Ryan KN, Adams KP, Vosti SA, Ordiz MI, Cimo ED, Manary MJ. **A comprehensive linear programming tool to optimize formulations of ready-to-use therapeutic foods: an application to Ethiopia.** Amer J Clin Nutr 2014; 100 (6): 1551-1558.

Introduction

In 2007, the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund issued a joint statement supporting the community-based management of uncomplicated severe acute malnutrition (SAM) in children 6-59 months of age (1). These community-based programs use ready-to-use therapeutic foods (RUTF), facilitate access to service, and encourage early care seeking. Evidence suggests increased coverage and recovery rate and low case-fatality rates (2). The joint statement set nutritional specifications for RUTF, and the standard formulation is a self-stable lipid-based product with a high micronutrient content (typically a peanut-based paste, with added oil, milk or whey powder, sugar, a micronutrient premix and an emulsifier). The joint statement encourages the local production of RUTF, when feasible, as part of the resources countries make available for the management of SAM; however, most RUTF are currently produced in more industrialized countries.

This issue of NNA summarizes an article published in the *American Journal of Clinical Nutrition* reporting on the development of a tool designed to identify low-cost ingredient combinations for RUTF formulations that are compliant with international standards and could be produced in Ethiopia using mostly locally available ingredients.

Methods

The researchers first developed a comprehensive list of ingredients acceptable for inclusion in RUTF, based on the database of the Food and Agriculture Organization of the United Nations (FAO), country-specific agricultural reports and food composition databases and communication with in-country collaborators. Information for each ingredient, including nutrient composition, geographic availability, food safety, processing techniques and price, was then added to a database of candidate ingredients. Ingredients that are highly perishable, or have a high moisture content or risk of microbial contamination were excluded.

Linear programming is a mathematical technique that selects an "optimal" combination of items or data (in this case, ingredients) while meeting pre-specified objectives and constraints.

In the present analyses, the pre-specified objective was to minimize the cost of the RUTF, and the constraints included meeting international nutrient composition recommendations and food quality requirements, using a targeted amount of locally available ingredients, and using minimum or maximum amounts of specific ingredients. The researchers selected 32 RUTF formulations to prepare in the laboratory based on qualitative considerations (feasibility of production, predicted sensory properties, etc.); based on organoleptic screening (acceptable taste, texture, and viscosity), 4 were further chosen for a pilot-level scale-up. The prepared formulations were analyzed for water activity, pH, macronutrient content (protein, lipid, carbohydrate) and total energy; and the analyzed values were compared to the value projected by the linear programming tool.

Results and Conclusions:

Sixty-one food ingredients met the selection criteria and were included in the Ethiopia nutrient database; 30 of these ingredients were locally available. The authors ran the linear programming model 125 times to test various combinations of ingredients, nutrients and quality constraints (e.g. macronutrient composition, fraction of formulation sourced from locally available ingredients). The four RUTF formulations chosen for further evaluation were based on a variety of ingredient combinations: 1) fish/pumpkin seed; 2) peanut/pea/pumpkin seed; 3) oat/peanut; and 4) millet. In addition, all formulations contained oil (palm, canola and/or soybean), sugar, cereal grain (maize, millet, oats, teff) and whey protein concentrate. The costs of the four novel formulations ranged from $ 0.104 – 0.125 USD per 96 g, as compared to $0.21 USD with the current RUTF formulation (based on ingredient prices for local production). The macronutrient content (protein, lipid and carbohydrate) measured by laboratory analyses differed by <±10% from the values calculated using the linear programming tool for most of the formulations. Total energy as measured in the laboratory was consistently greater than that predicted by the linear programming tool; however, laboratory methods used to measure energy may take into account energy which is not bioavailable.

The authors concluded that the linear programming tool was a functional and reliable way to create new RUTF formulations that meet international specifications and could be produced with mostly local ingredients. After further testing, the linear programming tool will be made available for public use, free of charge. The intended user will be individuals or organizations with food, food technology and nutrition experience, and a basic understanding of RUTF and spreadsheet-based optimization programs, such as linear programming.

Program and Policy Implications:

The present study reported on a comprehensive linear programming tool to optimize lower-cost formulations of RUTF using mostly local ingredients in Ethiopia. When this tool is made publicly available, it could be used by national and international organizations, local governments and food industries to formulate novel, lower-cost RUTF that utilize local ingredients and are technically feasible for local industry to manufacture. This tool could increase availability of and innovation in the local production of RUTF and potentially increase the number of children with SAM who receive community-based treatment.

NNA Editor's Comments*:

Ryan *et al*. showed that linear programming can be used to develop a variety of lower-cost RUTF formulations for local production. Extensive efforts were made to complete the database with a large number of candidate ingredients and related food composition data, and to identify purchase prices, and costs of transportation and processing of ingredients. Once the tool is made publically available, it can be adjusted to particular foods available in a specific region to help develop locally adapted RUTF formulations. Other context-specific information included in the tool (in particular, local prices) would also need to be collected and entered to apply the tool to other countries or regions. However, as the authors point out correctly, any new RUTF formulation may need a custom-design micronutrient premix and will need to be tested for stability, acceptability and effectiveness before it is used in the treatment of children with SAM.

*These comments have been added by the editorial team and are not part of the cited publication.

References:

1. WHO. Community-based management of severe acute malnutrition. Geneva (Switzerland): World Health Organization/World Food Programme/United Nations System Standing Committee on Nutrition/United Nations Children's Fund; 2007.
2. Collins S, Dent N, Binns P, Bahwere P, Sadler K, Hallam A. Management of severe acute malnutrition in children. Lancet 2006; 368(9551): 1992-2000. doi: 10.1016/S0140-6736(06)69443-9.

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