Peanuts in Life-Sustaining and Life-Sparing Foods

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RESEARCH SPONSORED at UGA and in Ghana, Uganda and Mali

by

USAID Peanut CRSP

Georgia Peanut Commission

USAID Peanut and Mycotoxin Innovation Laboratory

Justification for a new RUTF

The world's populations most vulnerable to malnutrition are:

1. Infants and especially weanling children.
2. Pregnant women and women of childbearing age.

Malnutrition and Pregnancy

- Undernourished girls not treated for malnutrition often grow up to be mothers
  - more likely to give birth to low birth weight babies
- Babies at greater risk of:
  - higher mortality
  - impaired mental development and are more likely to become…
- Malnourished pregnant women at greater risk of:
  - maternal mortality
  - morbidity

Limitations of Current RUTFs

- Current RUTFs are designed for children and while they can be used for pregnant women, little is known about effectiveness.
- RUTFs can be made locally, but all most contain powdered milk, which must be imported and is costly.
- Most RUTFs are like a peanut butter, which can be hard to swallow by those with compromised health.

The Concept

Ready-to-Use Therapeutic, Recovery, Supplementary Foods for malnourished populations made from local ingredients

Drinkable formulations that are more easily consumed by severely ill and malnourished individuals

Objectives

- Create a low-cost, peanut-based RUTF designed for specifically for pregnant women in Mali using computer optimization software
  - Mali has the 3rd highest birth rate in the world (CIA World Factbook, 2010).
- Process and characterize the physical properties of the products
- Compare nutrient content of the products to the software predictions

The Approach

- Use Computer Formulation (Creative Formulation CF4) for designing nutritionally optimized, least cost mixtures of locally available ingredients
- Use appropriate processing technologies to produce pilot scale amounts of formulas
- Develop innovative packaging and delivery systems
- Physical, chemical and biological evaluation

- **Advantages of a liquid RUTF**
  - **Formulations flexible to ingredient availability and cost**
  - **Reduced cost compared to e.g. PlumpyNut due to use of local ingredients (except for vit/min premix) No milk.**
  - **Local manufacture and distribution**
  - **Easily consumed**
- **Possible Disadvantages**
  - **Microbial stability?**
  - **Stability of labile nutrients (eg. vitamins)?**
  - **Distribution of liquid formulas?**

Formulate and produce peanut-based RUTFs

- **Inputs into software**
  - **Nutritional target**
    - **Population**
      - **Age, health state, gender**
    - **% Daily requirements to be delivered**
  - **Ingredients**
    - **Identity**
    - **Nutrient composition**
    - **Cost**

Formulation

- **Generated 30-35 formulations with software**
  - **4 best were chosen for processing and analysis**
- **Of the 13 ingredients, 6 were used:**
  - **Peanuts: 35-40%**
  - **Cowpeas: 20-30%**
  - **Millet: 4-21%**
  - **Rice: 7-40%**
  - ***Sesame: 15%***
  - **Barley: 5-15%**

Formulations

- **14 ingredients entered into the software**
- **Total of 6 formulations generated**
  - **3 with 3 different amounts of rice koji**
  - **3 with 3 different amounts of barley koji**

Percent Ingredient Composition and Cost for 6 Chosen Formulations							
Formulation	Cost ($/kg)	Peanuts	Cowpeas	Millet	Rice	Barley	Sugar
A	0.850	38.41	22.23	18.36	7.00	N/A	14.00
B	0.856	38.95	21.81	11.24	14.00	N/A	14.00
C	0.862	39.49	21.4	4.41	21.00	N/A	14.00
D	0.841	38.17	21.92	20.91	N/A	5.00	14.00
E	0.839	38.46	21.20	16.34	N/A	10.00	14.00
F	0.836	38.75	20.48	11.77	N/A	15.00	14.00

Koji

- **Fungal solid-state fermentation using *Aspergillus oryzae***
- **Used for centuries in Asian cultures to create:**
  - **Soy sauce**
  - **Miso**
  - **Sake**
- **Produced by steaming grains and inoculating grains with spores of *A. oryzae***

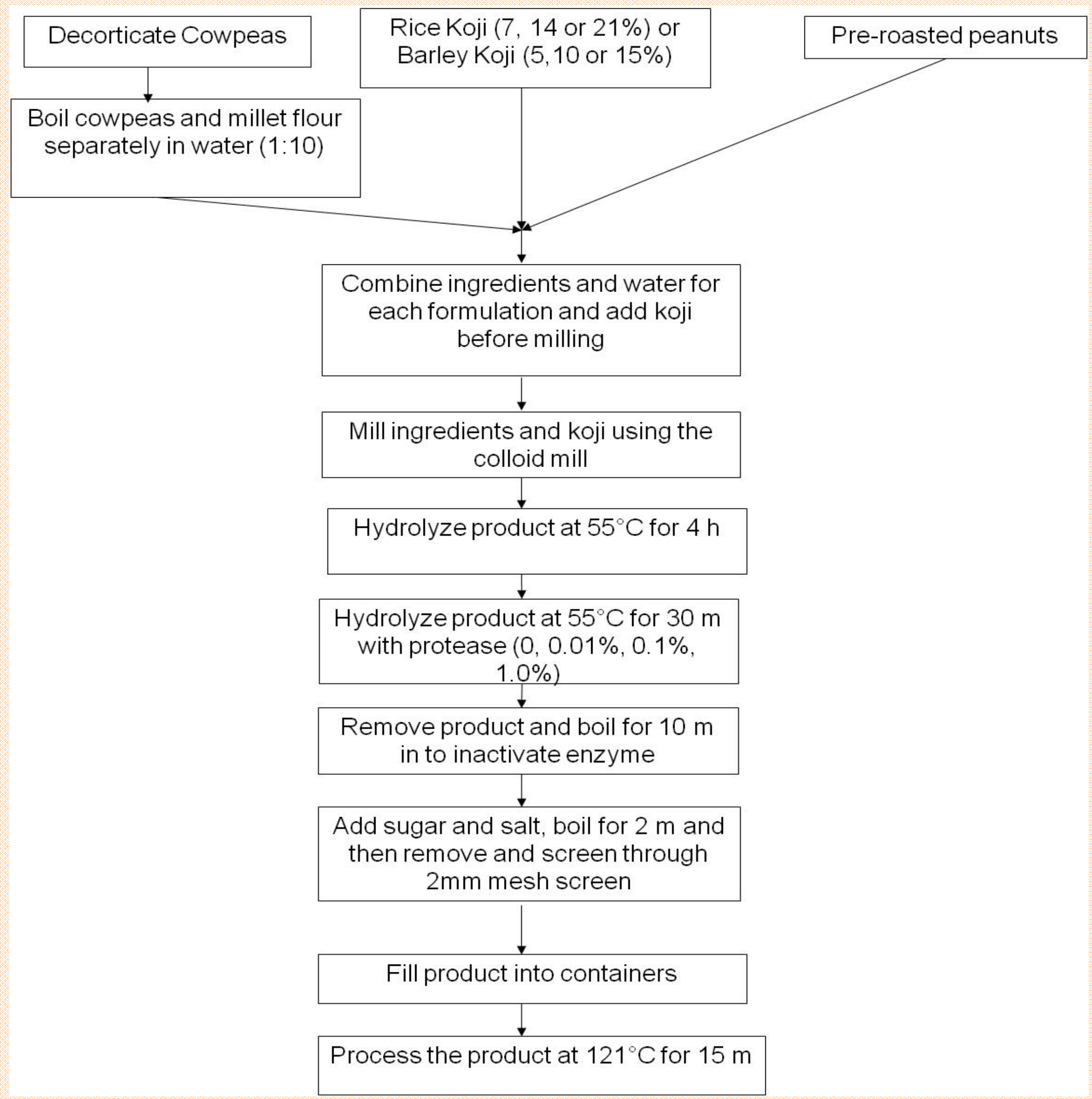
Koji Production

- Rice or barley soaked in water
  - 16 hours for rice and 2 hours for barley
- Grains steamed, cooled to 30 ± 2°C and inoculated with 2 g/kg of *A. oryzae spores*
- Put into incubation chamber at 28°C and 94% relative humidity
- Incubation split into 2 stages
  - Stage 1 ends at 20 hrs for barley and 24 hrs for rice
  - Temperature and humidity differs between two stages

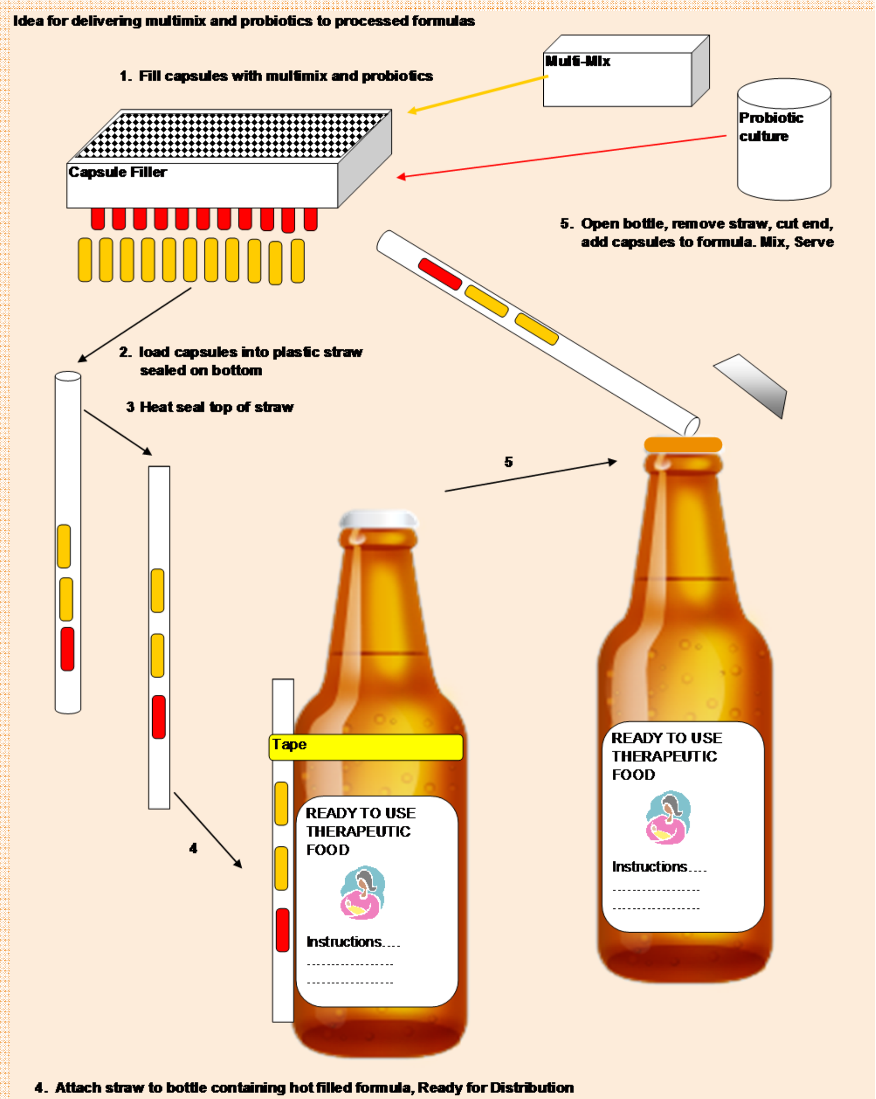
Processing

- Necessary cleaning, milling, decortication
- Hydrothermal processing (cooking)
- Use of rice or barley *koji* and bromelain to reduce viscosity due to biopolymers (starch, protein) and increase availability and nutrient density
- Heat treatment to denature enzymes and reduce microbiological load
- Packaging in appropriate containers
- Labeling with necessary information

Processing


Decorticate Cowpeas
Rice Koji (7, 14 or 21%) or Barley Koji (5,10 or 15%)
Pre-roasted peanuts
Boil cowpeas and millet flour separately in water (1:10)
Combine ingredients and water for each formulation and add koji before milling
Mill ingredients and koji using the colloid mill
Hydrolyze product at 55°C for 4 h
Hydrolyze product at 55°C for 30 m with protease (0, 0.01%, 0.1%, 1.0%)
Remove product and boil for 10 m in to inactivate enzyme
Add sugar and salt, boil for 2 m and then remove and screen through 2mm mesh screen
Fill product into containers
Process the product at 121°C for 15 m

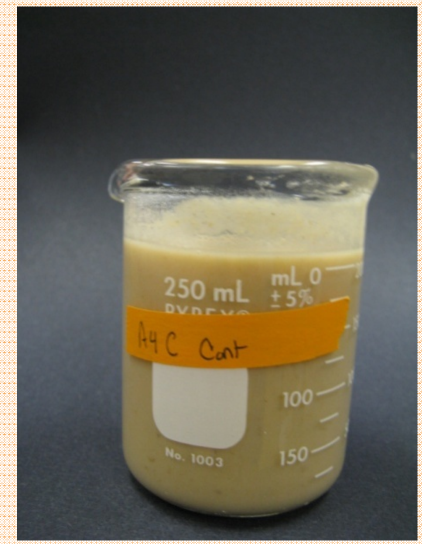
Processing


Idea for delivering multimix and probiotics to processed formulas
1. Fill capsules with multimix and probiotics
Multi-Mix
Probiotic culture
Capsule Filler
5. Open bottle, remove straw, cut end, add capsules to formula. Mix, Serve
2. load capsules into plastic straw sealed on bottom
3 Heat seal top of straw
5
4
Tape
READY TO USE THERAPEUTIC FOOD
Instructions....
READY TO USE THERAPEUTIC FOOD
Instructions....
4. Attach straw to bottle containing hot filled formula, Ready for Distribution

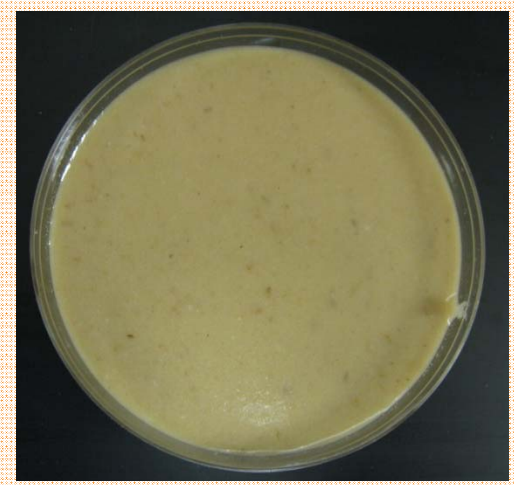
RUTF PRODUCTS

Barley Koji, 5%

Barley Koji, 10%



Barley Koji, 15%



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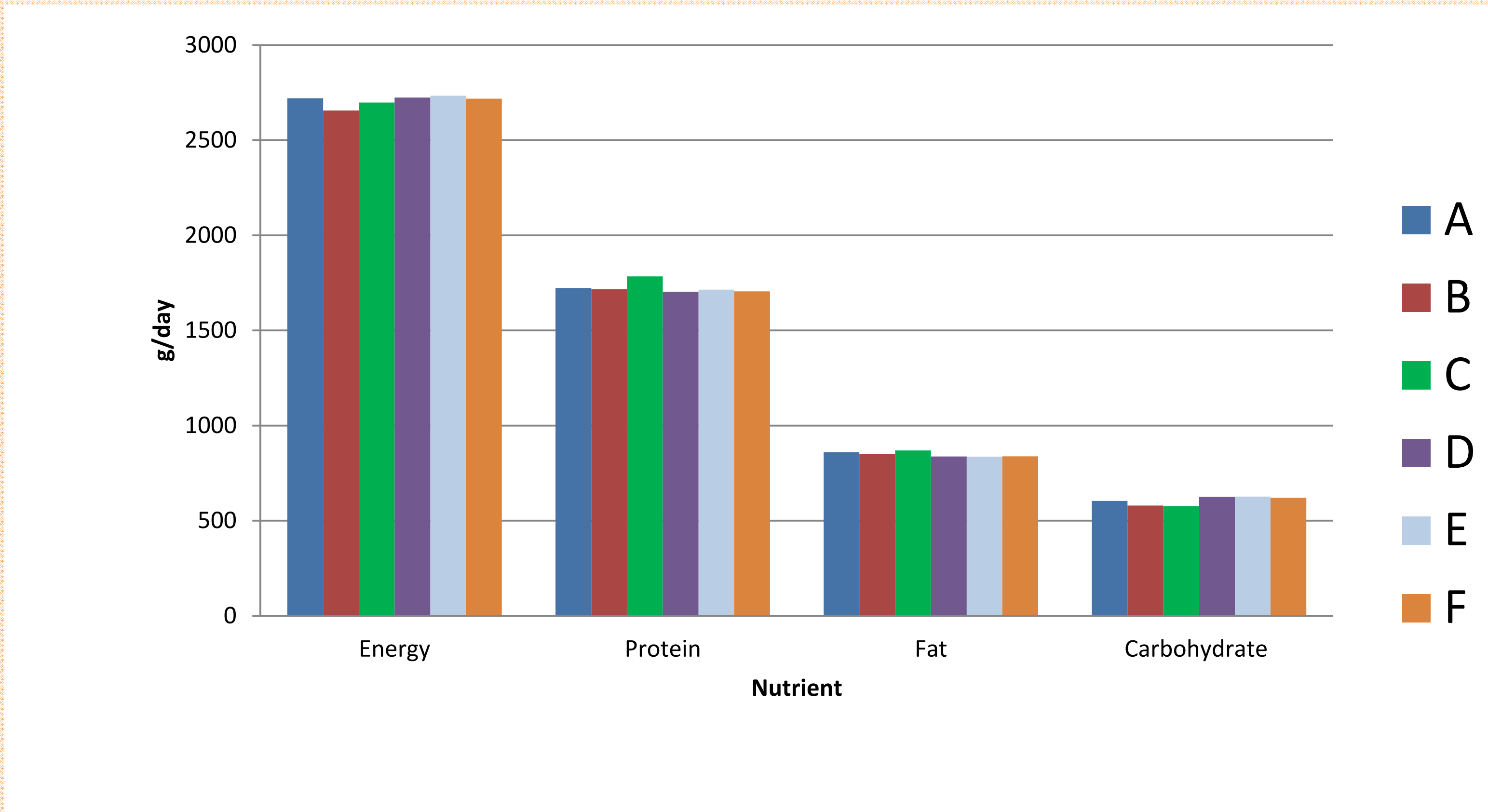
Evaluation

- Composition vs. predicted by software
- Physical characteristics
- Microbiological safety and stability
- Sensory acceptability in target populations
- Nutritional efficacy in target populations

Consumption to Provide RDA



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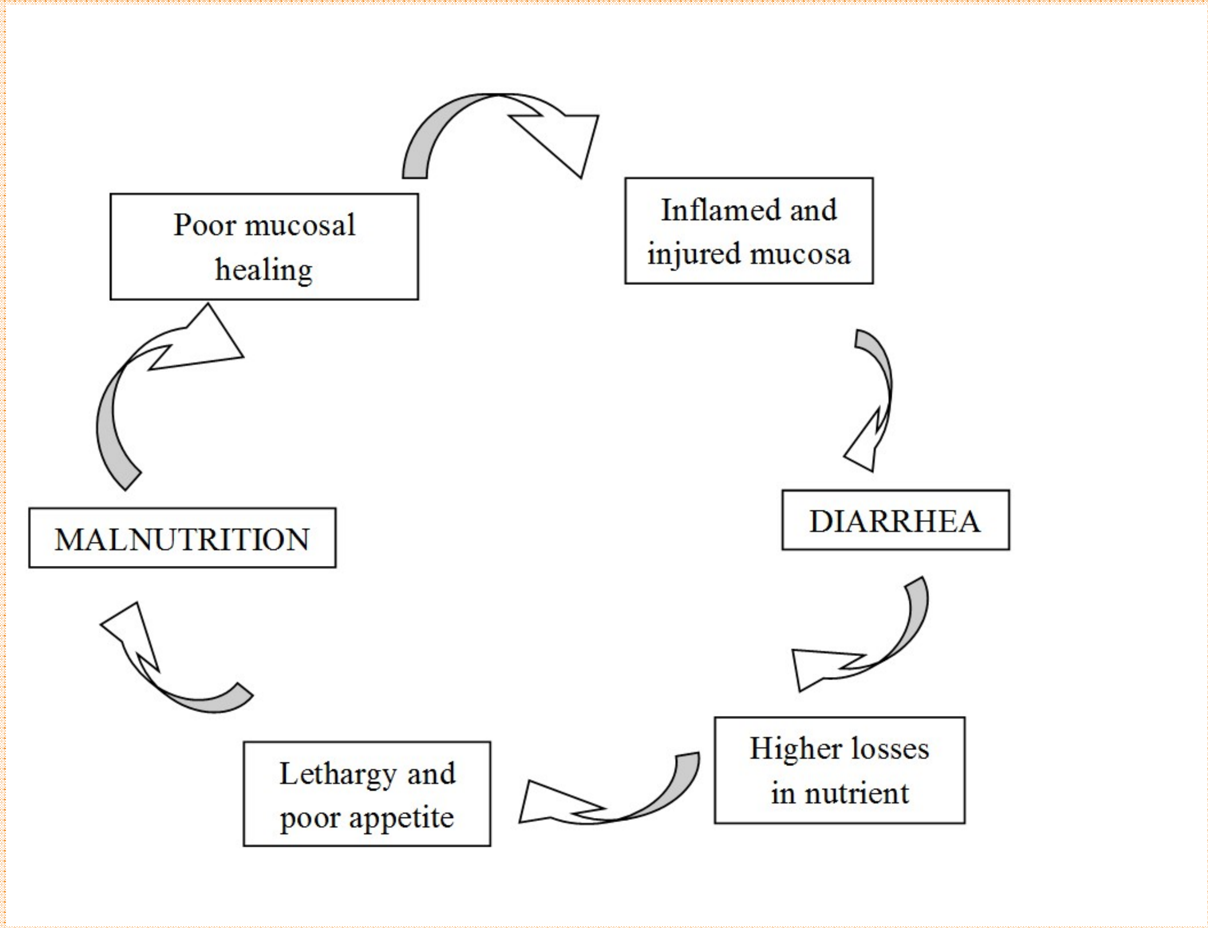
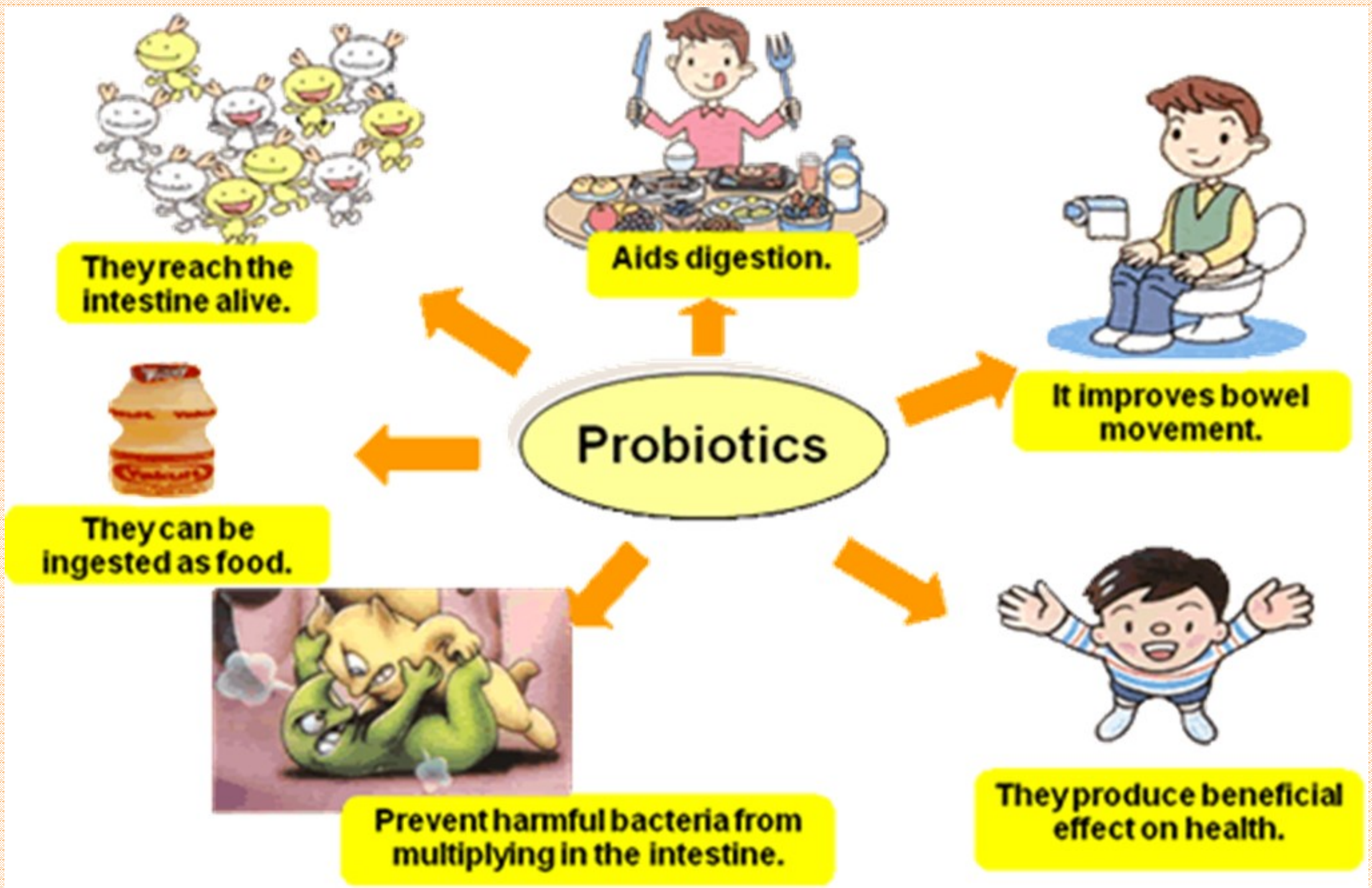
Relationship between diarrhea and malnutrition



Probiotics: Beneficial bacteria that can colonize the GI tract



Vehicles for probiotic delivery

Peanut Butter

Highly nutritious

Used in making RUTFs

Affordable.

The fact that bad bacteria can survive in peanut butter suggests that good ones can too.

Interventions in diarrhea management

Zinc and Vitamin A

Antimicrobials

Probiotics

OBJECTIVES

- To produce peanut butter containing probiotic organisms.
- To determine the survival of selected single, and multiple strains of probiotic bacteria in full fat and reduced fat peanut butter.
- To determine the fate of multiple strains of probiotic bacteria in peanut butter during a simulated gastrointestinal passage.

Methods

•Full fat and reduced fat peanut butter was pre-heated.

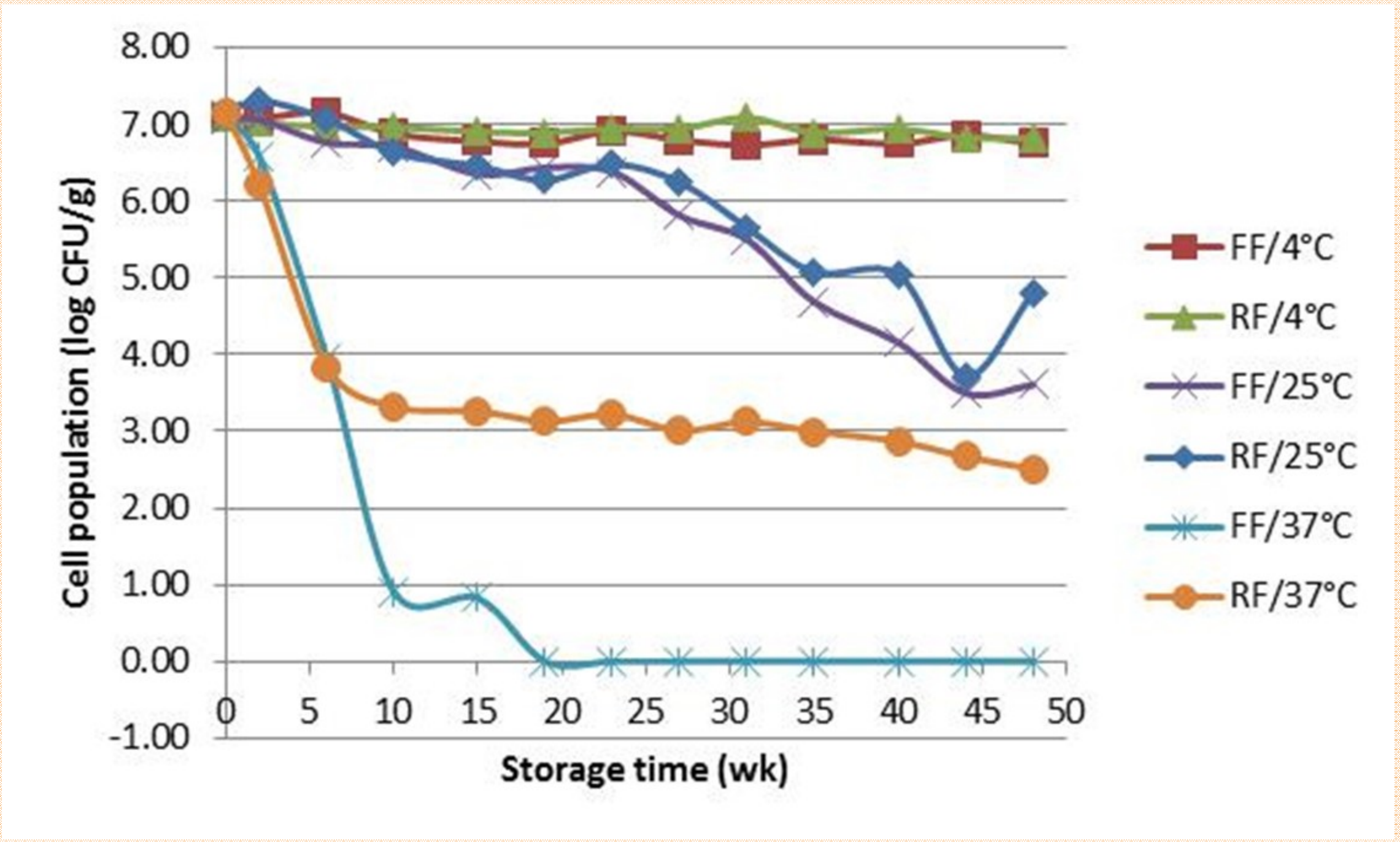
•Freeze-dried probiotic cultures were added.

•After mixing, products were placed in PET jars and sealed.

•Samples were stored at 4, 5, and 37C.

•Bacteria were periodically enumerated.

Survival of *Lactobacillus rhamnosus* GG populations in full fat peanut butter (FF) and reduced fat peanut butter (RF)



CONCLUSIONS

- Probiotics were able to survive the process used to incorporate them into peanut butter
- Probiotics were able to maintain survivability but survivability was influenced by strain type, storage condition and storage time
- Peanut butter protected probiotics during simulated gastrointestinal passage
- Peanut was able to protect the functionality of probiotics and thus probiotic bacteria was able inhibit the growth of pathogens

Peanuts in Life-Sustaining and Life-Sparing Foods

1. Peanuts are a nutrient-dense product that can form the basis for many intervention foods.
2. They contribute good quality protein to, and form the backbone of RUTFs and RUSFs.
3. The low moisture and intermediate- to high-fat content of peanut butter provides a novel means of delivering probiotic organisms to at-risk and other consumers.