

## Role of Functional Probiotic Food Groups in Enhancing CD4 Cell Profile of HIV Infected Population – A Short Systematic Review

Subhasree Ray<sup>1\*</sup>, Lavish Vaidya<sup>2</sup>

<sup>1</sup>Food Science & Nutrition, SNTD Women's University, India

<sup>2</sup>Supal/ami-in research centre, USA

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**ABSTRACT:** HIV infection results in gastro-intestinal tract damage, microbial translocation and immune activation, which are associated with potential loss of CD4 + T cell count and persistent diarrhea. Increased morbidity and mortality of Anti-Retroviral Vaccine (ARV) treated individuals is associated with these dysfunctions. To enhance Gastro-Intestinal (GI) physiology of ARV treated-HIV infected population functional probiotic food groups' revealed great efficacy. Probiotics are food with live bacterial culture, sufficient amount of which can confer great benefit to gut health and thus exert positive health benefits. Prebiotics are fermented ingredients that increase both activity and composition of GI microflora. Synbiotics are combination of probiotics and prebiotics. The current short systematic review aimed to study the use of probiotics, prebiotics and synbiotics in recovering immunological parameter in HIV infected population by reducing microbial translocation and increasing CD4 cell numbers. The findings demonstrated significant increment of CD4 cell level when experimented with these food groups. The challenge is to ensure probiotics in daily diet of HIV infected population with recommended dosage. Nutritional education should be accelerated to promote a cup of yogurt as a great addition to the gut care regimen for HIV infected population.

**KEYWORDS:** ARV, CD4 Cell, GI Health, HIV, Probiotics

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### I. INTRODUCTION:

HIV is a retrovirus that causes Acquired Immune Deficiency Syndrome (AIDS). The most common type of HIV virus is known as HIV-1 & is the infectious agent that has led to the AIDS epidemic. HIV-2 subtype is less common and less virulent but eventually portraying clinical picture similar to HIV1. HIV-1 type has a number of subtypes (A through H & O) which are differing from geographic distribution but finally all produce a clinical manifestation of AIDS. [1] HIV is generally transmitted sexually by body fluids like blood, semen, and vaginal liquid. [2]The infection is aided by Langerhans cells in mucosal epithelial surface as well as aided by the presence of other sexually transmitted diseases that can produce mucosal ulceration and inflammation. [3] The CD4 +4 lymphocytes have surface receptors via which HIV can attach and promote entry into the cell. The infection extends to lymphoid tissues which contain follicular dendritic cells that can become infected and provide a reservoir for continuing infection of CD4+ T-lymphocytes. Typically, during the initial or primary infection, HIV levels are highest (> 10 rest 6 copies/ml) & circulating CD4 + Lymphocytes counts drop rapidly as per progression of infection. [4] Since people with HIV suppressed immune systems that leave the body open to higher risk of infections and cancer, it is especially important to follow a healthy and balanced diet as much as possible. [5] HIV infection result in damage and dysfunction of the GI tract. HIV enteropathy includes pronounced decrease in CD4+ T cells, increased intestinal permeability, and microbial translocation that promotes systematic immune activation, which is implicated in diseases progression. [4]

The gut is the home to countless micro-organisms that are imperative for proper digestion and a healthy immune response. HIV infection and life saving treatment disrupt the balance of healthy micro-organisms and enhances the growth of harmful micro-organisms that leads to risk of gut infection and gastro-intestinal disorders. The immune capacity of a person with HIV is determined by the number of functional CD4 cells in the blood. Gut is abundant with enough amount of CD4. [4] However, the gut health of a HIV infected person is immune compromised and the numbers of CD4 cell is decreased. The risk of infection increases with this low profile of CD4 in the population. Probiotics in this context help in repopulating the gut with 'friendly' bacteria those can promote the general immune response of the infected population. Those live cultures of micro-organisms if administered in adequate amount can confer great benefit to HIV infected population. [6]

**Molecular Mechanism of Infection Generation and Development:** HIV is a member of the family, Retrovirus. The genus Lentiviruses, is a "slow" virus characteristically responsible for long duration set of symptoms. Retroviruses are compared with a "Trojan horse" because of their unusual process of proliferation by basically remaining latent. Retroviruses are single stranded, positive sense, enveloped RNA viruses. Upon entry into the target cell, the viral RNA is converted into double-stranded DNA by a virally encoded enzyme "reverse transcriptase". The resulting viral DNA enters the host cell nucleus and integrates itself into the cellular DNA by a virally encoded host cofactors. Once integrated, the virus may act in two different scenarios; the first scenario is when the virus becomes latent, allowing the virus to avoid detection by the immune system. Alternatively, the second scenario begins when the virus starts producing new virus particles that initiate a new replication cycle. [7] Eventually, the death of CD4+ host cells causes a drop in the CD4+ count and the body's capability to fight infections decreases critically. At this point, HIV infection is called, Acquired Immune Deficiency Syndrome (AIDS). With high replication rate and high level of errors, Retroviruses mutate rapidly. In addition, HIV "envelope" obtained from host cells during viral replication makes it complicated for the immune system to distinguish between virus particles and healthy cells. [7]

**Probiotics, Prebiotics and Synbiotics – Functional foods for health promotion:** According to the German definition, probiotics are defined viable microorganisms, sufficient amounts of which reach the intestine in an active state and thus exert positive health effects. Numerous probiotic microorganisms (e.g. Lactobacillus rhamnosus GG, L. reuteri, bifidobacteria and certain strains of L. casei or the L. acidophilus group) are used in probiotic food, particularly fermented milk products, or have been investigated as well as Escherichia coli strain Nissle 1917, certain enterococci (Enterococcus faecium SF68) and the probiotic yeast Saccharomyces boulardii with regard to their medicinal use. Among the numerous purported health benefits attributed to probiotic bacteria, the (transient) modulation of the intestinal microflora of the host and the capacity to interact with the immune system directly or mediated by the autochthonous microflora, are basic mechanisms. They are supported by an increasing number of in vitro and in vivo experiments using conventional and molecular biologic methods. In addition to these, a limited number of randomized, well-controlled human intervention trials have been reported. Well-established probiotic effects are: 1. Prevention and/or reduction of duration and complaints of rotavirus-induced or antibiotic-associated diarrhoea as well as alleviation of complaints due to lactose intolerance. 2. Reduction of the concentration of cancer-promoting enzymes and/or putrefactive (bacterial) metabolites in the gut. 3. Prevention and alleviation of unspecific and irregular complaints of the gastrointestinal tracts in healthy people. 4. Beneficial effects on microbial aberrancies, inflammation and other complaints in connection with: inflammatory diseases of the gastrointestinal tract, Helicobacter pylori infection or bacterial overgrowth. 5. Normalization of passing stool and stool consistency in subjects suffering from constipation or an irritable colon. 6. Prevention or alleviation of allergies and atopic diseases in infants. 7. Prevention of respiratory tract infections (common cold, influenza) and other infectious diseases as well as treatment of urogenital infections. Insufficient or at most preliminary evidence exists with respect to cancer prevention, a so-called hypocholesterolemic effect, improvement of the mouth flora and caries prevention or prevention or therapy of ischemic heart diseases or amelioration of autoimmune diseases (e.g. arthritis). [8]

A prebiotic is "a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well being and health", Today, only bifidogenic, non-digestible oligosaccharides (particularly inulin, its hydrolysis product oligofructose, and (trans) galactooligosaccharides), fulfill all the criteria for prebiotic classification. They are dietary fibers with a well-established positive impact on the intestinal microflora. Other health effects of prebiotics (prevention of diarrhoea or constipation, modulation of the metabolism of the intestinal flora, cancer prevention, positive effects on lipid metabolism, stimulation of mineral adsorption and immune-modulatory properties) are indirect, i.e. mediated by the intestinal microflora, and therefore less-well proven. In the last years, successful attempts have been reported to make infant formula more breast milk-like by the addition of fructo- and (primarily) galactooligosaccharides. [8]

The term synbiotic is used when a product contains both probiotics and prebiotics. Because the word alludes to synergism, this term should be reserved for products in which the prebiotic compound selectively favors the probiotic compound. In this strict sense, a product containing oligofructose and probiotic bifidobacteria would fulfill the definition, whereas a product containing oligofructose and a probiotic Lactobacillus casei strain would not. However, one might argue that synergism is attained in vivo by ingestion of lactobacilli on the one hand and promotion of indigenous bifidobacteria on the other hand. [9]

***Etiologies and Manifestations of Gastro-Intestinal disorders in Adults with HIV Infection:*** Gastrointestinal and hepatobiliary disorders are the most frequent complaints in patients with HIV infection. Advances in antiretroviral therapy are changing the nature of HIV disease and affecting many of the gastrointestinal manifestations. Before combination antiretroviral therapy, the best estimates suggested that 50 to 93% of all patients with HIV disease had marked GI symptoms during the course of their illness. Gastrointestinal (GI) manifestations of HIV disease include diarrhea, dysphagia and odynophagia, nausea, vomiting, weight loss, abdominal pain, anorectal disease, jaundice and hepatomegaly, GI bleeding, interactions of HIV and hepatotropic viruses, and GI tumors (Kaposi's sarcoma and non-Hodgkin's lymphoma). The evaluation of specific gastrointestinal complaints must be based on an assessment of the degree of immune-suppression. Progressive immune-compromise is associated with increasing prevalence of GI symptoms and remains the common endpoint for most individuals infected with HIV. [10] In a situation where immunodeficiency develops in HIV-infected individuals, one of the hardest-hit organs is the intestine. First, the enterocytes can undergo atrophy, as a result of the HIV virus infecting the enterocytes and damaging their function. Second, as the intestine is the largest immunological organ in the body, destruction of immune-competent cells in the intestine will cause intestinal dysfunction, which is among several symptoms observed in diarrhea.

Numerous studies have shown that diarrhea in HIV/AIDS can be caused by common pathogens, including viruses, fungi, bacteria and helminthes. What also complicates the situation is that, as well as infection by regular pathogens, the risk of infection by opportunistic agents increases as the patients become immunocompromised. There is however no specific mix of pathogens and opportunistic agents present in HIV-associated diarrhea, but the enteric pathogens vary from patient to patient and from country to country. One pathogen, which in immunocompromised HIV-positive individuals can cause chronic diarrhea, is *Cryptosporidium*. In immunocompetent individuals this infection is usually self-limiting, but not in HIV-positive immunocompromised individuals. Generally, no effective treatment of chronic diarrhea in HIV-positive immunocompromised individuals is available, but the mainstay of treatment is treatment with antiretroviral therapy (ART).

Some studies report high yields of identified causative agents while others report low figures. Though diarrhea is not life-threatening, but can severely hamper daily activities and lower quality of life. Diagnostic efforts should be made to try to find the causative agent and to treat with antibiotics and other specific therapies if possible. One study suggested that in immunocompetent individuals, defined as those with a CD4+ count of  $>200/\mu\text{L}$ , the infecting agents were ordinary pathogens, while in individuals with a CD4+ count of  $<200/\mu\text{L}$ , the infecting agents were opportunistic agents. However, the mainstay of therapy in chronic diarrhea of HIV-positive individuals in countries where it is economically and socially feasible is treatment with highly active ART (HAART). The risk of chronic diarrhea in HIV-positive patients has been reduced dramatically where HAART is accessible, and the decision to introduce HAART is now taken at higher CD4+ levels. Persistent ( $\geq 7$  days) diarrhoea affects up to 95% of persons with AIDS, frequently causing malabsorption, significant weight loss (slim disease), higher rates of extra-intestinal opportunistic infections, and increased mortality. Shigellosis, *Campylobacter* infection, and cryptosporidiosis occur relatively more frequently in HIV-1-infected persons than in persons without HIV-1 infection. Some agents produce diarrhoea almost exclusively in HIV-1-infected persons (e.g., *Mycobacterium avium* complex, cytomegalovirus, and HIV-1 enteropathy). Others cause more severe, more prolonged or more often recurrent diarrhoea in the presence of HIV-1 infection (e.g., *Cryptosporidium* species; *Isospora* species; *Salmonella* species; astrovirus, adenovirus, calicivirus, and, perhaps, *Microsporidium* species; *Cyclospora cayetanensis*; *Shigella* species; and *Campylobacter* species). Some agents apparently have unaltered courses but occur commonly in HIV-1-infected persons (e.g., *Clostridium difficile*).

***Gastro-intestinal disorders and probiotics:*** Probiotics have been used in a variety of gastrointestinal illnesses with varying degrees of success and supporting evidence. The proposed mechanisms of action for their benefit are multiple and include suppression or displacement of pathogenic bacteria, enhancement of innate immunity, and promotion of epithelial barrier function. [11,12] They are most often recommended to treat irritable bowel syndrome (IBS), antibiotic-associated diarrhea (AAD), *Clostridium difficile*-associated diarrhea (CDAD), and inflammatory bowel disease including pouchitis in addition to other gastrointestinal and non-gastrointestinal illnesses.[13,14] Commonly used protective microorganisms include various species of *Lactobacillus* and *Bifidobacterium* in addition to nonpathogenic *Escherichia coli* Nissle 1917, *Clostridium butyricum*, *Saccharomyces boulardii*, and *Streptococcus salivarius*.

**EVIDENCE ACQUISITION:** We have searched databases including the PubMed, EMBASE and Scientific Information Database (SID). All of those searches include evidences from clinical control trial and respective outcome between January 1998 and November 2014. Most of the data is recent and relevant. The detailed search strategy for each database is available as supporting information. The bibliographies of included studies were searched for additional references as unpublished studies. Two authors independently searched the titles, abstracts and key works of each searched article for potentially eligible studies.

**CURRENT STATUS OF KNOWLEDGE:** The gut harbors roughly 100 trillion microorganisms that help with immunity and digestion. HIV researchers have known since the early days of the pandemic that HIV can wreak havoc on the gut, which is home to an abundance of CD4 cells. This apparently occurs quite soon after someone is infected with HIV. Moreover, modern antiretroviral medications though well tolerated are causing serious gastro-intestinal disorders including nausea, vomiting, gas, or diarrhoea from mild to severe form. Yogurt as a delicious snack for many people, a healthy alternative to most pastries or potato chips can also raises CD4 counts and protect against some HIV-related Gastro-intestinal infections as this is an enriched source of probiotics.

A recent article explores the connection between yogurt consumption and gastrointestinal health, or "gut health," for people with HIV. Microbiologist Gregor Reid of Lawson Health Research Institute in Ontario, Canada, has been studying the health benefits of probiotics for over 25 years. He's created his own probiotic, called *Lactobacillus rhamnosus* GR-1, which he has put into a yogurt that is being used in research involving people with HIV. Reid and others around the world have conducted small studies that show probiotics have a positive effect on CD4 counts, though larger studies are certainly needed to confirm those findings. One of the studies involving Reid's probiotic yogurt is based in Tanzania, a country with one of the highest HIV rates on the world. In Mabatini, a small Tanzanian village, women nicknamed "yogurt mamas" are taught by North American interns the ins and outs of culturing yogurt with Reid's special probiotic. The women then sold cups of yogurt to the community, reserving 125 cups to be given for free to Mabatini's HIV-positive residents as part of the study. [15]

Researchers believe that supplementation with prebiotics and probiotics can help lower the risk of infection and inflammation for HIV patients taking antiretroviral drugs (ARVs). Jason Brenchley, of the U.S. National Institute of Allergy and Infectious Disease, and others were aware that people treated with ARVs have a higher mortality rate than uninfected individuals, and that HIV infection causes gastrointestinal (GI) tract damage, microbial translocation, and immune activation. Based on the results of the research, the team suggested that pre- and probiotics could provide adjunctive therapy for HIV infection that is well tolerated and inexpensive. Brenchley and colleagues treated macaques infected with simian immunodeficiency virus (SIV), a model of the human infection, with either ARVs alone or ARVs in combination with a symbiotic mixture of probiotics and prebiotics. Seven SIV-infected macaques received the symbiotic mixture of prebiotic inulin and a probiotic for 60 days. These macaques were found to have GI immune function and decreased inflammation compared to the control group. The subjects who received probiotics showed increased frequency and functionality of the GI tract. According to Brenchley and colleagues, symbiotic treatment resulted in increased frequency and functionality of GI tract APCs, enhanced reconstitution of and functionality of CD<sup>+</sup> T cells, and reduced fibrosis of lymphoid follicles in the colon. [16]

An observational retrospective study over a period of 3 years by Irvine et al was conducted to evaluate long term effect of probiotic yogurt supplemented with *Lactobacillus rhamnosus* Fiti on the immune function, defined by CD4 count among the people living with AIDS. The longitudinal comparative study found that, after commencing consumption, yogurt consumers experienced an additional increase of 0.28 cells/ $\mu$ L/day. Later the adjustment of the dosage with antiretroviral medication showed 0.27 cells/ $\mu$ L/day. The study introduced probiotic yogurt, made by local women in a low income community in Tanzania and found significant association between consumption of the yogurt and increase in CD4 count among HIV population. [17] The first study regarding benefits of probiotic yogurt on quality of life of women in Nigeria with HIV/AIDS depicted that yogurt containing *Lactobacillus rhamnosus* GR – 1 and *L. reuteri* RC-14 helped resolving moderate diarrhoea and increased CD4 count in HIV female patients aged between 18-44 years. The women had clinical signs of moderate diarrhoea, CD4 counts over 200 and not receiving antiretroviral or dietary supplements. One group of women was supplemented with 100 ml of yogurt per day for 30 days. Baseline, 15 and 30 days post-probiotic yogurt feeding were recorded respectively. The mean CD4 cell count increased at 15 to 30 days in 11 out of 12 probiotic treated patients compared to 3 out of 12 patients in the control group. Diarrhoea, flatulence and nausea were reported to be resolved in all participants, treated with probiotics in 2 days compared to the control group. [18]

HIV potentially infects and destroys CD4+ cells and leads to a gradual decline in the no. of CD4 cells. Su Y et al tried to understand interaction between lactobacillus and HIV by investigating the cell surface protein of lactobacillus and its role in blocking HIV – 1 transmission, by applying reverse transcription polymerase chain reaction. The findings showed that lactobacillus can use the receptors to bind HIV and block HIV infection. This may increase the CD4 T lymphocyte count in patients with HIV. The data provided direct evidence that lactobacillus expresses the CD4 receptor and utilizes that to block HIV transmission. [19] A Four week, randomized placebo-control trial with a symbiotic dietary supplement in chronic HIV – 1 infected woman on ART was conducted to study the efficacy of a symbiotic formulation containing 4 strains of probiotic bacteria and 4 non-digestible, fermented dietary fibre and restoring intestinal structure and functional integrity. Two groups have received the synbiotic formula and fibre only placebo formulation respectively. The synbiotic formulation significantly elevated levels of supplemented probiotic bacterial strains in stool including *L. plantarum* and *P. pentosaceus*, with the colonization of these two species being positively co-related with each other. T – Cell activation phenotype of peripheral blood lymphocytes showed modest changes in response to synbiotic exposure. In addition, CD38 expression on CD38 + T cells was lower in the fibre only group. The application of synbiotic treatment successfully increased the level of probiotic species in the gut during chronic HIV-1 infection. There was no significant presence of associated change in microbial translocation and markers of systematic immune activation appeared largely unchanged. [20]

Another double blind randomized controlled pilot trial showed synbiotic therapy decreased microbial translocation inflammation and immunological status in HIV infected people. The study involved four groups who were given a synbiotic, probiotics, a prebiotic and a placebo respectively for 16 weeks. From baseline to 16<sup>th</sup> week, the synbiotic groups demonstrated a decrease in bacterial DNA concentration in plasma. The probiotic and synbiotic groups demonstrated a decrease in DNA concentration in plasma. The probiotic and synbiotic groups showed a decrease in total bacterial load in faeces. The probiotic group exhibited a significant increment of beneficial bacterial load and a decrease in harmful bacterial load. In the synbiotic group, the CD4+ T cells count increased and the level of interleukin 6 cytokine decreased significantly. This study showed a significant increase in CD4+ T lymphocyte level in the synbiotic group that could delay the initiation of anti-retroviral therapy. Authors pointed out the novel aspect of consuming live bacterial cultures to decrease the costs in developing countries in the treatment of AIDS. [21]

A randomized-double blind-controlled study was conducted for 25 weeks among 65 HIV infected women in ART. Women were randomized to receive oral capsules containing *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14 or placebo. The CD4 count and immune markers (IgG, IgE, IFN $\gamma$  and IL 10) were measured at baseline and during follow up, the occurrence of diarrhea was reported daily. From baseline to 10 weeks follow up, the CD4 count declined on average 3 CD4 cells/ $\mu$ L with placebo versus 46 cells/ $\mu$ L an increase of 50 cells/ $\mu$ L with probiotics. During follow up at 25<sup>th</sup> weeks, the CD4 count increased with 19 cells/ $\mu$ L in the placebo versus 46 cells/ $\mu$ L with probiotics. There was no significant difference in immune markers, diarrhoea incidence or adverse effects were observed. [22] Micronutrient supplementation has been shown to reduce the progression of HIV but does not have an effect on the intestinal barrier or the intestinal microbiota of HIV patients but probiotics can potentially complement micronutrients in preserving the immune function of HIV patients. A randomized, double blind, controlled trial was conducted to study the effect of micronutrient and probiotic fortified yogurt on immune function of anti-retroviral therapy naïve 112 HIV patients. A total of 57 patients received micronutrient fortified yogurt and 55 patients received placebo for four weeks. The observation demonstrated an average decline in CD4 count of -70 cells/ $\mu$ L in the micronutrient probiotic group versus a decrease of -63 cells/ $\mu$ L in the micronutrient controlled group. There was no difference between groups was detected in incidence of diarrhoea or clinical symptoms. Hummelen R et al concluded that the addition of probiotics to a micro-nutrient fortified yogurt was well tolerated by HIV patients. [23]

## II. DISCUSSION:

The hypothesis that probiotic administration protects the gut surface and could delay progression of Human Immunodeficiency Virus type 1 (HIV-1) infection to the Acquired Immunodeficiency Syndrome (AIDS) was proposed in 1995. Over the last five years, new studies have clarified the significance of HIV-1 infection of the gut associated lymphoid tissue (GALT) for subsequent alterations in the microflora and breakdown of the gut mucosal barrier leading to pathogenesis and development of AIDS. Opportunistic agents' induced Persistent diarrhea is most common in patients with HIV infections. Current studies show that loss of gut CD4+ Th17 cells, which differentiate in response to normal microflora, occurs early in HIV-1 disease. Microbial translocation and suppression of the T regulatory (Treg) cell response is associated with chronic immune activation and inflammation. Combinations of probiotic bacteria which upregulate Treg activation have shown promise in suppressing pro inflammatory immune response in models of autoimmunity including inflammatory

bowel disease and provide a rationale for use of probiotics in HIV-1/AIDS. Disturbance of the microbiota early in HIV-1 infection leads to greater dominance of potential pathogens, reducing levels of bifidobacteria and lactobacillus species and increasing mucosal inflammation.

### **III. CONCLUSION - WAY FORWARD AND FUTURE DIRECTIONS:**

Patients are usually diagnosed with diarrhoea when three or more defecations occur per day; chronic diarrhea is diagnosed when this pattern is sustained for more than 3 months. Chronic diarrhoea is not a life-threatening condition, but it can severely diminish quality of life. In conditions of poor sanitation it places a particularly heavy psychological and social burden on afflicted patients. Chronic diarrhea in HIV patients is also an AIDS-defining condition, according to World Health Organization (WHO) criteria. To include probiotics as a functional food in the daily diet of the HIV infected patients is a two way challenge for the future – socioeconomic challenge and medical challenge. Socioeconomically, the overall aim for HIV-associated diarrhea should be that all disease-stricken individuals should have access to HAART, ensured sound hygiene, counseled for proper sanitary habits and followed up regularly to keep them away from additional development of GI disorders. Along with that a proper medical investigation and directed observation therapy should be undertaken for each individual with specific strategy. Once these are managed, the challenge is to ensure that antiretroviral agents can act optimally and distributed among all affected individuals. In doing so, there should be a high emphasis on good and adequate therapeutic nutrition based on probiotic functional groups to support GI health.

However, the world's resources are limited, especially in the developing countries. One priority would under such circumstances is to try to club the application of antiretroviral agents or HAART with adequate nutritional support. Probiotic based remedies can have a crucial role in sustaining CD4+ levels and can also diminish viral load, thereby saving time until the introduction of antiretroviral agents. Metabolic and digestive adverse affects of ART, including HAART, compelled to think for an optimum support derived from probiotic food groups as evident by existing literature. A dosage specific probiotic intervention can also be planned to treat each individual separately. A rationale plan of action with effective execution strategy has to be developed to support the HIV infected population, especially in developing countries. Researchers are still far from a verdict on the benefits of probiotics, but they all seem to agree that the yogurt can't hurt or can cause any severe physiological damage unless an individual is having any type of intolerance factor. Considering the connection between the gut and immune function, taking care of gut is an excellent idea to manage HIV infected situation. A good old-fashioned cup of yogurt or a yogurt smoothie, even can be a great addition to the gut care regimen.

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