Breast milk research to optimise infant nutrition:

fine-tuning of the protein mix

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Breast milk is the ideal food for babies. However, due to various factors, not every baby can have the mother's breast milk. In most countries around the world, the breastfeeding rate in newborns of 0-6 months is far below the recommendation from the World Health Organization.

In China, the rate of six months exclusive breastfeeding is only 20.8% (data released during promotion of breastfeeding forum on July 31, 2017 organized by UNICEF). In order to ensure the healthy growth of non-breastfed children, research on breast milk components and the development of infant formula has become a major issue.

Breast milk is one of the “gold standards” for the development of infant formula.
Milestones of Yili’s research on Chinese breast milk

- **2003**: Initiated preparation for an independent research project on Chinese breast milk.
- **2004**: Launched an independent research project on Chinese breast milk.
- **2007**: Established the first Chinese breast milk research database.
- **2009**: The Yili Maternal and Infant Nutrition Research Center was established; White Paper on Chinese Breast Milk Research was published.
- **2010**: Established corporate breast milk bank for breast milk research.
- **2012**: “Infant formula containing α-lactalbumin and β-casein and its preparation method” won the invention patent certificate issued by the State Intellectual Property Office.
- **2014**: Led the “12th Five-Year” National Science and Technology Pillar Project “Study on Chinese breast milk composition, applications, product safety control and commercialization”.
- **2015**: Signed collaboration agreements with Wageningen University and the University of California, Davis, on Chinese breast milk research.
- **2017**: Published a review of nutritional composition differences between Chinese and foreign breast milk, awarded with the Outstanding Contribution to Chinese and Foreign Breast Milk Research and Caring for China’s Maternal and Infant Health Social Responsibility Award.
- **2018**: Yili Maternal and Infant Nutrition Institute. Yili is launching new breast milk research projects, and has formed Yili’s own breast milk research database with independent intellectual property rights.
Proteins in human and cow’s milk

**α-lactalbumin** is the main protein found in human milk. It consists of a single-chain polypeptide containing 123 amino acids and is a compact calcium-binding globulin.

**β-casein** is the main component of human casein. It is a phosphorylated protein that exists in micellar form. This protein has a looser assembly and little tertiary structure.

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Hennet et al. Swiss Med Wkly. 2014 Feb 19;144:w13927

Source: FSA, 2002
Nutritional and physiological effects of α-lactalbumin and β-casein

- Rich in essential amino acids, especially cysteine and tryptophan
- Promote the absorption of trace minerals (iron, zinc)
- Immunomodulatory effect
- Prebiotic effect
- Antimicrobial effect (antibacterial)

α-lactalbumin

- Opioid effect
- Promote calcium absorption

β-casein

朱凌燕等 α-乳白蛋白对婴儿生长发育的影响的研究现况，中国生育健康杂志，2015，(26) 193-195
α-lactalbumin and β-casein – digestibility and allergenic aspects

◆ α-Lactalbumin is more easily digested than a whey protein concentrate (shown in rats by Pantako et al.); digestibility of bovine and breast milk α-lactalbumin is comparable due to their similar amino acid composition.

◆ β-casein is more easily digested than α-casein (in vitro study by Kerry Ingredients); α-casein is absent in human milk and addition of bovine β-casein can improve digestibility of infant formula (patent of Bindels et al., 2005).

◆ Since α-lactalbumin and β-casein are not the major allergens in milk, appropriately increasing the ratio of α-lactalbumin and β-casein in infant formula can alleviate the infant’s allergy to milk protein to some extent:
  • Studies have shown that β-lactoglobulin and lactoferrin are the major allergens in whey proteins, while α-lactalbumin plays a minor role in it (Natale et al., Monaci et al., and Sharma et al.)
  • In casein, α-casein is the most important allergen in casein, followed by κ-casein (Natale et al., Monaci et al.)

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Source: Handbook of Milk Composition, Jensen (ed.), 1995


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Similarity between human and bovine α-lactalbumin and β-casein

◆ Bovine α-lactalbumin is structurally and functionally similar to human α-lactalbumin, and thus, can be added to infant formula to resemble breast milk α-lactalbumin.

- 72% of the amino acid composition is the same (red), 6% is similar (grey)
- Also, the hydrolysis and digestion pathways of bovine and breast milk α-lactalbumin are similar (Chatterton et al.).

◆ Bovine and breast milk β-casein also have some homology in the amino acid composition (Greenberg et al.)
  - 47% of the amino acid sequences are identical
  - Most of the differences represent single base changes
  - 60% of the prolyl residues are located at the same position showing conservation of maximum digestibility
  - Charge and hydrophobic group distribution of the two are also substantially the same

Figure: Similarity between amino acid composition of bovine (upper) and breast milk α-lactalbumin (lower)
Source: "Advanced Dairy Chemistry - milk protein" (2003); UCC, FOX.

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"Infant formula containing α-lactalbumin and β-casein and its preparation method" was awarded the 16th "Chinese Excellent Patent".

Based on the results of breast milk research, Pro-Kido infant formula was developed, supplemented with α-lactalbumin and β-casein as patented. The content of α-lactalbumin and β-casein in Pro-Kido are comparable to breast milk levels:

- **α-lactalbumin** 0.23 g/100 ml
- **β-casein** 0.3 g/100 ml
Clinical trial verification

Basic info:
- Yili in collaboration with Sun Yat-sen University
- Experimental sample: JINLINGGUAN infant formula (PRO-KIDO™ I-PROTECH®, Phase I)
- Registration number: NCT03178474 (ClinicalTrials.gov)

Methods:
1. A quasi-randomized, open labeled, controlled trial.
2. Participants: 124 healthy full-term newborns with ages of 5-14 days at the enrollment (formula group 63, breast milk group 61); formula-feeding and breastfeeding were at least for three months
3. Intervention Duration: 12 weeks. Visits: 1 week (baseline), age of 7 and 13 weeks
4. Measuring length, weight and head circumference, stool characteristics, behavior, gut microbiota

Results: At age of 7 and 13 weeks, PRO-KIDO formula was comparable to the control group in terms of physical growth (weight, length, head circumference), feeding volume and behavior (crying, pleasure) of infants

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Yili established the first breast milk database in China, based on Yili’s breast milk research. Yili has collected > 6,000 breast milk samples and obtained > 1 million breast milk research data. The database covers global breast milk research, maternal and infant nutrition, infant formula, etc., with over 2,000 literatures and 20,000 products from 49 countries of the world.

Yili fine-tuned the protein mix of infant formula bringing it closer to breast milk by supplementation with α-lactalbumin and β-casein.

Yili’s patent “infant formula containing α-lactalbumin and β-casein and its preparation method” has got the invention patent certificate issued by the State Intellectual Property Office on November 21st, 2012, and was awarded the "Chinese Excellent Patent” in 2014.

Yili builds on solid scientific foundation to continuously optimize Yili infant formula based on breast milk composition.
THANK YOU

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