Original Article

Effect of a whey-predominant starter formula containing LCPUFAs and oligosaccharides (FOS/GOS) on gastrointestinal comfort in infants

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Development of new infant formulas aims to replicate the benefits of breast milk. One benefit of breast milk over infant formulas is greater gastrointestinal comfort. We compared indicators of gastrointestinal comfort in infants fed a whey-predominant formula containing long-chain polyunsaturated fatty acids, galacto-oligosaccharides and fructo-oligosaccharides, and infants fed a control casein-predominant formula without additional ingredients. The single-centre, prospective, double-blind, controlled trial randomly assigned healthy, full-term infants (n=144) to receive exclusively either experimental or control formula from 30 days to 4 months of age. A group of exclusively breast-fed infants served as reference (n=80). At 1, 2, 3, and 4 months, infants' growth parameters were measured and their health assessed. Parents recorded frequency and physical characteristics of infants' stool, frequency of regurgitation, vomiting, crying and colic. At 2-months, gastric emptying (ultrasound) and intestinal transit time (H_2 breath test) were measured, and stool samples collected for bacterial analysis. Compared to the control (n=69), fewer of the experimental group (n=67) had hard stools (0.7 vs 7.5%, $p<0.001$) and more had soft stools (90.8 vs 82.3%, $p<0.05$). Also compared to the control, the experimental group's stool microbiota composition (mean % bifidobacteria: 78.1 (experimental, n=17), 63.7 (control, n=16), 74.3 (breast-fed, n=20)), gastric transit times (59.6 (experimental, n=53), 61.4 (control, n=62), 55.9 (breast-fed, n=67) minutes) and intestinal transit times (data not shown) were closer to that of the breast-fed group. Growth parameter values were similar for all groups. The data suggest that, in infants, the prebiotic-containing whey-based formula provides superior gastrointestinal comfort than a control formula.

Key Words: gastric emptying, infant formula, whey, prebiotics, gastrointestinal comfort

INTRODUCTION

Abnormally delayed gastric emptying (GE) in infants can affect their feeding and therefore retard their growth. This condition is most often observed in preterm infants due to either their immature gastrointestinal (GI) tract or an allergy to cow's milk protein. GE has been shown to be affected by the type of nutrition. For example, the rate of GE decreases with intake of high energy foods and foods with high osmolarity, and increased with foods high in fibre.[1-4] Although published reports are inconsistent, different types of fatty acid may affect GE differently with short- and medium-chain fatty acids increasing GE more than long chain fatty acids.[5,6] Of particular importance is the observation that formula-fed infants have a slower rate of GE than breast-fed infants.[7]

In recent years, infant formulas containing probiotics, prebiotics and long chain polyunsaturated fatty acids (LCPUFAs) have been developed to replicate the properties of breast milk and improve various functional properties of infant formulas. Formulas predominantly containing whey as a source of protein are considered to be more similar to breast milk in terms of protein composition. Whey has been shown to have some of the benefits of breast milk, such as stimulating the growth of bifidobacteria.[8-10] Furthermore, there is evidence that, in infants, GE is more rapid after whey ingestion than after casein ingestion, but this remains controversial and more studies are required.[11-14]

Prebiotics, such as galacto-oligosaccharides (GOS) and fructo-oligosaccharides (FOS) are selectively fermented by bifidobacteria and are, therefore, considered to enhance the beneficial effects of probiotics. Additionally, these oligosaccharides increase faecal water content and thereby improve GI transit and comfort.[15-17]

LCPUFAs have also been added to infant formulas in recent years with the goal of better replicating some of

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the effects of human milk. LCPUFAs such as docosahexaenoic acid (DHA) and arachidonic acid (AA) have important functions as precursors of eicosanoids and other cyclo-oxygenase products, as well as structural components of cell membranes. Although studies on the specific health benefits of LCPUFAs in infants are inconsistent, it appears that dietary LCPUFAs play a role in improving the visual and cognitive functions of preterm infants.[18,19] The aim of the current study was to determine whether infants fed a whey-predominant formula containing LCPUFA and FOS/GOS exhibit better measurements of GI comfort than infants fed a standard starter casein-predominant formula with no additional constituents.

MATERIALS AND METHODS

Subjects

Subjects were healthy infants not older than 30 days of age at the time of enrolment, whose mothers had chosen to feed them exclusively with formula from 30 days to 4 months of age (formula-fed groups) or had chosen to exclusively breast-feed from birth until they were 4 months old (breast-fed group). Infants in the formula-fed groups could have been partially breast-fed prior to being 30 days old. To be included in the study, infants had to be healthy, full-term (gestational age ≥37 wk), and weigh between 2500 and 4500 g at birth. Infants were excluded from the study if they had congenital illnesses or malformation, had significant pre-or post-natal diseases, had required hospitalisation for ≥2 days, received antibiotic treatment, were known to have cow's milk allergy, had parents who were expected to have difficulty complying with the feeding regimen, or if they were participating in another clinical study.

This study was conducted between June 2006 and January 2008, during which time 224 infants were recruited. It was run in accordance with the principles and rules of the Declaration of Helsinki and adhered to Good Clinical Practice guidelines of the International Conference on Harmonization. It was approved by the Ethical Review Committee for Research in Human Subjects, Ministry of Public Health and the Faculty of Medicine, Chulalongkorn University, Thailand. Informed consent was obtained from the infants' legal representatives.

Trial design

The current study was a single-centre, prospective, randomised, double-blinded, controlled parallel-group trial with an unblinded reference (breast-fed) group. It was conducted at the Paediatric Gastroenterology Unit of the Chulalongkorn University Hospital in Bangkok, Thailand. Blinding was performed by labeling each tin of product with the same product code and protocol number, the only distinguishable feature being the colour of the label (yellow or blue). The identity of the specific product is blind to subjects, support staff, investigators and sponsor/manufacturers. Envelopes were used for randomization. Each envelope is identified by trial no., site ID, gender (boy or girl), and subject no. The product code and subject no. are printed on an inside card. Investigators need to open the envelope in a sequential manner to obtain the treatment code.

The study lasted approximately 18 months and infants (in formula groups) were fed exclusively with one of the two formulas until 4 months of age.

Upon enrolment, infants were randomly assigned to one of the two formula groups, stratified by sex. Infants received their assigned formula, a whey-predominant formula containing LCPUFAs and the prebiotics FOS/GOS (experimental formula group), or a standard casein-predominant formula lacking LCPUFAs and prebiotics (control formula group), starting at enrolment. Parents received instructions on preparation and feeding of the formulas.

Baseline measurements were taken at enrolment. Infants were fed ad libitum exclusively with their allocated formula from 30 days of age through 4 months of age. Follow-up visits took place when infants reached the age of 30±3 days, 60±3 days, 90±3 days, and 120±3 days.

Parents kept 3-day diaries prior to each visit, where they recorded the volume of the infants' formula, stool characteristics (frequency, consistency colour, and odour), digestive tolerance (occurrence of colic, crying, spitting, and vomiting), and general acceptance of the formula based on visual analogue scale (VAS). The study staff filled out case report forms at each visit and recorded the number of cans of formula distributed to each infant and the number that remained unused, any medication or treatment administered, and any concomitant intake of liquid, semi-solid, or solid food. At each visit, investigators took anthropometric measurements, reviewed the 3-day diary, and assessed any incidents of morbidity. Additionally, at the 2-month visit, GE time was measured by ultrasound and intestinal transit by H_2 breath analysis. Stool bacterial analysis was also performed at 2 months in a subset of 30 infants from each group.

Formulas

Formulas were isocaloric powdered "starter" formulas intended for full nutritional support of infants from birth to 6 months of age (Table 1). The experimental formula contained whey as the main source of protein, LCPUFAs and a prebiotic mixture of 90% GOS and 10% FOS (4 g/L of reconstituted formula). Both formulas were identical in taste and texture and were manufactured according to Good Manufacturing Practices and packaged by the sponsor.

Measurements

GE rate was initially selected as the primary outcome but GE time at 2 months of age was taken as the surrogate primary outcome and was calculated by modification of the method described by Darwiche and colleagues.[20] GE time was measured by ultrasound using the ACOUSON model Sequeoia 512 (Siemens, Germany) with an 8C4 transducer (4-8 mHz broadband) and the infant was laid in the seat designed to maintain a semi-reclining position that corresponds to the position of being held by the mother during breast feeding. The gastric antrum was identified by sagittal ultrasound scan at the level of the superior mesenteric vein entering the portal vein. At this point, the antral antero-posterior diameter was measured 3 times and the mean value was taken as the baseline Antral Cross Sectional Area (ACSA). The infant was fed with at least 60 ml of milk in less than 10 minutes without

Table 1. Formula nutrient compositions

	units	Experimental Formula	Control Formula
Energy	kcal/100 mL	66.8	67.9
Protein	g/100 kcal	2.11	2.47
Whey/Casein ratio	-	60/40	23/77
Fat	g/100 kcal	5.22	5.13
Arachidonic Acid	% of total fat	0.16	0
DHA†	% of total fat	0.16	0
Carbohydrate	g/100 kcal	11.16	10.98
Lactose/Maltodextrin ratio	-	70/30	70/30
GOS† + FOS† (GOS/FOS ratio)	g/100 kcal	0.6 (90/10)	0

† DHA = docosahexaenoic acid, GOS = galacto-oligosaccharides, FOS = fructo-oligosaccharides.

a pause in the semi-reclining position. The ACSA was measured at 10 minute intervals for 1 hour, and thereafter, at 20 minute intervals until the ACSA returned to the baseline value. The time it took for the ACSA to increase and return to the baseline value was taken as the total GE time.

The secondary outcomes were intestinal transit time, digestive tolerance (stool characteristics and infant's behaviour), anthropometric measurements (weight, recumbent length, and head circumference), and the occurrence of any adverse events (AEs).

Intestinal transit time was measured at 2 months of age using the H_2 breath-test. Prior to the test, infants were fasted for 4 h. Exhaled Alveolar air sample was collected and baseline H_2 and CH_4 were measured using Microlyzer SC (Quintron, USA) and CO_2 as a standard. Fasting baseline values of <10 ppm for H_2 and <8 ppm for CH_4 were considered to be normal. Thirty minutes after lactulose (1 gm/Kg) intake, serial breath H_2 and CH_4 from exhaled air samples were measured at 10 min intervals for up to 100 minutes. The time between the initiation of formula intake and the observation of the first sustained increase in alveolar H_2 or CH_4 concentration (3 consecutive increases of at least 3 ppm) was considered to be the oro-caecal transit time (OCTT).

Stool characteristics included mean frequency (number per day) as recorded in the 3-day diaries, consistency (small and hard, hard and lumpy, hard cracked, sausage-like, soft, loose, or runny), colour (brown, green, yellow, or black), and smell (normal, foul, or offensive). Digestive tolerance was assessed based on the number of episodes per day of colic, occurrence of crying, spitting up, and vomiting. The volume of formula intake was recorded by the care giver in the 3-day diary, as was general acceptability, which was evaluated using a VAS (0=dissatisfied to 10=satisfied).

Investigators measured the weight of naked infants on calibrated digital scales with differential significance of 5 grams. Measurements were taken three times during each visit and the mean was reported. Investigators also measured recumbent length three times on the standardised length boards and head circumference three times with standard measuring tapes. Measurements for all infants were made with the same instruments.

Stool was collected from infants at baseline and during the 2-month visit and stored at -20°C until further analysis. Samples were analysed commercially (Ribo Technologies BV, Netherlands) for the presence of Bifidobacteria, Lactobacilli, Enterobactericeae, Clostridia and Bacteroides, using fluorescence in-situ hybridisation (FISH).

The investigators assessed AEs based on interviews with the care givers and a review of the 3-day diaries. Any use of medication was also evaluated. AEs were defined as illnesses or signs or symptoms of illnesses (including abnormal laboratory measurements) that occurred or worsened during the course of the study. All AEs were evaluated by the investigators for causality and severity and recorded. AEs were assessed as serious if they were life-threatening, caused permanent harm, resulted in hospitalisation or extension of in-patient hospital treatment, or were considered to be medically relevant by the investigator. All other AEs were categorised as minor.

Statistics

Sample size calculation was based on the standard deviation of GE rate taken from Darwiche *et al.,* with σ=6.8% and a difference of Δ=5% considered as clinically relevant.[20] A sample size of n=57 per group was required to show superiority on an α-level of 5% and power of 86% in a 2-sided non-parametric test. Assuming a 20% drop-out rate, n=71 per formula-fed group was required. The number of infants in the breast-fed group was based on showing equivalence in weight gain (see below). Thus, in this group n=56 was required. Adjusting for a 20% drop-out rate, n=70 was required in the breast-fed group. Both sample size calculation and the eventual randomisation were performed using the software R. (http://www.r-project.org/). All statistical analyses were performed with Statistical Analysis System, version 9.1 (SAS Institute Inc, Cary, NC).

Primary outcome (GE time) was analysed using the intention to treat (ITT) population. Mean GE was compared between groups using ANOVA testing a non-equivalence hypothesis and *p*-values adjusted according to Tukey. Intestinal transit time was analysed similarly to GE.

Mean stool counts were compared between groups using ANOVA, and the odds ratios (OR) and 95% confidence intervals (CI) for the various stool characteristics were calculated using logistic regression and *p*-values adjusted for multiplicity using the Bonferroni method.

Weight gain (from birth to 4 months of age) was compared between the experimental and the control groups using a mixed model. Non-inferiority hypothesis was tested using the non-inferiority margin of $\underline{\Delta}$=3.0 g/day based on recommendation of the American Association of Paediatrics. In order to declare non-inferiority, the lower

boundary of the 90% confidence interval (CI) for the treatment difference must lie above Δ=–3.0 g/day. Other anthropometric measures were tested for non-equivalence hypotheses.

For the analysis of stool microbiota, bacterial counts were log transformed and counts reported per g of stool. Bacteria counts below the detection limit were set to the value of the detection limit ($1x10^6$ colony forming units/g). Any differences between the experimental and control groups were assessed using Wilcoxon rank sum test adjusting for multiplicity according to the Hommel method.

RESULTS

Study population

Two hundred and twenty-four infants were enrolled in this study and 169 of these infants completed the study. Drop-out rate was slightly higher in the experimental group compared with the control group (25% vs 19%) but this was not statistically significant (Figure 1). Baseline characteristics were similar between the groups (Table 2).

Gastric emptying

Although a small treatment effect of 1.75 mins was detected between the two formulation groups, suggesting a slightly shorter mean GE time for the experimental group, no statistically significant differences were detected compared with the control group (Table 3). A similarly small difference was detected between the two formulation groups for intestinal transit time (data not shown) that was not statistically significant.

Formula acceptability and tolerance

The acceptability of the formula based on mean VAS scores was similar in the experimental formula group (8.3±2.1) and the control formula group (8.1±1.8). The profile of the behaviour characteristics is fairly similar for the experimental and control groups.

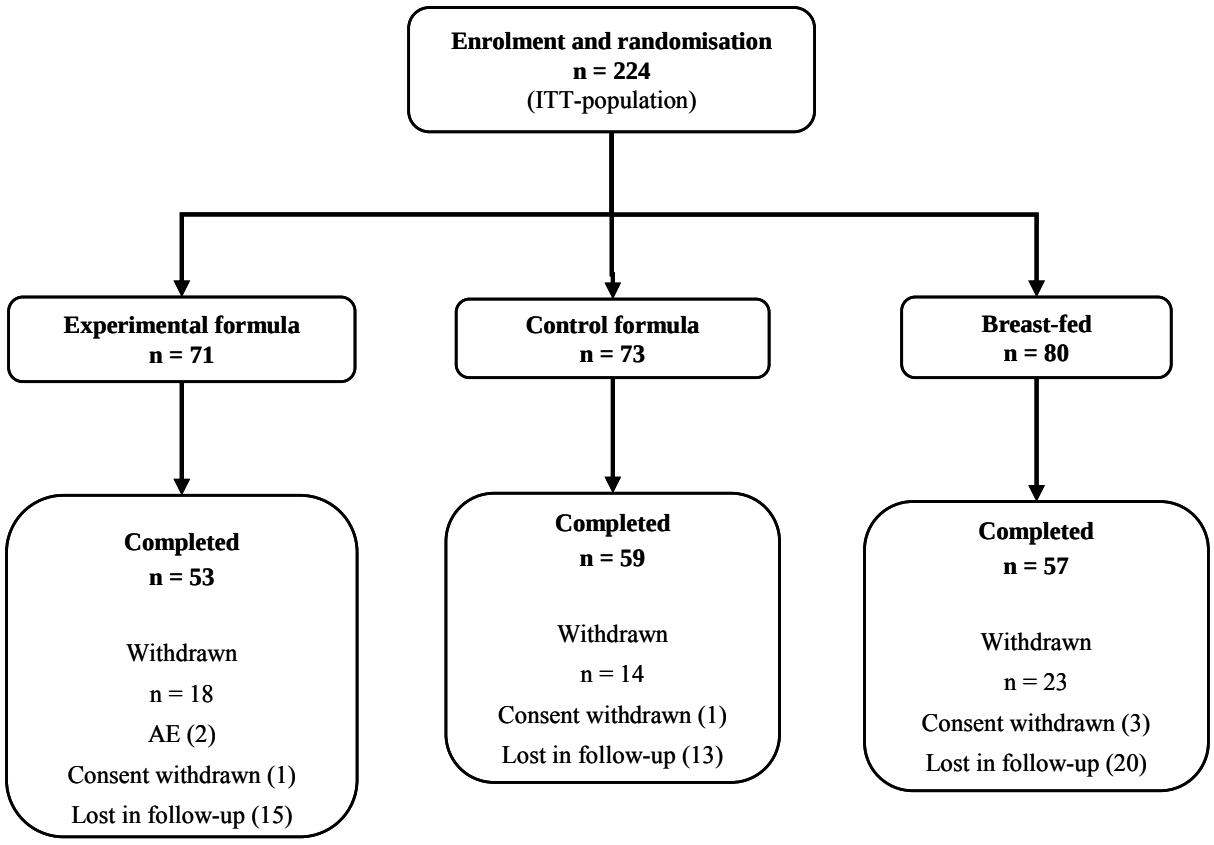

Figure 1. Disposition of recruited patients (ITT = intention-to-treat).

Table 2. Baseline characteristics (mean ± SD) of infants (intention-to-treat group)

	Treatment Groups		
	Experimental	Control	Breastfed
Girls (n)	38	38	35
Age (days)	16.7 ± 5.2	16.0 ± 5.6	16.8 ± 6.0
Weight (kg)	3.4 ± 0.5	3.4 ± 0.5	3.5 ± 0.3
Height (cm)	51.4 ± 2.0	51.1 ± 2.6	51.9 ± 2.1
Head circumference (cm)	35.0 ± 1.5	34.9 ± 1.1	35.0 ± 1.1
Boys (n)	33	35	45
Age (days)	15.6±4.7	16.5 ± 4.4	16.4 ± 5.5
Weight (kg)	3.4 ± 0.5	3.5 ± 0.5	3.5 ± 0.4
Height (cm)	51.8 ± 2.0	51.4 ±1.9	51.3 ±3.7
Head circumference (cm)	35.3 ± 1.3	35.3 ± 1.0	35.5 ±1.0

n = number of infants

Stool characteristics

The diary recordings of stool characteristics revealed that there was a statistically significant difference between the experimental and control groups with regard to stool consistancy with less hard stools ($p<0.001$) and more soft stools ($p<0.05$) being produced for the experimental group (Table 4). Stool frequency was marginally higher (0.8 vs 0.7 count/day) in the experimental group compared to the control group, but the difference was not statistically significant ($p=0.28$). Stool colour and odour were not significantly different between the two formula groups.

Anthropometric measurements

Body weight throughout the study was generally within acceptable limits for all groups compared with WHO growth standards. The mean body weights were similar for the three groups throughout the study. Growth in terms of weight gain during the study for the experimental group met the non-inferiority criteria compared with the control group. The mean body weights of the infants at each month of the study are shown (separately for gender) in Figure 2.

No statistically significant differences were detected

Table 3. Gastric emptying time (minutes) measured by 2-D ultrasound in infants at 2 months – data shown for the intention-to-treat group.

	Treatment Groups		
	Experimental	Control	Breastfed
Number of infants	53	62	67
Mean	59.6	61.4	55.9
Standard deviation	21.4	18.9	18.0
Standard error of the mean	2.9	2.4	2.2
Median	50.0	60.0	60.0
Minimum value	30.0	20.0	20.0
Maximum value	140	130	130
Lower quartile	50.0	50.0	40.0
Upper quartile	70.0	70.0	60.0

Table 4. Mean stool consistency over the course of the study – intention-to-treat population†

	Treatment Groups								
	Control formula			Experimental formula			Breast-fed		
Stool Consistency	n	mean (%)	SD	n	mean (%)	SD	n	mean (%)	SD
Hard	69	7.5*	13.6	67	0.7*	3.9	75	0.6	3.1
Soft	69	82.3**	20.8	67	90.8**	18.8	75	73.1	33.9
Runny	69	10.2	18.0	67	8.5	18.5	75	26.3	33.8

* $p < 0.001$; ** $p = 0.0112$, n = number of infants, SD = standard deviation

†The data here has been re-classified since certain categories for stool consistency registered few entries. This re-classification was as follows; Hard = Small hard + Hard lumpy +Hard cracked and Soft = Sausage like + Soft + Loose, and did not alter interpretation of the results.

Table 5. Mean and median bacterial count and mean percentage of total bacterial count at 2 months†

		Treatment groups		
		Experimental	Control	Breast-fed
Bifidobacteria	n	17	16	20
	mean (SD)	9.75 (1.0)	9.14 (1.2)	9.73 (1.1)
	median	10.14	9.56	10.0
	mean % (SD) of total	78.1 (44.7)	63.7 (42.3)	74.3 (38.1)
Lactobacilli	n	8	15	7
	mean (SD	8.06 (0.6)	7.79 (0.8)	7.91 (0.8)
	median	8.11	7.91	7.95
	mean % (SD) of total	3.6 (7.7)	3.2 (8.1)	1 (1.3)
Enterobacteriacae	n	20	20	18
	mean (SD)	8.28 (0.6)	8.63 (0.6)	8.07 (0.9)
	median	8.49	8.71	7.99
	mean % (SD) of total	6.9 (18.4)	15.2 (21.9)	5.5 (12.1)
Clostridia	n	14	12	10
	mean (SD)	7.59 (1.1)	8.26 (1.2)	8.22 (1.1)
	median	7.23	8.54	8.00
	mean % (SD) of total	3.1 (6.7)	9.4 (11.7)	5.6 (8.4)
Bacteroides	n	9	3	7
	mean (SD)	8.06 (0.7)	7.78 (0.5)	7.85 (1.4)
	median	8.3	7.65	8.0
	mean % (SD) of total	1.9 (2.9)	1.3 (1.3)	3.5 (6.9)

n =number of infants, standard deviation = SD

†bacterial count = log colony-forming units/g as determined by fluorescence in-situ hybridisation

between the experimental and control groups for body length and head circumference.

Stool microbiota

Total bacterial count was similar in all groups. Bifidobacteria, the most predominant species identified in all groups, were found in higher percentages in the experimental (78.1%) and breast-fed (74.3%) groups compared with the control group (63.7%). Despite the low level of samples analysed, the stool microbiota of the experimental group appeared to resemble that of the breast-fed infants better, (with higher Bifidobacteria and lower Clostridia and Enterobacteriacae counts) (Table 5) than did the microbiota of the control group.

Adverse events

Two hundred and twenty-eight AEs were reported in 123 infants. AEs occurred in 49%, 56%, and 59% of infants in the experimental, control and breast-fed groups, respectively. The most frequently occurring AEs were upper respiratory tract infections. GI problems (diarrhoea, vomiting, and constipation) were reported in infants at a rate of 11% in the experimental formula group, 15% in the control formula group, and 9% in the breast-fed group. There were no significant differences in occurrence of the different AEs between groups.

Three AEs were identified as serious by the investigator (one in each treatment group).

DISCUSSION

We hypothesised that an experimental formula containing whey as the main source of protein and oligosaccharides would improve gastrointestinal comfort since these ingredients have been previously implicated as promoting good gastrointestinal health.[11-13,15-17] The current study provided evidence that the GI comfort of infants fed the experimental whey-predominant prebiotic containing formula was superior to that of infants fed the standard casein-predominant control formula. Infants in the experimental group had significantly less hard and more, soft stools than the control group. Although not reaching statistical significance, the experimental group also tended to have a slightly faster mean GE time (1.75 min; p=0.88) and higher stool frequency (p=0.28) than the control group. Also, the experimental group appeared to have higher *Bifidobacteria* and lower *Clostridia* and *Enterobacteriacae* than the control group and was closer to the breastfeeding group. Taken together, the results obtained with the whey-predominant FOS/GOS-containing formula support the view of improved gut comfort in terms of stool consistency, GE time, GI symptoms and stool microbiota compared with a standard casein-predominant control formula without prebiotics.

Oligosaccharides have a bulking effect in the colon, increasing colonic motility and reducing intestinal transit.[15] Also, previous studies have shown that infants fed a whey hydrolysate formula have higher GE compared with those who had been fed a casein-predominant formula.[11-13]

An explanation for the absence of any statistically significant difference between the formula groups in GE time, and for some of the other measures of GI comfort, may be that the number of infants enrolled was not sufficient to detect differences. Specifically, in the current study, sample size calculation was based on a previous study that compared the GE rate in healthy subjects with that of diabetic subjects.[20] Because up to 50% of diabetic patients have been reported to suffer from gastroparesis, the number of subjects required to observe a treatment effect between these two populations may be smaller than comparison of two healthy populations.[21] Our study compared the effect of different formulas in healthy infants, in whom an effect may not be readily detectable. Indeed, in contrast to previous studies that had shown that breast-fed infants have faster GE than formula-fed infants, we did not observe statistically significant differences in GE between the formula-fed infants and the breast-fed infants.[7] Nevertheless, our results indicated a tendency for the experimental formula, as compared to the control formula, to increase gastric and intestinal transit and showed that the experimental formula was safe and well-tolerated.

The lower boundary of the 90% CI for difference in mean weight gain in the two formula groups was higher than -3.0 g/day indicating that the experimental formula is not inferior to the control formula based on the predefined criteria of non-inferiority. Thus, it was established that the feed formulas did not effect normal growth. A study with a larger number of infants is probably required to establish whether GE in infants is significantly affected by the experimental formula used in this study. The results presented here indicate, however, the safety of the whey-predominant prebiotic-containing formula. It also showed improved gut comfort in terms of stool consistency, GE time and GI symptoms; in addition, the microbiota composition of infants fed the experimental formula appeared to resemble that of the breast-fed formula. Additional studies with whey predominant and prebiotic-containing formulas will be required to further support these findings.

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Original Article

Effect of a whey-predominant starter formula containing LCPUFAs and oligosaccharides (FOS/GOS) on gastrointestinal comfort in infants

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乳清蛋白為主並含長鏈不飽和脂酸及寡糖的新生兒配方奶對嬰兒腸胃道的舒適性

開發新的嬰兒配方奶粉的重要目標是複製母乳的好處。母乳優於配方奶的益處之一，是腸胃道的舒適性。比較兩種配方奶粉對腸胃道的影響：一種以乳清蛋白為主，並含長鏈不飽和脂酸、半乳糖寡糖和果寡糖；對照配方奶粉是以酪蛋白為主，不添加上述成分。此為單一研究中心、前瞻性、雙盲的控制性試驗，將健康、足月的 144 位嬰兒隨機分派到實驗組或對照組，實驗時間從出生 30 天到 4 個月齡。另以哺餵母乳的嬰兒共 80 位當參考組。在第 1、2、3 和 4 個月測量嬰兒的生長參數以及評估健康狀況。父母親負責記錄嬰兒生理狀況，包括糞便的頻率和特色，溢奶、嘔吐、哭鬧和腹絞痛的頻率。在第 2 個月時，以超音波測量胃排空以及用氫呼氣試驗測量腸道轉運時間，並收集糞便作微生物分析。與對照組相比，實驗組中祇有少數嬰兒有硬便(0.7 比 7.5%，$p<0.001$)，軟便情形較多(90.8 比 82.3%，$p<0.05$)。三組的糞便微生物組成(雙歧桿菌比例)分別如下：實驗組為 78.1%、對照組為 63.7%、母乳組為 74.3%。三組胃排空時間：實驗組為 59.6 分鐘、對照組為 61.4 分鐘、母乳組 55.9 分鐘。實驗組和對照組的腸道轉運時間與哺餵母乳組相近。各組的生長參數值類似。上述數據顯示，比較對照配方奶，以乳清蛋白為主且含益生菌的配方奶提供嬰兒較佳的腸胃舒適性。

關鍵字：胃排空、嬰兒配方奶、乳清蛋白、益生菌、腸胃道舒適性