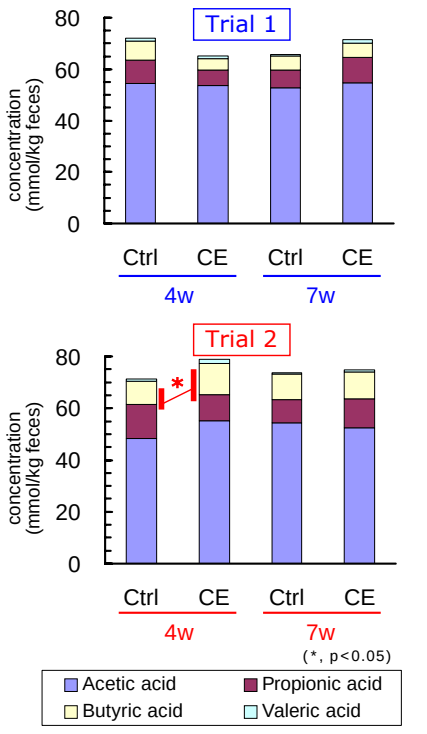




Fecal bacterial community composition



Fecal OA profile



✓ Feed intake, daily gain and occurrence of diarrhea of the calves were not affected by the CE supplementation in both trials. All the calves were healthy in each trial.

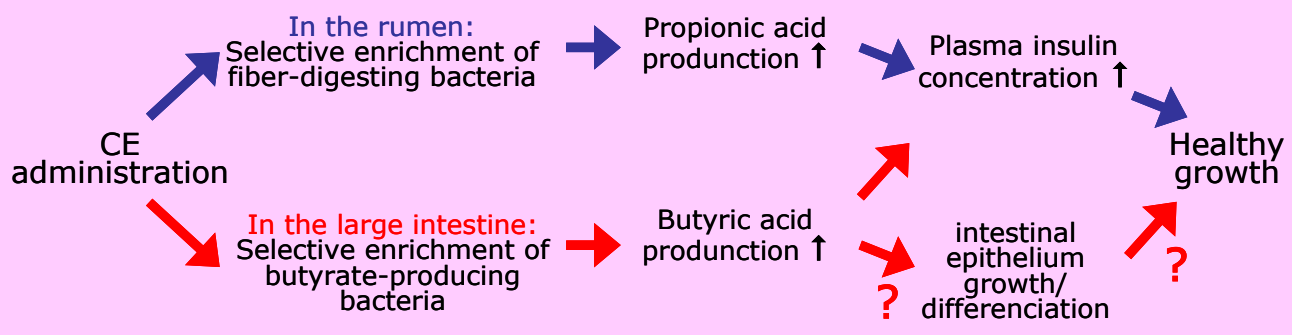
✓ The *Bacteroides-Prevotella* groupand the *Cl. coccoides-Eu. rectale* group constituted the major fraction of the fecal bacterial community of the animals. *Cl. coccoides-Eu. rectale* group is a cluster to which many butyrate-producing bacteria isolated from the human gut belong. The community composition and the organic acid profile were not different between CE group and control group in Trial 1. In Trial 2, ***Cl. coccoides-Eu. rectale* group was higher** (16.0% vs 27.5%, $p<0.05$) in the feces of CE group than control group at 4 weeks of age and **fecal butyric acid concentration was higher** (9.0 vs 12.0 [mmol/kg feces], $p<0.05$) at that time. CE had no effect on the populations of other groups, including "harmful" (*Enterobacteriaceae*) and "beneficial" (*Lactobacillus* and *Bifidobacterium*) bacteria.
The CE effects were observed only in whole-milk fed calves, possibly because of the intestinal community brought on by the whole milk ingestion and/or of any milk-specific components.

Conclusions & Implications

- **CE is utilized by specific microbes inhabiting calf intestine, resulting in the change of intestinal SCFA profile.**
- **The effect of the CE supplementation varies with type of liquid feed.**

A previous in vivo test (Hasunuma et al, 2011) indicated that CE feeding in calves induced improvement in DG and feed efficiency during the post-weaning period, mainly due to the enhancement of rumen VFA production by affecting specific groups of rumen microbes. In this study, we found that CE has a potential in changing bacterial flora in the large intestine too, resulting in enhancing butyric acid production in the organ. In addition to increasing plasma insulin concentration, butyric acid is involved in the growth and differentiation of intestinal cells, thereby improving digestion and absorption. This may also contribute to the improvement of the growth performance in an older age.

Possible mechanism of CE administration for healthy growth of calves



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