

The Multiple Micronutrient Report

A Solution for Hidden Hunger

A clinical study conducted under the World Health Organization's scientific research guidelines by the following collaborating organizations, which demonstrates the high potential of Food Supplement Concentrate in alleviating anemia, VAD and improving the immune system in malnourished African children.

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Hidden Hunger

We all know that food can fill the belly, the question is; does the available food supply *effectively feed the body*? Food is composed of macro and micro nutrients. The macro nutrients are three; protein, carbohydrates and fats, they are the most well studied and understood components of food. They supply the energy and building blocks to run the body. **Micronutrients**, on the other hand, number in the hundreds of thousands; they include **vitamins, minerals, anti-oxidants, phytochemicals, trace elements**, and more. Micronutrient deficiency is known as the Hidden Hunger, it plagues the globe in the form of disease and malnourishment. Micronutrients are **more vulnerable to loss** than macro nutrients, through agricultural techniques, soil viability, storage, processing, temperature and final food preparation.

Foundational research in the health sciences focused on single micronutrients and on those most necessary to a healthy human life. In particular, single micronutrients such as vitamin A, Iron, Folate and Iodine have been found to be essential in eradicating and preventing many diseases and distressing conditions such as birth defects and blindness. Now many researchers are exploring these four findings:

- 1) The superior effect that the recognized **essential micronutrients** exhibit in **combination**.
- 2) Previously unrecognized multiple **trace elements** are critical to human nutrition.
- 3) The macro nutrients in **food** act together with the micronutrients for the most effective and efficient nutrient delivery system. This **eliminates the toxicity** found in single micronutrient dosages, particularly Vitamin A and Iron.
- 4) **Anti-oxidants** play a strategic role in **preventative** healthcare.

Recommendations from the Harvard Medical School to The World Health Organization state it in simple terms; “*Adequate nutrition, which is best achieved through the consumption of a balanced [1] healthy diet, is vital for health and survival...*” The world’s health authorities recommend fresh, unprocessed and properly prepared foods to access the highest level of these nutrients, which include active enzymes to assist in digesting food and in enhancing the bio-availability of micronutrients.

The Multiple Micronutrient Report looks at a Multi-Micronutrient Dense Food Supplement Concentrate* (FSC) and its clinical effects on undernourished babies in two of the most poverty [2] stricken areas in Kenya. In Kenya, the mortality rate of children under the age of five is 11%.

Study design

290 children were recruited, 267 (92%) met the *vulnerability inclusion criteria* which are as follows;

1) 6-30 months old, 2) anemic and 3) undernourished. The subjects consisted of 42.4% males and 57.6% females, average age was 16.3 months. A nurse practitioner visited the children each day to administer the nutrients. They were served in a maize flour gruel or with cooled water, if the child seemed dehydrated. Three groups were randomly assigned in a single blind setting for a **7-month period**, mid-April to mid November 2002. High-transmission malaria season coincided with 3 months of the study. This season demonstrates a high level of malarial parasitaemia within

[3] the population, which typically leads to measurable nutrient loss . The nutrients were *accepted by 95.3 of the subjects, a high compliance rate.* This demonstrates wide-spread acceptance by the local population of the FSC Supplement.

The study was formulated to test for specific clinical indicators in the following preventable diseases

- 1. Iron-Deficiency Anemia**
- 2. Immune System Compromise**
- 3. Vitamin A Deficiency (VAD)**
- 4. Malnutrition**

The nutrients used in the study:

FSC - (Food Supplement Concentrate)

One serving contains: 18 amino acids, fructose (glycemic index 35-equivalent to the sugars in one apple), omega 3 and 6 fatty acids, active food enzymes, 25 multi-micronutrient fortificants including beta-carotene, **vitamins**; B1, B2, B3, B6, B12, C, D3, E, K, **minerals/trace elements**; phyto-iron, calcium, zinc, selenium, molybdenum, copper, G.T.F. chromium, manganese, magnesium, boron and vanadium. Hygienic biologically-controlled aquaculture of *Spirulina Platensis* utilizing nutrient hyper-accumulation technology, comprises the source of the amino acids, EFA's and many of the phytonutrients. Contains 50% of recommended adult dietary intake (RDI) for prevention of deficiency. **Food-safe, Child-safe.** Flavors: berry, butternut and lemon, mixed in cooled water or stirred into gruel for daily consumption in study.

Vitamin A

6 to 12 month olds: **100,000 IU** vitamin A palmitate

Over 12 months: **200,000 IU** vitamin A palmitate

Vitamin C + Glucose

40 mg. ascorbic acid + 32 grams glucose (glycemic index 100- equivalent to white sugar).

Designed to simulate an **FSC placebo** while providing a single essential micronutrient to children.

Large single dose Vitamin A follows WHO/INACG/UNICEF guidelines to prevent Vitamin A Deficiency. VAD is a chronic problem in Kenya; this is why the study was formulated with each group receiving this single essential micronutrient. **Over consumption of single micronutrients Vitamin A, Iron, and others can cause accumulation in the body when they are in an isolated**

[\[4\]](#)

form and can lead to toxicity. Group 2 received vitamin A only in the form of the beta-carotene found in the FSC. Beta-carotene is a non-poisonous, food-sourced precursor of Vitamin A. There was no evidence of Vitamin A toxicity with the FSC + Vitamin A group, thereby leading to the conclusion that the beta-carotenes in the FSC had no adverse reaction and the body does not hyper-accumulate Vitamin A when beta-carotene is present as the precursor. Food-sourced iron

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(phyto-iron) has also been demonstrated to be non-toxic . Iron Supplements are often accompanied by disturbing digestive complaints and can severely poison the human system if over

[\[6\]](#)

consumed.

The subjects were divided, randomly into 3 Groups, each group received either FSC or FSC

placebo *and* High-Dose Vitamin A or Vitamin A placebo.

Group 1

FSC + Vitamin A

Group 2

FSC + Placebo Vitamin A

Group 3

Glucose with Vitamin C (Placebo FSC) + Vitamin A

Baseline Situation

Background: The 1999/2000 national micronutrient survey in Kenya revealed compelling evidence regarding the magnitude and severity of micronutrients malnutrition among children and women of reproductive age. The quality of life and socio-economic consequences of these deficiencies include:

- 1 – **Preventable Anemia**; debilitating and often fatal. Top priority; WHO/UNICEF
- 2 - **Preventable Vitamin A Deficiency** – severe disabilities. Top priority; WHO/UNICEF
- 3 - **Preventable Intellectual and physical handicaps and development disorders** – declining quality of life, productivity declines. Top priority; World Bank, Governments
- 4 - **Excessive illnesses; immune system weakness, chronic and fatal diseases** – AIDS World Pandemic. Top priority; United Nations calls for global funding of HIV/AIDS prevention and treatment. The 3 x 5 Initiative was designed to treat 3,000,000 People Living With Aids by 2005, changing AIDS into a manageable chronic disease.

Supplementation was decided to be an expedient solution, to protect the vulnerable groups. Within the context of public health service, identification of efficacious and cost-effective strategies would be required prior to launching large scale interventions. This case study was carried out in Kenyan coastal communities where chronic childhood malnutrition and poor health indicators have persisted, to test the feasibility of a community based intervention. Malarial parasitaemia was exhibited by a large proportion of children, as the wet season (2-7th months) worsened malaria transmission during the study.

33% of FSC Groups
were **protected** from
malarial anemia

Malarial parasitaemia

Beginning: **24.6%** of children

Final: (7 months) **42.4%** of children

One of the most striking results of the study was the change in mortality and morbidity rates

Expected deaths: 32
Actual deaths: 0
Population of 290 children

Mortality rates among children under 5 in Kenya study

Baseline: 11.2%

Final (7months) 0%

Grossly sub-optimal protein and energy intake among subjects was magnified by acute food (protein and calorie) shortage. At the time of the survey **only 10% of the households had reserve food** (maize or cassava). Many households participated in the common cultural practice of pooling food for all weaned children, irrespective of age, among other unfavorable factors. This caused younger children to receive less food on the average.

Wasted
Overall **8.4%**
reduction

Severely Underweight (wasted)

Beginning: **18.6 %** of children
Final: (7 months) **10.2 %** of children

Despite severe food shortages, malaria and predominance of sub-optimal baseline beginning weights, the overall wasting index was reduced at the end of the study.

VAD
Overall **48.2%**
reduction

Vitamin A Deficiency (VAD)

Beginning: **85.7%** of children
Final: (7 months) **37.5%** of children

Anemia
53.9% reduction
in
FSC Group

Anemia

Beginning: **87%** of children
Final: (7 months): **FSC Groups** (Group A and Group B): **33.1%** of children

Clinical Indicators

Anemia

Anemia is a condition in which the red blood cell count drops and the body starves for oxygen. The majority of anemia cases in the world are diet related and therefore preventable. Adequate dietary iron is essential in preventing anemia. Current research shows the additional positive effect in treating diet related anemia of Vitamin A and other assorted micronutrients.

Hb g/dL– Haemoglobin concentration (grams per deciliter of blood) clinically measures the red blood count or severity of anemia. Haemoglobin is an oxygen transporter found in red blood cells. Anemia is a debilitating condition due to a decrease of oxygen delivered to the cells. It causes extreme fatigue, complications with all health conditions and even death. *All anemia measurements were calculated with corrected weighted measurements compensating for malaria infection within the clinical population.*

Hb Increases

FSC Groups	+ .80 g/dL
Placebo FSC Group	+ .15 g/dL

Additional Clinical Research Findings on Anemia

Excerpt: *Biomed Environmental Status*, 1996 Sept

“Most governmental programs to control widespread iron deficiency in the developing world involve providing daily supplements of iron to all children and pregnant women. *This approach generally has poor results* due in part to dose-related undesirable gastrointestinal side effects and the lack of effective absorption and retention of iron consumed on a daily basis. (Italics added)

Excerpt: *Child Trop*. 1981; (133): 1-36.

Among the elements which contribute to the formation and development of red corpuscles and to the synthesis of hemoglobin, the following should be noted: *iron; other minerals, i.e., copper, zinc, magnesium, cobalt, molybdenum; vitamins, especially folic acid and vitamins B12 and amino acids.*

Iron Deficiency Anemia is preventable and currently effects up to 50% of the population of several [\[7\]](#) developing nations, it accounts for staggering losses; in both human suffering and loss of [\[8\]](#) productivity . During pregnancy and lactation, anemia can cause permanent damage to the developing child⁶. Anemia contributes to the prevalence of other pandemics such as malaria and [\[9\]](#) HIV/AIDS . Many relief agencies have targeted Iron Deficiency Anemia as a top priority⁷.

Immune Compromise

Clinical indicators for a healthy immune system include;

- 1) **White Blood Cells**
- 2) **Interleukins**

White blood cells (Leucocytes) include:

- A) **Lymphocytes** - B and T cells
- B) **Monocytes** - macrophages
- C) **Granulocytes** – histamine response & defense

An immune response to a foreign antigen requires the presence of a macrophage in combination with a B or T cell. **The T cells, CD4**, produce crucial chemicals, Interleukins that communicate orders and orchestrate immune response.

A) **Lymphocytes** B cells - release antibodies

T cells – respond to infection and foreign cells:

- 1) CD4 - T-Helper Cells
- 2) CD8 – T-Suppressor cells
- 3) NKC – Natural Killer Cells

B) **Monocytes** – known as macrophages or “big eaters”, they destroy invading cells

C) **Granulocytes**

- 1) Neutrophils – First line defense against foreign cells
- 2) Eosinophils – Specific defense against parasites and toxins
- 3) Basophils – Mediate histamine response

Lymphocytes – CD4, CD8, Natural Killer Cells

CD4 cell counts are used to assess immune status, when CD4 < 350, the US government guidelines

[\[10\]](#)

recommend HIV treatment , CD4 < 200 indicates a severely compromised immune system (AIDS). When CD4 cell count drops, the ratio between CD4/CD8 becomes smaller. A healthy **CD4/CD8 ratio is close to 2**. Malarial infection leads to a clinical decrease in CD4 and increase in CD8 counts. *The final seven (7) months mean ratios for the FSC groups remained within clinical guidelines for determining healthy immune system function. This finding reveals the benefit obtained by the children despite persistent malarial infection throughout the study.*

CD4/CD8 ratios

Group 1 – (FSC + Placebo A)	1.87
Group 2 – (FSC + Vitamin A)	1.87



Ø **Natural Killer Cells were highest** in the FSC Groups (1 and 2) at Final (7 months).

Ø **Neutropenia** (lowered neutrophils) has been **associated with anti-malarial medicines** [\[11\]](#)

. All participants in the study who exhibited malarial infection were prescribed anti-malarial medicine. **Clinical Neutropenia did not manifest among the study population.** Neutrophils **increased** in the FSC Group 1 and decreased in Group 2 and in Group 3. The lowest neutrophil counts at Final (7 months) were **2.75** (WBC x 10⁹/L) in Group 2. Neutropenia is defined as neutrophil counts below **1.0** (WBC x 10⁹/L), Neutrophils are the most numerous WBC and are counted as first line defense. Depending upon the progression and type of disease, neutrophil counts can either rise or fall.

Ø Monocytes increased in all groups (**monocytosis**); this is a common tendency with sub-optimal caloric intake and indicates a responsive immune system.

Ø **Leucopenia**, a decrease in overall White Blood Cell count (WBC) was also present. Leucopenia, a tendency in malarial infection, was noted in all 3 Groups, the smallest drop was in Group 1 (FSC + Placebo), followed by Group 2 (FSC + Vitamin A). This is consistent with findings in severely malnourished and chronically infected populations.

Ø **Eisonophil** counts were highest in Group 2, FSC + Vitamin A, indicating a positive immune response to parasitic infection due to malaria

Interleukins

These chemical messengers modulate inflammatory reaction, white blood cell response and provide a profile of how the immune system responds. Cytokine milieu describes the snapshot of immune chemistry that is presented in the blood profile. The cytokines considered in this study:

Interleukins

The **FSC Groups** showed a shift towards

- 1) **activation of cellular immune system**
- 2) **lower concentration of inflammatory** cytokines at Final (7 months) measurements.

IL – IB

IL – 6

IL – 8

IL – 10

IL – 12p70

TNF – a

VITAMIN A DEFICIENCY (VAD)

Vitamin A (Retinol) is a fat-soluble vitamin that is stored as retinyl palmitate in the liver as reserves. Vitamin A is found mainly in fish liver oils, liver, egg yolks, butter and cream. Green leafy and yellow vegetables contain beta-carotene which is also converted to retinyl palmitate by the body. Unlike Vitamin A, beta-carotene is non-toxic (easily assimilated and released by the body), and in addition, is a powerful anti-oxidant. VAD is the world's leading cause of irreversible

[\[12\]](#)

blindness in children and mortality rates are more than 50% in severe VAD . High-dose Vitamin A (200,000 IU) has been a cost-effective strategy to help ease these tragic consequences. Toxic overdose is a very real threat with high-dose Vitamin A therapy. During pregnancy and lactation therapeutic doses must not exceed two times the RDA to avoid possible damage to the

[\[13\]](#)

child (RDA = 5000IU)

Vitamin A is measured by retinol levels in blood serum and liver stores. Serum Retinol only falls after liver stores are exhausted¹¹

	Serum Retinol (μ mol/L)
normal	.7 to 2.8
low	.35 to .66
deficient	Less than .35

At the beginning of the study only .4% (10 children out of 259) had stable Vitamin A status. Over the course of 7 months the serum Retinol almost **doubled** for all groups. Increases were greatest in the FSC Groups, though not statistically significant

Average Serum Retinol status μ mol/L

	Baseline	Final	Difference
Group 1 (FSC + Placebo Vit. A)	.47	.84	+.37
Group 3 (Placebo FSC + Vit.A)	.49	.81	+.32

The conclusion is that FSC, with beta-carotene content, can effectively treat VAD without the associated risk of toxicity of high-dose Vitamin A.

Malnutrition

The focus of malnutrition studies in the past have been on caloric intake and energy requirements pertaining to protein, carbohydrates and fats. Micronutrients are now receiving the attention of studies relating to preventable chronic and fatal diseases. Malnutrition is by definition, a state of receiving less than optimal nourishment in the form of macro and micronutrients. It is measured in

children by the z-score, calculated as a statistical device using height-for-age (stunting), weight-for-age (underweight) and weight-for-height (wasting).

z - scores

z < -1	Mildly undernourished (wasting and stunting)
z < -2	Moderately undernourished (wasting and stunting)
z < -3	Severely undernourished (wasting and stunting)

Despite continued food shortages and high-transmission malaria season, all groups showed improvements in average z-scores.

A) Group 1 (FSC + Placebo A) showed an **11% reduction in stunting** over the 7 month period.

B) Group 2 (FSC + Vitamin A) showed a **15% increase in weight gain** at Final.

Conclusion

We all need micronutrients. In a world of shortages and social instability, an effective and efficient micronutrient delivery system is a must. The world's authorities concur that a fresh, varied and unprocessed diet is the best source of essential micronutrients. In the absence of this, the Kenya Study has proven the effectiveness of a food supplement concentrate, FSC, to;

- 1) Alleviate anemia**
- 2) Improve the immune system**
- 3) Eliminate VAD**
- 4) Reverse the ravages of malnutrition.**

This study recommends the implementation of a Public Health application using an FSC, such as Liqua-Health, is highly indicated as **an efficacious intervention and as a Right**; *its use should be advocated, especially among venerable populations.*

The specter of starvation and malnutrition has been a problem throughout the ages. A working solution is at hand, a perfect example of the world's emerging second green revolution; considering the need, not only for the essential macronutrients for energy requirements, but also the essential micronutrients necessary to promote health.

[1]

Nutrient requirements for people living with HIV/AIDS, WHO Report, May 2003

[2]

Child Mortality, WHO Bulletin, 2000

***FSC** – Manufactured under the trade name Liqua-Health™

[3]

Malaria and Anemia, Clara Menendez MD et al.,

[4]

Establishing human nutrient requirements for worldwide application, WHO, 2003

[5]

Iron, MedLine Plus, US National Library of Medicine, 2004

[6]

Iron, MedLine Plus, US National Library of Medicine, 2004

[7]

Guidelines for the control of Iron Deficiency Anemia, WHO, 1995

[8]

Iron Deficiency Anemia Finally Reaches the Global Stage of Public Health, Nutrition in Clinical Care
Volume 5 Issue 5 Page 217 - September 2002 doi:10.1046/j.1523-5408.2002.05502.x

[9]

Micronutrient Deficiency Information System, WHO, (MDIS), 2004

[10]

www.thewellproject.org

[11]

White Blood Cell and neutrophil counts following amodiaquine treatment, WHO, P. Olliaro et al

[12]

Combating Vitamin A Deficiency, www.WHO.int, 2003

[13]

Vitamin A Deficiency, Merck Manual