

The potential role for probiotic yogurt for people living with HIV/AIDS

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In demonstrating that it is feasible to create a community-run kitchen that produces probiotic yogurt, and that this can contribute to the health of people with HIV/AIDS, we embellished the 2001 Food and Agriculture Organization (FAO) and World Health Organization (WHO) Report on Probiotics that recommended efforts be made to take probiotics to developing countries. We proved that driven by humanitarian goals not profit, probiotic yogurt can be produced in the world's poor regions. This food can be safely consumed by HIV/AIDS subjects, and in many of them benefits can be accrued in gut health, nutritional and potentially immune status. Such outcomes have a scientific rationale, many social implications, and perhaps most importantly raise the question, why have developed countries not tried harder to bring nutrition-based probiotics to people in need?

Introduction

In 2003, United Nations Special Envoy for HIV/AIDS in Africa, Stephen Lewis challenged staff and students at The University of Western Ontario in Canada, to do something to help the people of sub-Saharan Africa facing enormous challenges from malnutrition and the adverse effects of HIV/AIDS. His oration led to the formation of Western Heads East (WHE), a group of university personnel committed to making a difference as challenged.

The Food and Agriculture Organization (FAO) and World Health Organization (WHO) challenged the

global scientific community working on probiotics ("live microorganisms which when administered in adequate amounts confer a health benefit on the host") to take these probiotic concepts to the developing world.¹ Through WHE, this outreach was achieved with the creation of Fiti probiotic yogurt produced in a community kitchen in Mwanza, Tanzania.

Yogurt Delivery System

The reason for selecting yogurt was several-fold. It can be produced in a sustainable manner locally and therefore doesn't rely on importation, and it provides nutrition and is an excellent carrier for probiotic organisms. The probiotic strain *Lactobacillus rhamnosus* GR-1 was selected because of its good survival in milk,^{2,3} and its ability to be delivered in a yogurt form,^{4,5} resulting in palatable taste and texture.⁴ In addition, a previous study suggested that this strain when added to yogurt could enhance immunity,⁵ and alleviate diarrhea in HIV subjects.⁶

The process of making the yogurt in an impoverished area, requires a reliable milk source and delivery (in our case by bicycle); burners to pasteurize the milk; refrigeration for storage; and most importantly a suitable site to store and propagate the bacterial cultures, and regularly test quality assurance.

The probiotic yogurt is a source of many important nutrients and energy-rich in protein and fat. It contains about 9 g of protein per serving yielding >15% of the recommended daily allowance and 8 g of fat per serving. In addition, it is a rich source of many micronutrients, including

zinc, phosphorous, calcium (33% of daily recommendation), pantothenic acid, vitamin B₁₂ (>40% of daily recommendation), and riboflavin. Based on Health Canada food standards the yogurt would be considered a “good source” of calcium (containing >15% of the daily value approximately 1,000 mg) and vitamin A (10% of daily recommendation).

Challenges Faced by the Community where the Yogurt is Made

Sub-Saharan Africa (SSA) has borne the burden of the global HIV/AIDS crisis with 70% of all reported HIV-positive cases located in the region.^{7,8} Of great concern, the disease is affecting the largest youth generation in history, and the most productive adults aged 20 to 40 years, leaving older family members and orphaned children to battle with stigma, ostracism, and the inevitable cycle of poverty and disease.

In Tanzania, the HIV/AIDS problem has increased overall medical expenditures, with an estimated 17 illness episodes requiring hospitalization and intensive care prior to death.⁹ Gender-based inequalities in health are marked by power imbalances between men and women, with women having little or no power to negotiate safe sex, and little or no control over contraception and their personal health, putting them at greater risk of becoming infected. African women aged 15 to 49 years are roughly 1.3 to two times more likely to be infected than men of the same age.¹⁰

The physical characteristics of homes are important determinants of the health and socio-economic status of household members. In the Mwanza Mabatini community where our studies have taken place, the challenges are enormous and emphasize why novel ways have to be created to bring probiotic foods to these people. In a randomly sampled population, 22% accessed their water from an unprotected public well, 88% were still using traditional pit toilets and 71% shared their sanitation facility with other households (Andoniou E, et al. unpublished). Flooring materials mostly comprised earth or sand (67%) with fewer able to afford cement (33%). The predominant

materials used for constructing walls in dwellings were poles and mud (67%), and sundried bricks (25 percent). About 35% of households used iron sheeting for roofing, and 67% have grass/leaves as their roofing material. The most commonly owned items were paraffin lamps (63%), radios (57%) and bicycles (35%). Only 12% of the sample owned a telephone, and none owned a television or a refrigerator as 98% of households did not have electricity. No-one owned a motorized vehicle. Forty three percent reported always having a problem in meeting daily food needs. Ninety eight percent of households stated that knowing where to access the required health services was a concern, and all indicated that medical facilities are not easily accessible due to distance, with 96% of respondents lacking the resources for public transportation. Ninety-four percent stated that paying for treatment posed a substantial barrier to obtaining health care. Although costs are covered for health services at government hospitals, prescriptions and treatments are an out-of-pocket expense.

Testing the Health Benefits of Probiotic Yogurt in this Population

There are three areas of interest in the potential effects of probiotic yogurt in this population: (1) Can it help general health in children and adults, including gut health and indicators of malnourishment? (2) Does it help to improve CD4 counts in HIV-infected subjects? (3) Does it have an impact on vaginal health, and potentially stabilizing the microbiota to one that lowers the risk of acquisition of HIV and other sexually transmitted pathogens?

The first study (Andoniou E, et al. unpublished) followed 49 male and female adults (age 35–45), with 29 receiving the probiotic yogurt (250 mL daily for 30 days) and 20 not. Five in each group were taking anti-retroviral therapy (ART).

Compliance was considered to be good, but on average, participants still missed 3–5 days yogurt, due to being too sick to travel, lacking a family member to assist with program adherence by delivering yogurt, or fear of domestic violence against women who were leaving the home to get yogurt. After beginning yogurt

consumption, almost all of the participants had marked improvements in their weight, and eight showed an improvement in their weight category, moving from severely to moderately underweight or from moderately underweight to mildly underweight. The consumers of the probiotic yogurt had significantly greater levels of thiamin, riboflavin, biotin, vitamin C, pantothenic acid, calcium ($p < 0.0001$), copper, phosphorus and potassium than controls (who had not consumed the yogurt) at end of study. An evaluation of health improvements was made from both self-perceptions and physician diagnoses. Consumers of the probiotic yogurt had significantly fewer fungal conditions over the time period of 60 days [$r = 0.417$, $n = 49$, $p < 0.01$], fewer episodes of diarrhea [$r = 0.372$, $n = 49$, $p < 0.01$], and substantially lower degree of fatigue [$r = -0.365$, $n = 49$, $p < 0.01$].

The findings, albeit preliminary, led to a second study based out of the Mwanza community kitchen, which has recently been published in reference 11. This was an observational retrospective longitudinal comparison of the development in CD4 count within subjects (before and during probiotic yogurt consumption) and between probiotic yogurt consumers and non-consumers. Yogurt was consumed for a median [range] of 357 [3–1,062] days (in other words at least once a week, but we could not confirm daily intake). A total of 68 yogurt consumers and 82 non-consuming controls participated in the study.

Before starting consumption, the 68 yogurt consumers had experienced an average increase in CD4 count of 0.16 cells/ μ L/day [95% CI; 0.06–0.27, $p = 0.002$]. After commencing consumption, probiotic yogurt participants had an additional increase of 0.28 cells/ μ L/day [95% CI; 0.10–0.46, $p = 0.003$]. When adjusting for length of time using ART medication, this remained 0.17 cells/ μ L/day [95% CI; 0.01–0.34, $p = 0.04$]. The additional CD4 increase during the first 70 days was 0.73 CD4 cells/ μ L/day [95% CI; -0.02–1.50, $p = 0.6$], and it continued to rise. After this initial period the CD4 count continued to rise at 0.2 CD4 cells/ μ L/day [95% CI; 0.03–0.4, $p = 0.02$].

To put these increases in perspective, studies have estimated that ART increases

the average annual CD4 count by 90 cells/ μ l versus an average decline of 20–50 cells/ μ l/year without treatment.^{12–14} If the results obtained with the probiotic yogurt could be extrapolated out to one year, this would not be too dissimilar to ART.

All participants, except one, completed a one-on-one interview, which provided an interesting perspective. Those who had received the probiotic yogurt reported the ability to work 8 hours a day, compared to 6 hours for the non-consumers ($p = 0.01$), and one day of fever a month compared to a median of 2 days a month ($p = 0.01$). Probiotic yogurt consumers stated no diarrheal symptoms during the study period (56 of 67 = 84%) compared to 57 of 82 (69%) participants not consuming yogurt ($p = 0.05$). Lastly, 45 of 67 (52%) probiotic yogurt consumers reported no impact (intermediate or severe) of gastrointestinal symptoms on everyday life compared to 24 of 82 (39%) among the non-consumers ($p = 0.004$).

Next Steps

Studies on the vaginal microbiota of a component of this Mwanza population have just been completed and have shown the presence of four bacterial vaginosis (BV) microbiota profiles dominated by clusters of Prevotella and Atopobium with Gardnerella, and two healthy clusters dominated by *Lactobacillus crispatus* and *Lactobacillus iners*.¹⁵ The extent to which probiotic lactobacilli in capsule or yogurt form can manipulate the vaginal microbiota remains to be determined.

In terms of the immune response to probiotic yogurt consumption, the results to date are insufficient to categorically claim that CD4 counts can be boosted. In a double blind, controlled trial of 112 HIV-positive subjects randomized to receive either a micronutrient fortified yogurt supplemented with ($n = 55$) or without ($n = 57$) *L. rhamnosus* GR-1, only subjects with advanced immune-suppression (200–350 CD4 cells/ μ L) experienced an increase in CD4 count (Hummelen R, et al. unpublished). This is the first time sub-sets of CD4 starting counts have been examined, and we can only hypothesize what is happening. Potentially, when the CD4 count is

lower than 350, the gut barrier function is more permeable and can be improved by the probiotic, and a degree of immune stimulation also induced. Further studies are needed to explore this phenomenon.

Encouragingly, the probiotic yogurt has now been consumed by several thousand children and adults in Mwanza, as well as in new kitchens in Kenya and Rwanda, without any reports of major side effects. In Mwanza, over 350 people consume it every day, of which around half are HIV positive. The overall experience is that gut health and general well-being is being improved, but without larger studies we cannot enumerate placebo effects, and the nutritional impact without the *L. rhamnosus* GR-1 strain.

In performing studies in this part of Africa, the challenges are substantial. Ethics review is done by a single national system which can take up to nine months; laboratories are under-funded and basic bacterial culture work requires payment, even though the beneficiaries are citizens of Tanzania; and the logistics of doing studies are not simple. Nevertheless, the potential benefits are in some cases life over death, or at least a significantly better quality of life.

Far be it for anyone to suggest that a fermented food could be equivalent to pharmaceuticals in terms of managing the HIV/AIDS crisis, but the issue warrants some discussion. The management of HIV/AIDS patients is complex and ART drugs can be exceedingly toxic,^{16,17} as well as expensive. Although ART is free to HIV infected patients in Tanzania, many people do not like the side effects especially when they have sub-optimal daily food intake. Others cannot pay for transportation to the clinic or for other medications that are recommended. The approach of developed countries in providing relief for the HIV positive populations is primarily to provide ART, as most drugs are developed and approved in the developed world. Consideration of using food to treat HIV/AIDS would be impossible, as the legislative process in developed countries defines a food as not being used to treat or prevent disease. While this is somewhat understandable in terms of controlling foods and drugs and setting standards of documentation

for claims, it tends to blind reasoning. We appear to have set views of what is feasible in the developing world, yet we fail too often to empower these populations who are not soon likely to build pharmaceutical factories and become self-sufficient in that regard.

For such a change in mindset to occur, and for data to be appropriately obtained to gauge the degree to which probiotic food can provide relief, governments (in developed and developing countries) and organizations such as WHO and the Bill and Melinda Gates Foundation may have to take a lead role. To date, there is no indication that the potential for this intervention is properly understood. Rather, there appears to be a perception that because it is not high scale or high tech, it won't work. While small community kitchens are far from the ultimate solution, they have the advantage of producing products from local resources, having them consumed within days without the requirement for cold storage and cold distribution networks, and empowering local people from the grass roots. If probiotic yogurt can improve the gut and general health of only a portion of an impoverished population, and enhance the immune status of only HIV positive subjects with a CD4 count between 200–350, and improve compliance and tolerance of ART, would this not be worthy of pursuit? Certainly, setting up social businesses that empower local people, could help rejuvenate communities. Many challenges remain, not the least of which is determining the mechanisms whereby lactobacilli and fermented milk affect an HIV infected host.

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