Design of Multifunctional Milk Powder Spoon Based on Environment-friendly and Developmental Concept

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Abstract Recycling of junks is positive for the environmental protection. Along with the proposal of three-child policy, purchase volume of milk powder surely will experience a drastic growth, and the milk powder spoon as an affiliated product will win the attention of parents. Against the background of consumption upgrading, consumers have had higher requirements on the humanization and safety design of products. Most of milk powder spoons on the market are plastic, and the disposal of waste milk powder spoon has gradually become a burden for the environment. Based on the environment-friendly and developmental concept, and also the characteristics of infant development, this paper proposed the "in-one" design, applied color and tactile designs into the milk powder design, chose food grade silicone to make the milk powder spoon not only a spoon but also a baby teether toy, so as to expand the service life and functions of the product, meet the requirements of saving energy, protecting environment and developing circular economy, which also to some extent reduces the burden on environment brought by plastics, improves the efficiency of junk recycling, and meet the individualized needs of consumers.

Keywords Milk powder spoon, Innovative design, Infant development characteristics, Environment-friendly, Developmental

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Most of milk powder spoons on the market are made of plastics and sold as an accessory of the canned or bagged milk powder. Considering the population in China, the government has released policies to promote population growth, such as three-child policy, which to some extent would contribute to the growth of milk powder sales for a long time in the future. As a result, the abandoned plastic milk powder spoons will also increase, these synthetic materials degrade extremely slowly in the natural world and will destroy soil quality and contaminate the environment badly. In view of this, the authors put forward a kind of multifunctional milk powder spoon design made of food-grade silica gel, the spoon is not only safe and soft, but also designed with both functions of a spoon and a silicone teether, moreover, it is easy to sterilize, not easy to damage. In addition to these basic functions, the spoon can also be placed into a specially-made fruit-shaped tumbler bottle to realize its tertiary utilization for the early education of infants. In conclusion, this milk powder spoon is designed on the basis of environment-friendly and developmental concept, which on the one hand can meet higher requirements of consumers to guarantee physical and mental health of the younger generation, build an infant product and early education toy for infants in China, on the other hand is a more humanized design to promote the sales volume of milk powder, make the milk powder more competitive, and ensure the vitality of milk powder market. Moreover, the design will greatly reduce the volume of plastic waste and the burden on environment, it is green and pollution-free, and contributes to the environment protection cause in China.

1 Background for the design of multi-functional milk powder spoon

Most infant milk powder on the market is mostly canned, and the spoon is often a free gift for the canned milk powder. According to the *2022 Statistical Bulletin of National Economic and Social Development* released by National Bureau of Statistics, the newly-born population in 2022 was 9.56 million in China, the birth rate was 6.77% with a gradual decline year by year, and the effect of "three-child" policy has not been fully seen; on the contrary, per capita disposable income of Chinese people has grown by 2.9% from the last year, keeping basically in synchronous with the economic growth[1], and therewith the consumption concept has also upgraded, the infant product market has constantly evolved and grown more diversified and refined. For the present consumers, the milk powder spoon is mainly considered as an accessory of the milk powder, but not an independent product. Zhang Yanyan[2] proposed that the promotion and innovation of milk powder spoon could also promote the sales of milk powder and expand the user market. Therefore, it is imperative to innovate the image of milk powder spoon and improve its quality.

1.1 Pain point analysis

Milk powder spoon can be made of many materials, most of them on the market are made of food-grade PP composites, another 2 common materials are ordinary plastics and 304 food-grade stainless steel. The advantages of food-grade PP composites and 304 stainless steel are safe, healthy and clean, because they are suitable for high temperature sterilization. But food-grade PP composites are easy to aging and rupturing, and the stainless steel costs higher and is hard and heavier. Common plastic milk powder spoon is easy to carry, and costs less, but is not suitable for high temperature sterilization and not friendly to environment. Silica gel materials is poisonless and harmless, resistant to high temperature and mold, and soft and suitable for baby biting. Along with the implementation of the ban on free plastic bags, silica gel milk powder spoon surely will have better market prospects.

1.2 Consumer demand analysis

The users of milk powder are infants

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and the consuming subjects are their parents. With the development of the times, modern consumers have had higher requirements on the quality of products, and also on the function and humanized design of products[3]. According to *Market Insight Report of China's Baby and Maternal Nutrition Products in 2023* issued by Shanghai IIMedia Research Marketing Consultation Corporation Limited, the main consumer group on the maternal and infant market is the generation after 90s and 95s, they prefer safe, healthy and developmental infant products, thus the market scale of maternal and infant nutrition will gradually expand along with the transition and promotion of the household consumption ability and willingness despite the decline of the birth rate[4], as Fig.1 shows. New generation parents concern more about the health and mentality of children, they are willing to purchase safe and toxic-free products with developmental functions, and they hope that these products can help train children's basic abilities, such as vision and finger movement, and at the same time are easy to clean but resistant to damage. However, the fact is that most young parents consider the milk powder spoon only as a tool for taking milk, so it is natural to use the plastic milk powder spoon gifted by the milk powder, but they never think about the pollution caused by the plastic spoons. Meanwhile, there is no multi-functional milk powder spoon on the market, and consumers fail to realize their potential early education and developmental functions, so they pay less attention to its quality and raw materials.

1.3 Development analysis of environmental protection industry

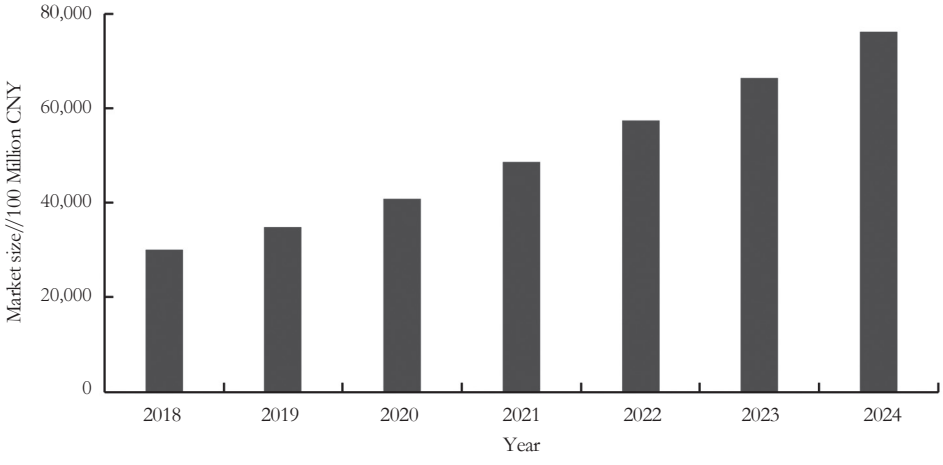
As the tremendous damage of human environment brought by the economic development, many countries have released green environment policies, and devoted greatly into the industries based on green technologies to seek for the coordinated development of environment protection and economy, which generated and promoted the development of environment protection industry. Among these products, molds in daily life and baby tableware are important for human health, and taken highly by the country. Since January 1, 2001, China banned the usage of disposable foamed plastic boxes, thus the invention and experiment of various environment-friendly tableware has won increasing attention, for example, the usable tableware made of mainly starch, and environment-friendly design of food packaging. Food-grade silica gel will play an important role on the environment protection industry.

Most food-grade silica gel is used in baby nipples of feeding bottles, and baking tableware as a food contact substance. The previous researches focused on the verification of its safety and the reduction of its volatile substances, but not the innovative application of the materials. Therefore, during the promotion of environmental protection industry, more efforts can be devoted to the expansion of its application, the combination of its environment-friendly and safe function with other fields, bring new vitality to the market, and get ready for the further coordinated development with the economy.

2 Design of multi-functional milk powder spoon

2.1 Raw materials

The multi-functional milk powder spoon is made of silica gel, its heat resistance, sanitation, softness, and anti-sticking surface make it suitable for being used as infant products[5]. The silica gel milk powder spoon can solve the problems of current plastic spoons, such as not easy to clean, easy to germinate bacteria, short life span, easy to stick to hands or powder, thus silica gel is now considered as an optimal choice for making multi-functional milk powder spoons. Moreover, thermochromic materials are added into the design, the blocking unit is made with the materials that change color at or above 25 °C. The color of blocking unit can help confirm that if it is suitable to use after being sterilized in boiled water, to avoid milk powder caking.



Note: The data is sourced from IIMedia Research

Fig.1 Scale and forecast of maternal and infant industry market in 2018–2024

2.2 Appearance

The product is made of 3 parts, spoon, blocking unit and fruit-shaped tumbler shell. The spoon part consists of spoon head, temperature measuring section, block unit slot, and spoon handle teether as Fig.2 shows. After finishing its function as the spoon, the blocking unit can be placed into the slot (the finished product resembles nipple in both appearance and function), to realize the transformation from milk powder spoon to teether.

Thermochromic materials are added into the blocking unit (Fig.3), to ensure that the temperature drops into suitable point after being sterilized, so as to avoid milk powder caking and not to destroy the nutrition of milk powder because of the high environment temperature. Meanwhile, it prevents babies from suffocating when biting and hurting their throats.

The outer shell of the set is designed as fruit-shaped tumbler toys, the ripple-patterned appearance is different from the smooth surface of the blocking unit, which can increase the tactile experience of infants, help them to know the differences between roughness and smoothness through touching.

2.3 Functional development of the multi-functional milk powder spoon

2.3.1 Visual stimulation. Infants' cerebral cortex development is not mature, touching the outer world through the sensory organs can stimulate the development of cerebral cortex, and enhance their abilities. First, this product design considers the visual development of 0 to 12-month-old babies: 80% of the information captured by their brains are from vision. Visual development is a dynamic process, infant stage is an important stage for their eyeball and visual development. Therefore, high-efficiency visual stimulation can accelerate the brain development, deepen the cerebral gyrus, and further develop the brain potentials.

Previous researches show that 0 to 4-month old infants are in the black and white visual

development stage. During this period, babies can only see black and white, and only things within 20–30 cm. Colorful things are useless for the new babies, on the contrary, patterns with strong comparison between black and white, and concise outlines are more effective in stimulating their vision and brain development. Around 4 months, infants become more sensitive to colors and shapes, show preferences for red because of its higher brightness in the spectrum. About 7 months, infants begin to know some colors with higher saturation, researchers suggest to give them colorful toys to improve their abilities of knowing and identifying colors.

Considering these characteristics, colors are skillfully applied on the outer appearance of the milk powder spoon, which to some extent helps develop the eyeball development of children.

3.3.2 Satisfaction of oral phase. For the baby teething, the design combines the function of milk powder spoon and teether, helps the healthy physical and mental development of infants, and also improves the use efficiency of the spoon and increases its service life.

From the perspective of psychological development, Sigmund Freud proposed that babies at the age of 0 to 12 months old are in the oral phase, 90% of the normal babies explore the world through their mouths, and it is also a kind of early activity of exploring and learning.

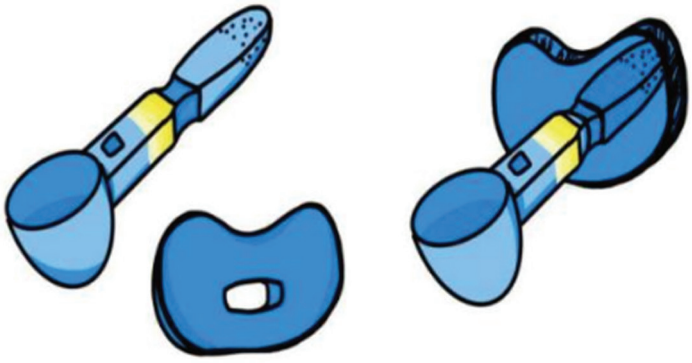


Fig.2 Subassembly and assembly images of the milk powder spoon

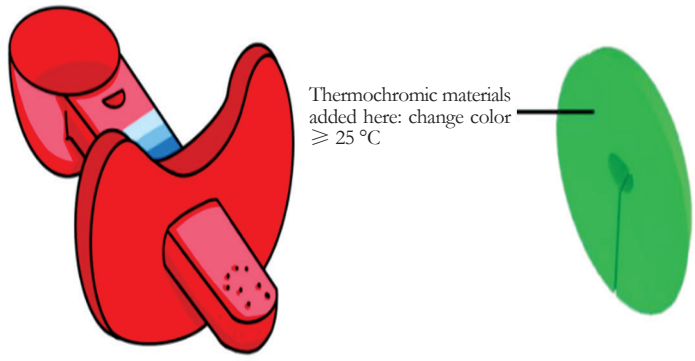


Fig.3 Application of thermochromic materials

Fig.4 Assembly products of tumbler toys

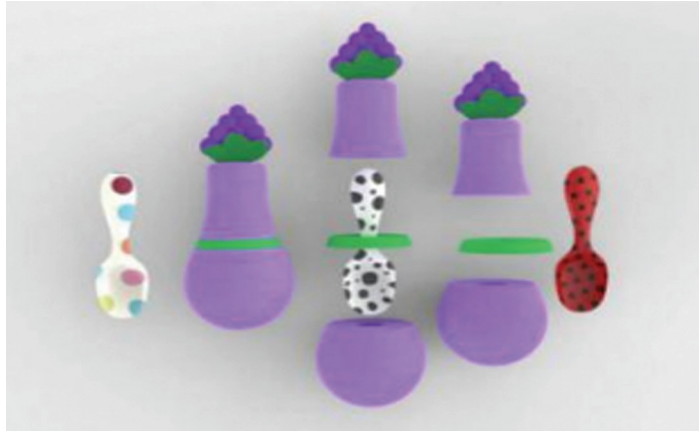


Fig.5 Disassembly of tumbler toys

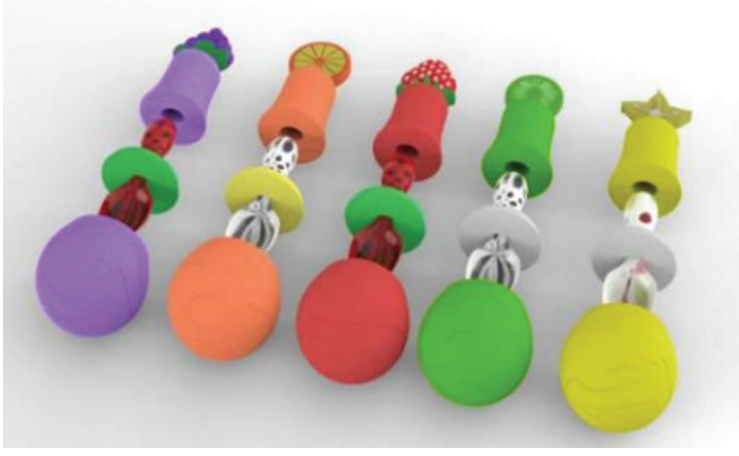


Fig.6 Display of the sets

From the perspective of physical development, baby teething causes gum itching because it stimulates the nerve receptors in the gum, so babies often suck their thumbs involuntarily. But there are numerous bacteria on fingers, babies will easy get sick for "biting" their own fingers, and stopping their sucking is not good for their physical and mental health, thus it is necessary to give them a suitable and safe teether.

During their growth, infants explore the world through their mouths and tongues, and need something to grind during the teething period, the design of teether should be scientific and healthy[6]. In addition to the basic function of taking milk powder, the spoon can be transformed into the teether after adding the blocking unit for babies sucking and biting. The teether part has protruding particles to enrich their experience, the scale of spoon parts is precisely designed as Fig.7 shows, the block unit is broader than babies' mouths to ensure their safety; the length of spoon handle behind the blocking unit is also safe for babies. The spoon can also be sterilized using steam sterilizers or boiled water, and will not deform or produce any toxic substance during the sterilization. Color and shape of the milk powder spoon can better train infants' grasp strength and vision, and guarantee their physical health. The blocking unit can be taken off when used as the spoon. Biting function is one of the spoon functions, after the babies' visual development period, the spoon can be used as the teether, the protruding particles help enrich babies' oral experience.

3.3.3 Tactile experience. After the milk powder spoon finishes its function as the teether, it can be placed into the fruit-shaped tumbler bottle to realize its tertiary utilization. The outer shell of the set is designed as fruit-shaped tumbler toys with ripple patterns, the comparison between smooth and rough surfaces of the toy can increase the tactile experience of infants, help them to learn about the world during touching.

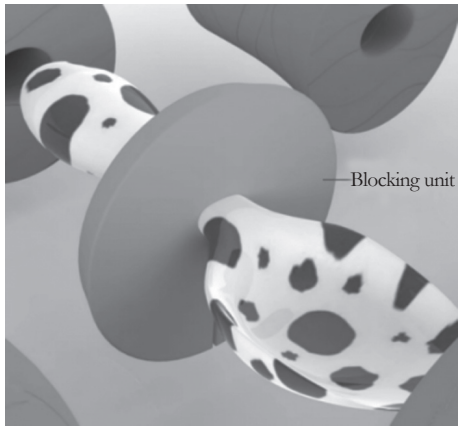


Fig.7 Blocking unit

The shell can also be used as the grasping and holding toy, the silica gel products will not hurt infants' soft skin. Different fruit-shaped shells help produce different visual effects, train the babies' hand-eye coordination and small muscle groups, different lines and shapes of the fruits enrich infants' knowledge experience and improve their spatial cognition.

4 Conclusion

Based on the environment-friendly and developmental concept, and the coordinated development of environment protection industry and market economy, the design added early education functions into the milk powder spoon design after fully investigating infants' visual stimulation, satisfaction of oral phase and demands on tactile experience, put forward the spoon and fruit molds of various forms and colors according to different developmental stages of infants. In addition to attracting baby users' attention, it tries to train their hand-eye coordination, sensitivity to colors, visual concentration and cognitive ability[7]. Moreover, the detachable design of the spoon is easy to transform, and it is also recyclable and can be used after sterilization. As a teether for babies' teething period and an early education toy for improving babies' space perception ability, the design greatly extends the service life of milk powder spoon, which increases the use efficiency of resources, contributes to the environment protection industry and will surely have bright development prospects.

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