



# Plumpy'Nut : Synergies between a Pediatrician and Food Scientist

Zoila Chevez & Katie Burton



Photo courtesy of Edesia Nutrition

## Food Science in Action:

- ✓ Nutrition
- ✓ Food engineering
- ✓ Food chemistry
- ✓ Food processing
- ✓ Product development
- ✓ Food packaging

**Plumpy'Nut** is a Ready-to-Use Therapeutic Food (RUTF) developed by French Pediatrician André Briend and French food processing engineer, Michel Lescanne. Plumpy'Nut is a fortified peanut butter-like paste that contains essential nutrients like fats, carbohydrates, proteins, vitamins, and minerals; each sachet contains about 500 kcal. This innovative product does not need to be mixed with water, cooked, or refrigerated; therefore, it is perfect for developing countries where there is limited access to potable water or refrigeration. Over the past years, RUTF has been used in many countries to treat severe malnutrition among young children. RUTF has been widely distributed and recommended among different UN branches like World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF), and the World Food Program (WFP), which recommend its use as part of the standard of care for treating malnourished children in Community-Based Management of Acute Malnutrition (CMAM) programs.

## Introduction

Malnutrition is a major world concern that impacts children the most. As of 2020, almost 150 million children are suffering from stunting (low height for age) and 45.4 million from wasting (low weight for height).<sup>1</sup> Every 10 seconds a child dies from malnutrition.<sup>2</sup> The side effects of malnutrition can be devastating and can lead to lower IQs, premature mortality, and weaker immune systems. It is estimated that malnutrition costs the global economy US\$3.5 trillion.<sup>3</sup> The COVID-19 pandemic has impacted the already existing malnutrition crisis. Worldwide school feeding

programs temporally closed to prevent the spread of the virus forcing a shift towards household feeding, which put additional challenges on families already dealing with reduced income due to work absences.<sup>4</sup> The financial struggles on families led them to opt for unhealthy and cheaper food options.

Before the advent of RUTF, in acute nutrition emergencies the best means of treating malnutrition required children to be taken to therapeutic feeding centers (TFCs) for around the clock treatment with therapeutic milks. French pediatrician Dr. André Briend saw several

instances through history that put him on his journey to revolutionize how severe acute malnutrition (SAM) was treated.<sup>5</sup> Some arresting events include the worst humanitarian crisis since World War II faced by the former Yugoslavia in 1992, leading to thousands of Europeans without food. Additionally, in 1994, mass genocide was happening in Rwanda, leading to millions of Rwandans fleeing to other countries and experiencing lack of nutrition.<sup>6</sup> During these hunger emergencies, there were not enough TFCs to manage all the children that needed aid, nor were the centers close enough to many of the communities they were meant to serve. Dr. Briend goal was to provide a solution to malnutrition that could be administered at home. In 1996 Dr. Briend partnered with food engineer, Michel Lescanne, and met his objective by developing a RUTF (the first of which was known as Plumpy'Nut).<sup>5</sup>

Plumpy'Nut (Figure 1) consists of peanut paste, sugar, vegetable oil, dairy powders, and twenty-three vitamins and minerals. It provides 500 calories, 45g of carbohydrates, 30g of fat, and 13g of protein. Severely malnourished children are treated with 1-3 sachets per day for 6-10 weeks.

## Response

Initially, Plumpy'Nut was only produced by the company Nutriset, which is based in France. They sold Plumpy'Nut to UNICEF who would distribute the product as needed. Given the success of Plumpy'Nut, demand increased dramatically. In

2005, Nutriset set up a franchising plan enabling the local production and distribution of Plumpy'Nut in developing countries. Part of the benefit of a franchise system is that franchisees have access to Nutriset's technical support. It also provides advantages to local communities by contributing to their economy and industrial development as well as cutting the cost of transportation. The first local factory in the Nutriset PlumpyField network was opened in Niger, and since then the network has expanded to nine countries (Ethiopia, Niger, Nigeria, Burkina Faso, Guinea, Sudan, Madagascar, India, and Haiti).<sup>7,8</sup>

There are several considerations that go into the development of RUTF as a product that provides all the nutrients required to promote growth and improve overall health in children with severe acute malnutrition. Some of the critical considerations include high content of nutrients such as calcium, phosphorus, magnesium, and potassium; high energy density ingredients such as fat and sugar; adequate protein content; sensory acceptability; convenience; and easy ways to prepare the product.<sup>8</sup> For developing countries affordability and low risk of contamination is necessary due to the lack of refrigeration and other preservation methods.<sup>7</sup>

During the early development of Plumpy'Nut, peanuts were used as a main ingredient as they were available in many countries where malnutrition programs were located. The product was developed to provide similar nutritional qualities to therapeutic milk, which was the previous standard of care.<sup>7</sup> RUTF, in comparison



Figure 1. Plumpy'Nut RUTF. (Photo courtesy of Edesia Nutrition)

**Box 1. List of abbreviations and terms****CMAM:** Community-based management of acute malnutrition**CTC:** Community-based therapeutic care**F-75 and F-100:** therapeutic milk-based formulas that are used to treat severe malnutrition. F-75 provides 75 kcal and 0.9 g protein/100 mL, whereas F-100 provides 100 kcal and 2.9 g protein/100 mL.**PDCAAS:** Protein digestibility-corrected amino acid score, a food's protein quality**RUTF:** Ready-to-use therapeutic food**SAM:** Severe acute malnutrition**TFC:** Therapeutic feeding center**UN:** United Nations**UNICEF:** United Nations International Children's Emergency Fund**USAID:** United States Agency for International Development**WFP:** World Food Programme**WHO:** World Health Organization

to the therapeutic milk, had greater energy intake due to the high energy density (>5 times), RUTF can be used without the need for water to dissolve it, and it has longer shelf life.<sup>9</sup>

Additionally, Plumpy'Nut is an oil-based product with a low water activity, which doesn't provide an environment for bacteria to breed, and allows for a long shelf-life. The product is energy dense, portable, and a manageable portion size for children suffering from malnutrition. Having an ideal amount of high-quality protein is key. Too much protein could lead to the body producing urea, leading to additional renal solute load, which can be a problem in malnourished children. Too much protein might also have a negative impact on appetite, which is especially harmful in malnourished children undergoing treatment.<sup>7</sup>

There are many key needs for producing Plumpy'Nut and RUTF in general:

1. Properly formulated to meet all nutritional and chemical requirements.
2. Grind all ingredients to a particle size < 200 microns to create an emulsion with sugars and fat and reduce separation of the ingredients.<sup>10,11</sup>
3. Produce the RUTF without the introduction of water in a low moisture facility. RUTFs must have a water activity less than 0.6.<sup>10</sup>

4. Embed the protein and carbohydrate components of the food into the lipid-based matrix.<sup>10</sup> The paste must be ground and homogeneously mixed with the oil properly stabilized to ensure minimal phase separation over the shelf life in conditions up to 30 degrees Celsius.
5. The paste must be packaged with the right barrier properties that allows for a 24-month shelf life. In addition, all the vitamins and minerals included must be properly formulated to meet a 24-month shelf life.
6. Quality testing requirements: water activity, microbiology, viscosity, nutritional, and management of food safety risks

Initially, the packaging was not sealing properly due to Plumpy'Nut's high fat composition or splitting open due to failing glue.<sup>12</sup> However the expertise of food engineer Michel Lescanne was key to finding the perfect package for Plumpy'Nut.<sup>12</sup>

Since the inception of RUTF, formula updates have been considered, such as:

- a. Determining if soy, corn, or chickpea versions are possible, while mitigating antinutritional factors.<sup>13,14</sup>
- b. Testing dairy, peanuts, or alternate vegetable ingredients to meet WFP's specs for minimum amount of protein, PDCAAS, fats, omega-3

and omega-6 ratios, and vitamins and minerals.<sup>13,14</sup>

- c. Continual process to approve new ingredient vendors while ensuring the product is within specification cost improvement, and identifying interchangeable ingredients when there are supply chain issues.<sup>13,14</sup>

Beyond developing and producing RUTF, a program was needed to distribute it to malnourished children. This is where Dr. Steve Collins stepped in, whom Briend described as “the key person to change the approach”<sup>5</sup> One of the goals in developing RUTF was to allow caretakers to feed children at home, instead of taking the children to a TFC. The new approach was called Community-Based Therapeutic Care (CTC).<sup>15</sup> CTC allowed children who were not experiencing any medical complications from malnutrition like diarrhea or anemia to be treated in their own homes.

In 2000, the Ethiopian government banned TFCs as they believed them to be ineffective. So Concern Worldwide and Valid Nutrition set up a pilot program for CTCs, called [Community-Based Management of Acute Malnutrition](#) (CMAM).<sup>5</sup> Concern Worldwide is a global community of humanitarians, community members, supporters, donors, and volunteers who share a common vision of a world where no one lives in poverty, fear, or oppression. A partnership was established between Concern Worldwide and Collins’s humanitarian research organization, Valid Nutrition ([learn more about Valid Nutrition](#)). Volunteers from Concern Worldwide and Valid Nutrition were trained on how to recognize the signs of malnutrition in children and how to take measurements to determine if the child was malnourished. They were also trained on how to administer RUTF in children’s homes. Children were monitored through home visits by these trained health workers. Concern Worldwide and Valid Nutrition set up extra monitoring over the course of 9 months to validate the combination of CTC’s and RUTF was beneficial to children.<sup>5</sup>

## Results

- Research conducted over the past 15 years demonstrates that RUTF has the following benefits:
  - It can rapidly put weight on a sick child<sup>16</sup>
  - It costs less and is more effective than hospitalization<sup>16</sup>
  - With RUTF treatment, more than 81% of children recover<sup>17</sup>
  - After six to eight weeks and about 30 pounds of RUTF, young children are transformed. Their hair grows back and regains its color, they look healthy and energetic, and they are more focused<sup>10</sup>
- Andrew Kamara, Director of Logistics at Edesia, said, “I have seen kids come from skin and bones to happy children that are gaining weight. They’re talking. They’re singing. They’re dancing.”
- CMAM and RUTF proved to be as impactful as hoped by Concern Worldwide and Valid Nutrition. During famine, child mortality rates can reach up to 20 to 30%. With the combined use of CMAM and RUTF, mortality rates were as low as 4.5%. That meant an incredible number of lives saved.<sup>5</sup>
- Concern Worldwide conducted another study in Sudan. There were 25,000 acutely malnourished children in this study. Very similar results were seen with a drastic reduction in mortality rates.<sup>5</sup>
- RUTF products are used in CMAM programs in over 70 countries.<sup>5</sup>
- Manary, et al.(2004) compared children's weight-for-height growth rate when consuming 3 different diets including RUTF with an average weight gain of 5.2 g/kg/day.<sup>18</sup> Teshome et al., reported similar results with weight gain rate of 5.4 g/kg/day and a median recovery time of 36 days.<sup>19</sup>
- More awareness and education are needed for parents and caretakers when using RUTF. The overall goal of RUTF is that children consume 1-3 sachets per day for 6-10 weeks to gain 15-20 g/kg/day.<sup>20</sup>



## Lessons Learned

- Before Plumpy’Nut, therapeutic milks (F-75 and F-100) were used, which consisted of a liquid diet recommended by the WHO.<sup>21</sup> Dr. Briend and his team modified the formulation creating what we now know as Plumpy’Nut. The synergism between a pediatrician and a food scientist made Plumpy’Nut the product that we know today.
- Ready-to-use therapeutic foods (RUTF) provide one of the best solutions to tackle malnutrition among children because they are nutritious and convenient. Plumpy’Nut was the original RUTF developed. RUTFs like Plumpy’Nut can be locally produced in or near the countries where they are needed. RUTF production uses local materials when possible, though some ingredients may be imported.<sup>22</sup> New products can be developed according to ingredient availability; however, those need to meet standards established by the main purchasing agencies such as UNICEF, USAID, and WFP. Standards include: does not contain anti-nutritional factors, heavy metals, or pesticides that may represent a hazard to health<sup>23</sup>
- Local production is not able to keep up with the demand for Plumpy’Nut. Fortunately, in 2007, Navyn Salem was watching a special on a television program called *60 Minutes*.<sup>24</sup> She was inspired to create Edesia and built a partnership with Nutriset. They are a large producer of Plumpy’Nut and have grown to 25,000 MT/ year.
- Edesia’s production facility is in Rhode Island, USA, but they are part of Nutriset’s network which includes producers in 9 countries in the developing world, and they assist with technology transfer so countries can produce their own Plumpy’Nut. The Edesia team also provides R&D support if the countries want to launch their own RUTF based on access to ingredients specific to their country. R&D support comes in the form of finding ingredient suppliers and equipment for production and starting up factories.
- Currently, the main buyers of RUTF are non-profit agencies like UNICEF, USAID, and WFP. When RUTF started, 8 weeks of treatment was around US\$50. Today,

Plumpy’Nut cost has been impacted by the COVID-19 pandemic and the Ukraine war. The cost to produce Plumpy’Nut has dramatically increased as ingredient prices have increased, as well as the cost in transportation. Additionally, some production facilities have limited personnel. In May 2021, prices of Plumpy’Nut increased by 23%, and UNICEF is expecting another 16% increase.<sup>25</sup>

- In 2022, there was a major funding announcement by USAID of an additional US\$250M to go to UNICEF for RUTF. In September, USAID announced an additional US\$280M in matching funds. With these additional half a billion dollars dedicated to RUTF in 2022 and 2023, the world will be able to reach about 50% of children with SAM (instead of the historical 25%). Due to this increase, factories around the world are adding shifts and scaling up their production. Nonprofit organizations are concerned about how to maintain/sustain this higher level of funding to have an impact in the longer term (at least the next 5 years).

## Next Steps

- Plumpy’Nut is mainly targeted for children, but proliferations of products are needed for other vulnerable populations: such as pregnant and lactating women, and people living with HIV/AIDS.
- Other protein sources should be included or investigated as alternatives that could be more locally available and lower cost. In 2017, Valid Nutrition and Ajinomoto developed a milk-free soy-maize-sorghum RUTF fortified with amino acids, and showed that a milk-free RUTF can be successful when properly formulated.<sup>26</sup>
- Briend et. al (2015) remarks that further research is necessary to determine the total dietary intake of children including RUTFs and traditional local foods to better adjust the amount of Plumpy’Nut sachets they consume each day.<sup>21</sup>
- Further assessments are needed to determine the appropriate use of ingredients such as enzymes. In theory, acid-resistant phytase

could be included in water-free RUTF to improve the absorption of iron and other nutrients, but this has never been tested.<sup>21</sup>

- The team from Edesia highly remarks the importance of financial support and advocacy as the two most influential ways where people can get involved. As a company, Edesia is looking forward to doubling its size to reach more children in need. Additionally, they are looking for strategic partnerships with suppliers of key ingredients like milk, vegetable oil, peanuts, vitamins, and minerals.
- Numerous studies have been conducted on the benefits of RUTF, however, the effects on relapse and mortality remain uncertain and more research on this area is needed.<sup>27</sup> More research needs to be done to evaluate the retention of different vitamins and minerals in fortified rice during cooking. Some preliminary research indicates that some vitamin A is lost during cooking depending on the fortification technique (hot and cold extrusion) and the cooking method. In addition, more information is needed to determine the bioavailability of these micronutrients after cooking.<sup>13</sup>

## References

1. World Health Organization. The UNICEF/WHO/WB Joint Child Malnutrition Estimates (JME) group released new data for 2021 [Internet]. The UNICEF/WHO/WB Joint Child Malnutrition Estimates (JME) group released new data for 2021. 2021 [cited 2023 Mar 27]. Available from: <https://www.who.int/news/item/06-05-2021-the-unicef-who-wb-joint-child-malnutrition-estimates-group-released-new-data-for-2021>
2. World Food Program USA. What is Child Malnutrition & Why Are Children Hungry Around the World [Internet]. Photo: WFP/Badre BahajiFAQ: The 6 Things You Need to Know About Childhood Hunger. 2021 [cited 2023 Mar 27]. Available from: <https://www.wfpusa.org/articles/what-you-need-to-know-about-child-malnutrition/>
3. Global Panel. Cost of Malnutrition. Why policy is urgent [Internet]. Global Panel on Agriculture and Food Systems for Nutrition. 2016 [cited 2023 Mar 27]. Available from: <https://www.glopan.org/cost-of-malnutrition/>
4. Arachu Castro. Challenges posed by the COVID-19 pandemic in the health of women, children, and adolescents in Latin America and the Caribbean | United Nations Development Programme [Internet]. UNDP. 2020 [cited 2023 Mar 27]. Available from: <https://www.undp.org/latin-america/publications/challenges-posed-covid-19-pandemic-health-women-children-and-adolescents-latin-america-and-caribbean>
5. Olivia Giovetti. RUTF and CMAM: The story of a humanitarian revolution [Internet]. 2022 [cited 2023 Mar 27]. Available from: <https://www.concernusa.org/story/rutf-cmam-humanitarian-revolution/>
6. World Food Programme. History | World Food Programme [Internet]. [cited 2023 Mar 27]. Available from: <https://www.wfp.org/history>
7. Guimón J. Innovation to fight hunger: The case of Plumpy'nut. 2009 Oct 8 [cited 2023 Mar 27]; Available from: <https://smartech.gatech.edu/handle/1853/36636>
8. Michaël Zumstein, Agence Vu. Local Solutions to Fight Malnutrition [Internet]. 2017 [cited 2023 Mar 27]. Available from: <http://www.plumpyfield.com/file/resources/plaquette-e-ppf-2017-en.pdf>
9. Diop EHI, Dossou NI, Ndour MM, Briend A, Wade S. Comparison of the efficacy of a solid ready-to-use food and a liquid, milk-based diet for the rehabilitation of severely malnourished children: a randomized trial. *The American Journal of Clinical Nutrition*. 2003 Aug 1;78(2):302–7.
10. Manary MJ. Local production and provision of ready-to-use therapeutic food (RUTF) spread for the treatment of severe childhood malnutrition. *Food Nutr Bull*. 2006 Sep;27(3 Suppl):S83-89.
11. Santini A, Novellino E, Armini V, Ritieni A. State of the art of Ready-to-Use Therapeutic Food: A tool for nutraceuticals addition to foodstuff. *Food Chemistry*. 2013 Oct 15;140(4):843–9.
12. Scott-Smith T. Sticky technologies: Plumpy'nut®, emergency feeding and the viscosity of humanitarian design. *Soc Stud Sci*. 2018 Feb 1;48(1):3–24.
13. Awuchi, Chinaza Godswill, Igwe, Victory Somtochukwu, Amagwula, Ikechukwu O. Ready-to-Use Therapeutic Foods (RUTFs) for Remediating Malnutrition and Preventable Nutritional Diseases. *International Journal of Advanced Academic Research*. 2020 Jan;6(1):47–81.
14. Michaelsen KF, Hoppe C, Roos N, Kaestel P, Stougaard M, Lauritzen L, et al. Choice of foods

- and ingredients for moderately malnourished children 6 months to 5 years of age. *Food Nutr Bull.* 2009 Sep;30(3 Suppl):S343-404.
15. Concern Worldwide US. Community Management of Acute Malnutrition [Internet]. Concern Worldwide. [cited 2023 Mar 27]. Available from: <https://www.concernusa.org/project-profile/community-management-of-acute-malnutrition/>
  16. de Pee S, Bloem MW. Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6- to 23-month-old children and for treating moderate malnutrition among 6- to 59-month-old children. *Food Nutr Bull.* 2009 Sep;30(3 Suppl):S434-463.
  17. Budul AB, Farah AM, Nour TY. Treatment Outcome of Severe Acute Malnutrition Among Children (6-59 Months) in Outpatient Therapeutic Feeding Program in Gursum District, Somali Region, Ethiopia. *Science Journal of Public Health.* 2020 Mar 17;8(2):36.
  18. Manary M, Ndkeha M, Ashorn P, Maleta K, Briend A. Home based therapy for severe malnutrition with ready-to-use food. *Arch Dis Child.* 2004 Jun;89(6):557-61.
  19. Teshome G, Bosha T, Gebremedhin S. Time-to-recovery from severe acute malnutrition in children 6-59 months of age enrolled in the outpatient treatment program in Shebedino, Southern Ethiopia: a prospective cohort study. *BMC Pediatrics.* 2019 Jan 28;19(1):33.
  20. Bazzano AN, Potts KS, Bazzano LA, Mason JB. The Life Course Implications of Ready to Use Therapeutic Food for Children in Low-Income Countries. *Int J Environ Res Public Health.* 2017 Apr 11;14(4):403.
  21. Briend A, Akomo P, Bahwere P, De Pee S, Dibari F, Golden MH, et al. Developing food supplements for moderately malnourished children: lessons learned from ready-to-use therapeutic foods. *Food Nutr Bull.* 2015 Mar;36(1 Suppl):S53-58.
  22. World Health Organization, Programme WF, Nutrition UNSSC on, Fund (UNICEF) UNC. Community-based management of severe acute malnutrition : a joint statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund [Internet]. World Health Organization; 2007 [cited 2023 Mar 27]. Available from: <https://apps.who.int/iris/handle/10665/44295>
  23. UNICEF. This 'peanut butter' has changed the world [Internet]. 2021 [cited 2023 Mar 27]. Available from: <https://www.unicef.org.au/stories/peanut-butter-has-changed-the-world>
  24. Global Impact [Internet]. Edesia Nutrition. [cited 2023 Mar 27]. Available from: <https://www.edesianutrition.org/global-foods/>
  25. Miranda Grizio. Cost-Reduced Therapeutic Food Can Feed More Kids [Internet]. 2022 [cited 2023 Mar 27]. Available from: <https://www.ift.org/news-and-publications/food-technology-magazine/issues/2022/december/columns/7-food-security-cost-reduced-therapeutic-feed-more-kids>
  26. Bastmeijer J. Ukraine war pushes up price of emergency food for starving children. *The Guardian* [Internet]. 2022 Aug 18 [cited 2023 Mar 27]; Available from: <https://www.theguardian.com/global-development/2022/aug/18/ukraine-war-pushes-up-price-of-emergency-food-for-starving-children-plumpy-nut>
  27. Schoonees A, Lombard MJ, Musekiwa A, Nel E, Volmink J. Ready-to-use therapeutic food (RUTF) for home-based nutritional rehabilitation of severe acute malnutrition in children from six months to five years of age. *Cochrane Database Syst Rev.* 2019 May 15;5(5):CD009000.