# Research on ready-to-use therapeutic food seeks drastic reduction in fatalities from severe acute malnutrition

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MIT graduate student Tonghan Gu (right) works with technicians at a facility in Vasai, India, to produce a batch of ready-to-use therapeutic food in powdered form. The formula he has developed uses local ingredients to make it more appealing to children. Credit: Ben Miller/MIT Tata Center

For chemical engineer Tonghan Gu, a typical day of fieldwork in Mumbai, India, begins not in a lab, but with a visit to Shree Char Bhuja Dairy. The clerks at this small shop in the city's northern suburbs are friendly, if slightly puzzled, as they handle his request for 10 one-liter pouches of milk. The daily transaction takes only a minute or two, but it is part of a project that seeks a lasting impact in the fight against child malnutrition.

Gu, an MIT Tata Fellow and a PhD candidate in the Department of Chemical Engineering, works with ready-to-use therapeutic food (RUTF), a high-calorie, nutrient-dense paste that is the most widely-used outpatient treatment for severe acute malnutrition. While RUTF has seen success in many African countries, it has failed to get the same foothold in India due to issues with palatability, reliability of water supply, and cost.

However, patent-pending research from Gu and T. Alan Hatton, the Ralph Landau Professor in the Department of Chemical Engineering, describes a new RUTF formula that uses local ingredients to increase palatability for Indian children, can be powdered and spray-dried to make transportation and storage easy, and is affordable in the poor communities where severe acute malnutrition is most prevalent.

The new formula is made possible by advances in stabilizing emulsions at the nano-scale. Now, Hatton says, "the goal is to see this approach used throughout India."

## A deadly dilemma

Severe acute malnutrition is a life-threatening condition that occurs when a child's weight-for-height ratio falls below a value set by the World Health Organization, and is characterized by "severe wasting"—a massive loss of body fat and muscle—and sometimes by edema, which

causes swelling in body tissues. It is estimated to affect roughly 20 million children worldwide each year, and 8 million in India alone, with a fatality rate as high as 30 percent.

"It often happens when children are moderately malnourished, and then some external factor, like crop failure or disease, worsens the situation," says Gu. "With good management, the fatality rate could be reduced to less than 5 percent."

Current treatment options are limited to expensive nutrition programs in hospitals, and the existing RUTF formula, created and patented by a French company. This comes in the form of a heavy, viscous paste made primarily from milk powder, peanut butter, oil, and sugar. While the efficacy of this formula is scientifically proven, it has met with several barriers to adoption in India.

"The biggest issue is that Indian children don't like to eat it," Gu explains. "Peanut butter is not part of their diet, so the palatability is quite bad."

It's not as simple as forcing them to choke down a meal they don't enjoy. Children suffering from severe acute malnutrition must complete a six week course of treatment, meaning they will eat more than 100 consecutive meals of RUTF. Reports from Sion Hospital in Mumbai indicate that many children consume only one-third of the required amount. And there is another catch: Due to concerns about contamination and waterborne illness, children are instructed not to drink water while using RUTF. This rule protects the producers and distributors of the food from liability, even as it is impossible to comply with, since the RUTF has a dry and oily consistency.

Additionally, Gu estimates that the cost of existing RUTF—about 30 rupees per meal—is more than twice what many poor families typically

budget for food.

## The milkshake solution

"We are trying to make something more like a milkshake," Gu says. "It's a mix of high-energy components, using local foods like chana dal [chickpeas]. We can even add spices to create different flavors. We've found that children really like the drinkable version."

Hatton and Gu's proposed formula is designed to agree with the local palate, using ingredients and flavors that children are already accustomed to eating, and the ability to further customize with spices means that the RUTF can be adapted to regional tastes within India. Its low-viscosity, milkshake-like consistency makes consumption easier for infants and toddlers.

After a successful pilot scale demonstration in Mumbai using locally sourced foods and the milk from Shree Char Bhuja Dairy, they believe moving to industrial scale is feasible. "From a scientific and engineering perspective, we have resolved the essential problem of stabilizing these oil droplets for long term shelf life," Hatton says. "Now we're moving into the next phase of manufacturing and marketing."

For mass production, they use a machine called a colloid mill to homogenize the ingredients. Then, through a process called spray-drying, the droplets of liquid oils and micronutrients are micro-encapsulated inside solids, resulting in a dry powder. The mixture can be reconstituted on-site with milk or clean water, requiring only 30 seconds of stirring by hand.

"There is not much difficulty in producing the microcapsules, which have been commercialized for other applications. The difficulty is to restrict the choices of solid components—essential for the stability of

the dry powder—to affordable local agricultural products, instead of more expensive artificial additives," says Gu.

Thanks in part to wholesale purchasing of local ingredients, Gu expects the price-per-meal to be significantly lower than the existing RUTF, removing another critical barrier to adoption.

But some obstacles remain, such as gaining government approval, conducting a clinical trial in a hospital, and solving what Gu calls "the water dilemma." Just as with the existing RUTF, it's important for it to be consumed along with clean water—not an easy task in many parts of India where both piped water and groundwater supplies may be contaminated.

"The best-case scenario is if they can reconstitute the RUTF with milk, which is widely available," Gu says. "The cow acts as a kind of filter."

The MIT team is collaborating with researchers at the Indian Institute of Technology in Bombay to finalize the formula and overcome the implementation challenges. Gu has high hopes for filling a critical gap: "I think our formula gives children with severe acute malnutrition a better chance to get the nutrients they need."



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