

Maximizing Recovery Rates and Growth with Dairy-containing Supplements

Heather C. Stobaugh, Ph.D.
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Moderate Acute Malnutrition

- What is MAM?
 - Increased risk of dying
 - Susceptible to illness
 - Development of SAM
- MAM Diagnosis:
 1. Mid-upper arm circumference (MUAC)
 - 11.5 – 12.4 cm
 - Recovery = MUAC \geq 12.5 cm
 2. Weight-for-height z-score (WHZ)
 - WHZ < -2 and ≥ -3
- Burden of MAM
 - 33 million children
 - MAM & SAM account for 11.5% U5 mortality
 - South Asia, Africa, Middle East



Current Treatment



- Supplementary Feeding Program (SFP)
- Provision of specially formulated foods:
 - Fortified blended food (corn-soy blend)
 - Ready-to-Use Supplementary Food (RUSF)
- Currently, no international standards
- Include high quality protein, such as whey, in food
- Effective treatment, while keeping costs low

Whey Protein and Permeate

- Whey is a co-product of cheese manufacturing and known to have many growth and other health benefits
- Whey protein concentrate (WPC80):
 - high quality amino acid profile
 - builds muscle and counteracts tissue breakdown
 - Helps to retain absorbed AAs
 - bolsters immune systems
- Whey permeate:
 - high in lactose
 - energy source
 - may improve gut health
 - facilitates the absorption of growth-supporting nutrients

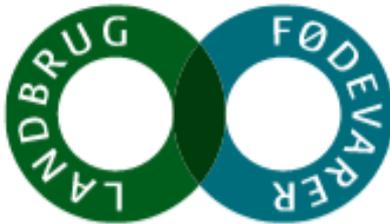


Partnering for a Solution



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- The **US Dairy Export Council**, **Danish Dairy Research Foundation**, and **Arla Foods** partnered with Washington University in St. Louis, from 2012-2014.
- Aim: to test if whey protein and whey permeate could be included in the food used to treat moderate acute malnutrition

Study Location: Malawi

- 18th least developed country
- Primarily rural areas, subsistence farming
- Maize consumption
- Malnutrition peaks during rainy season
- 40% of children are stunted
- Under-five mortality rate: 6.8%



Research Methods

- Randomized, double-blind, controlled clinical effectiveness trial
- Participants:
 - 2259 children 6-59 months old
 - diagnosed with MAM (MUAC: 11.5-12.4 cm)
- Compared treatment foods:
 - **Whey RUSF**: containing whey protein concentrate and whey permeate
 - **Soy RUSF**: a traditional treatment food containing soy protein (“control food”)
- Outcomes:
 - Recovery rate (MUAC 12.5 cm or above)
 - Non-recovered, developed SAM, death, or default
 - Growth factors (weight, length, LOS, etc)



Research Methods

- Informed Consent – caregivers were informed of the research and consented to participate
- Randomization – children were randomly assigned to receive either Whey RUSF or Soy RUSF
- Blinding – caregivers, nursing staff, nor researchers were aware of the type of food each child received, keeping treatment consistent across all participants
- Food Appearance – the two foods were similar in look, smell, taste as well as packaging



Treatment Foods

Comparison of Ingredients		
	Whey RUSF	Soy RUSF
Ingredients:	%	%
WPC80	4.9	
Whey Permeate	18.7	
Soy Meal, extruded		24.0
Micronutrient Mix-Whey	3.5	
Micronutrient Mix-Soy		4.6
Sugar	24.4	25.7
Palm Oil	10.0	10.0
Soy Oil	7.6	7.3
Peanut Paste	29.4	26.9
Emulsifier	1.5	1.5

Comparison of Nutrients (typical daily ration)

	Whey RUSF	Soy RUSF
Total g of RUSF	103.35	103.35
Energy (kcal)	516.34	559.52
Protein (g)	11.42	17.06
Lipids (g)	35.74	36.84
Selected Micronutrients		
Calcium, Ca (mg)	519.13	659.71
Iron, Fe (mg)	9.44	9.42
Magnesium, Mg (mg)	149.87	247.20
Phosphorus, P (mg)	600.33	793.53
Potassium, K (mg)	762.84	1195.91
Zinc, Zn (mg)	10.58	14.36
Folic acid (µg)	255.61	98.50
Vitamin A, (RAE)	1051.26	1288.92
Anti-nutrients		
Phytic Acid (g)	0.21	0.45

Treatment Foods

Comparison of AA Profile (typical daily ration)		
	Whey RUSF	Soy RUSF
Aromatic AAs [g (% total AA)]	1.32 (12.2)	2.13 (12.5)
Histidine (g)	0.25	0.44
Phenylalanine (g)	0.49	0.88
Tryptophan (g)	0.17	0.19
Tyrosine (g)	0.41	0.63
Branched-chain AAs [g (% total AA)]	1.79 (16.5)	2.73 (16.0)
Isoleucine (g)	0.47	0.69
Leucine (g)	0.82	1.27
Valine (g)	0.50	0.76
Sulfur-containing AAs [g (% total AA)]	0.43 (4.0)	0.39 (2.3)
Cysteine (g)	0.22	0.19
Methionine (g)	0.21	0.20

	Whey RUSF	Soy RUSF
Other AAs [g (% total AAs)]	7.30 (67.3)	11.81 (69.2)
Alanine (g)	0.44	0.72
Arginine (g)	0.97	1.67
Aspartic acid (g)	1.25	2.05
Glutamic acid (g)	2.09	3.35
Glycine (g)	0.50	0.82
Lysine (g)	0.57	0.89
Proline (g)	0.51	0.81
Serine (g)	0.49	0.87
Threonine (g)	0.48	0.63
Protein Digestibility-Corrected Amino Acid Score (PDCAAS)	1.00	0.78
Digestible Indispensable Amino Acid Score (DIAAS)	0.72	0.74

Results

Primary and secondary outcomes between groups

	Whey RUSF (n = 1144)	Soy RUSF (n = 1086)	<i>P</i> value
Recovered [<i>n</i> (%)]	960 (83.9)	874 (80.5)	0.039
Time to recovery (d)	29.3 ± 19.0	30.4 ± 20.1	0.22
Did not recover [<i>n</i> (%)]	184 (16.1)	212 (19.5)	0.039
Developed SAM [<i>n</i> (%)]	117 (10.2)	128 (11.7)	0.27
Remained moderately malnourished [<i>n</i> (%)]	49 (4.3)	52 (4.8)	0.64
Default [<i>n</i> (%)]	16 (1.4)	28 (2.6)	0.064
Died [<i>n</i> (%)]	2 (0.17)	4 (0.37)	0.44
MUAC at final visit (cm)	12.66 ± 0.53	12.59 ± 0.56	0.0088
MUAC gain (mm/d)	0.26 ± 0.27	0.22 ± 0.28	0.0025
WHZ at final visit	-1.08 ± 0.86	-1.18 ± 0.90	0.0077
WHZ change to final visit	0.77 ± 0.62	0.70 ± 0.66	0.012
Weight gain to final visit (g/kg/d)	2.95 ± 2.04	2.79 ± 2.16	0.11
Weight gain to 2 nd follow-up visit (g/kg/d)	2.88 ± 2.18	2.65 ± 2.30	0.042
Length gain to final visit (mm/d)	0.30 ± 0.28	0.29 ± 0.29	0.18

Cost-effectiveness Analysis



- Aim: assess marginal cost-effectiveness of treatment between two different foods
- Approach: societal perspective
- Costs:
 1. **Food:** raw materials, shipping and transportation, import and duty taxes, packaging, factory operations, and product testing
 2. **SFP operations:** staff salaries, supplies, storage, etc.
- C-E ratios generated: *per child recovered*
 1. **Food cost** per child recovered
 2. **Total cost (food + SFP operations)** per child recovered

Results

Cost-effectiveness Analysis

	Whey RUSF	Soy RUSF
Cost to produce food	\$3.13	\$2.78
Food cost per child recovered	\$11.96	\$10.56
Total cost (food + SFP operations) per child recovered	\$54.34	\$54.76



Conclusions

- Whey RUSF was superior, despite 33% less total protein and 8% less total energy
- Possible biological causal pathway
 - Amino acid absorption
 - Bioactive peptides
 - High lactose
 - Low anti-nutrients
- Cost-effective approach
- Further research:
 - Determine optimal level and type of dairy proteins
 - Dose response studies
 - Isonitrogenous and isocaloric foods



Questions and Discussion

Thank you

Heather.Stobaugh@tufts.edu