

ONE HEALTH, FERMENTED FOODS AND GUT MICROBIOTA

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Abstract

The microbioma is presently one of the hottest areas of scientific and medical research and exerts a marked influence on the host during homeostasis and disease. Fermented foods arise in the human relationship to the microbial environment. Further to the traditionally recognized effects of fermented foods and beverages on the digestive health and well-being there is now strong evidence on their general health benefits, namely the significance on the gut microbiota and brain functionality. We highlight the possibilities in this field, how little is still known, and call for a convergence of interdisciplinary research fields of One Health microbe-nutrition with fermented foods and gut-brain research. A consequence of civilisation, changes in present-day society in diets with more sugar, fat and salt, habits and lifestyle, contributes to the likelihood of an inflammatory microbiome, particularly the global epidemics of obesity and mental health. Although two recent papers claim that probiotics perturb rather than aid in microbiota recovery back to baseline after antibiotic administration in humans, consuming fermented foods has shown to reduce inflammation so improve gut health and the proper function of the body's immune system.

Keywords: *One Health, fermented foods, microbiota, nutrition*

Introduction

The microbioma is presently one of the hottest areas of scientific and medical research and exerts a marked influence on the host during homeostasis and disease. Humans as hosts have co-evolved with microbes over thousands of years, and each body habitat has

a unique set of microorganisms shaping its microbiota. These bacteria live on the skin, in the corners of the eyes, in the oral cavity, under fingernails, and most importantly in the guts. Until recently, the healthy placenta was considered to be a sterile organ but now is known to harbour a unique microbiome [1].

And science and medicine are now becoming fully aware that one cannot be healthy without the right mix of bacteria in the microbiota, our “forgotten organ”, and the host–microbe interactions occurring in the intestinal mucosa [2]. Indeed, there are 10 times more cells from microorganisms like bacteria and fungi in our bodies than there are human microscopic cells naked to the eye.

Many species of bacteria, specifically those found in the invisible universe of human microbiota, composed of nonpathogenic commensal microbiota from the *Firmicutes*, *Tenericutes*, *Proteobacteria*, *Bacteroidetes*, and *Fusobacteria* phyla, are resistant to isolated petri dish cultivation. They can be successfully cultivated in association with other microbes, meaning in communities of different bacteria species. But without being able to isolate them research is difficult. That is why research is being conducted to create new technologies in order to study the rest of the human microbiome [3].

Despite the impact of fermented foods and beverages on gastro-intestinal wellbeing and diseases, their many health benefits or recommended consumption has not been widely translated to global inclusion in world food guidelines [4]. When fermented foods and beverages are supplemented with probiotic bacteria, they provide numerous extra nutritional and health characteristics [5].

Young individuals with autism often have a reduced number of microorganisms in the gut and atypical digestive health conditions like chronic gastrointestinal and functional bowel disorder causing discomfort, diarrhoea and bloating, abdominal pain and cramping, described as irritable bowel syndrome (IBS) [6]. Children with autism spectrum, besides the genetic predisposition show a disruption of the indigenous gut flora and an elevated number of promoting the overgrowth of potentially pathogenic (toxin-producing) *Clostridia* in the gut [7]. The effectiveness of fermented foods, mushroom biomass and probiotics in relieving gut symptoms in autistic children has been studied [8][9][10].

The One Health concept, introduced at the beginning of the 2000s, is a worldwide strategy for promoting interdisciplinary partnership and information in all facets of health care sciences, perceiving the interrelationship between humans, animals, plants, and their

common environment [11]. By working with physicians, veterinarians, osteopathic physicians, dentists, pharmacists, nurses, ecologists, wildlife professionals, and other scientific-health and environmentally related specialists will be possible to monitor and control public health threats and to learn about how diseases spread among people, animals, and the environment [12].

The point of this mini review is to highlight the possibilities in this field, how little is still known, to call for a convergence of the research fields of One Health microbe-nutrition with fermented foods and gut-brain research. There is indeed more research concerning isolated probiotic commercial supplements in this field than there is work concerning the health benefits of common fermented foods, since major industries usually do not fund this type of research. Besides, probiotics are no panacea and most studies look at probiotics in stool samples, not directly in the gut, and future progress may shift from one-size-fits-all, universal company-made probiotics to personalized probiotics or fermented foods based on individual needs.

Fermented foods, body and mind

Fermentation brings about changes in yeast and microorganisms, in the absence of air and fermented foods retains its enzymes, vitamins and minerals, which are usually destroyed by processing.

The use of fermentation in conserving food and beverage, as a means to provide better taste, improve nutrition and food safety, bio preserve foodstuffs, and promote health properties, is a well-known ancient practice. Traditional and modern dietary practices utilise fermented foods and beverages contributing significantly to the food chain value and belong to a category of foods called “functional foods” by having an additional function health-promotion or disease prevention effect.

Fermentation may enhance the described benefits of a wide variety of foods, herbs and beverages, acting upon the absorption and activity of their secondary metabolites and chemical elements. There is recent evidence on the health benefits of fermented foods and beverages, beyond the popular recognized effects on the gastrointestinal function, namely their relevance on gut microbiota, correlated to human health and to several infectious, inflammatory and neoplastic disease processes [13], and brain functionality [14].

Despite the disagreement among mental health practitioners and researchers pertaining to the aetiology, categorization and medical care of several mental disorders, current research regarding fermented foods, the microbiome, and their effect on human health, particularly the global epidemic of mental health, describe the problems as associated with the modern lifestyle and western diet being high in sugar and saturated fat [15].

It is implicated in causing the degradation of the intestinal mucous membrane, contributing to weaken the tight barrier against the ingress of harmful substances, and the protection against a reaction to omnipresent harmless compounds. Ingestion of vibrant probiotics, especially in fermented foods, is found to cause significant positive improvements in balancing intestinal permeability and barrier function, with indirect effects on depression, anger, anxiety, and levels of stress hormones [16].

An intestinal 'inflammatory microbiome' appears to exist, one that may contribute to altered mood via intestinal permeability, systemic and local lipopolysaccharide (LPS) burden, and even direct-to-brain microbial communication [17].

In the developing world, when poor people has not enough food, main priority is not hygiene, safety and nutritive factors and they consume less nutritious and non-healthy diets where chemical, microbiological, zoonotic and other hazards pose a health risk [18]. Nevertheless, in Africa, estimates for mental disorders and depression vary widely but seemingly less common than in developed societies, but factors other than diet exist that exacerbate them such as socio-economic changes, urbanicity, alterations in dietary habits and, more recently, the sedentary behaviour on youth [19].

People from Sub-Saharan Africa, often plagued by civil conflicts, drought, floods, famine and disease, but with huge biodiversity of plants and herbs, tend to rely on traditional healers who often interpret mental illness in terms of possession or curse and tackle mental health, among other typical rituals, also by advising traditional plants, herbs, fermented foods and beverages [20][21]. Many rural communities in Africa rely totally on traditional fermented foods as the primary source of nutrition for nourishing objectives and cultural traditional practices [22].

In Mozambique and Zimbabwe is normal that traditional fermented foods are even used for weaning from the age of four months. The commonest fermented foods known are *mahewu*, a traditional fermented, malted sour, non-alcoholic maize or cassava thin porridge), sour milk and sour porridge [23].

Is now well established that gut bacteria is closely tied to immune health [24]. A large majority of the immune system resides in the tonsils and gut, so when gut health is imbalanced, it is hard for the body's immune system to function properly. There are also a number of factors common in modern life that can throw human's gut bacteria off, such as processed foods and antibiotics. The use of antibiotics does have several short and long-term implications in the ecology of the normal gut microbiota [25].

Two remarkable and perhaps controversial very recent papers claim that probiotics perturb rather than aid in microbiota recovery back to baseline after antibiotic administration in humans and improved by autologous faecal microbiota transplantation (FMT). Indeed they suggest that probiotics might not be quite as good for us as commonly thought and says they could even be harmful if taken after antibiotics [26][27].

Our guts control and deal with every aspect of our health. How we digest our food and even the food sensitivities we have is linked with our mood, behaviour, energy, weight, food cravings, hormone balance, immunity and global wellness [28]. Our microbiota is essentially what determines our overall health. Eating fermented foods, especially organic vegetables, unpeeled and unpasteurized, supply the fibres, minerals, vitamins, and trace-elements found in freshly-harvested vegetables, together with enzymes, lactic bacteria, and lactic acid, which are all important for health.

Each person is unique in their needs and sensitivities. Fermented foods (e.g. aged cheese, red wine, and sauerkraut) may be very therapeutic for some while others may have an intolerance to histamine since there is no histamine free diet. This amine occurs naturally and is a neurotransmitter in the central nervous system [29].

One Health approach

FAO, OIE and WHO have recognized a joint responsibility for addressing zoonotic and other high socio-economic impact diseases. These international U.N. Organisations developed a Tripartite Concept Note setting a course of action and proposing a long time frame for global partnership oriented to coordination of global activities addressing health hazards and risks at the human-animal-ecosystems crossroads [30].

Recognising the health hazards and risks at the human–animal–ecosystems interface is a key element of their stoppage and management. The One Health approach is critical to attend prevalent public health concerns, which comprise emerging infectious, parasitic

and zoonotic diseases. Some 60% of human infectious diseases (zoonoses) are of animal origin, while 75% of emerging animal (even aquatic) diseases/pathogens can be transmitted to humans. Some 80% of agents that can be used for potential bioterrorism are also pathogens of animal origin [31].

Through strong partnerships with human, animal, environmental health and civil society organizations it is possible to stimulate advances concerning a safe and secure world with less infectious disease threats to human security.

Dealing with fermented foods, is studying the links between human, animal, environment, foods and microbiota that impacts the organoleptic and physicochemical characteristics of foods as well as human health [32]. Fermentation convert sugars, in the absence of oxygen, into organic acids, gases, alcohols, and carbon dioxide, and provides several benefits such as new and desirable tastes and textures, enhancement of nutrients (e.g. linoleic acid; bioactive peptides;), removal of toxic or undesirable food constituents (e.g. phytic acid; bitter-tasting phenolic compounds), delivery of probiotic bacteria (e.g. *Lactobacillus delbrueckii*; *Streptococcus thermophiles*) and inhibition of foodborne pathogen.

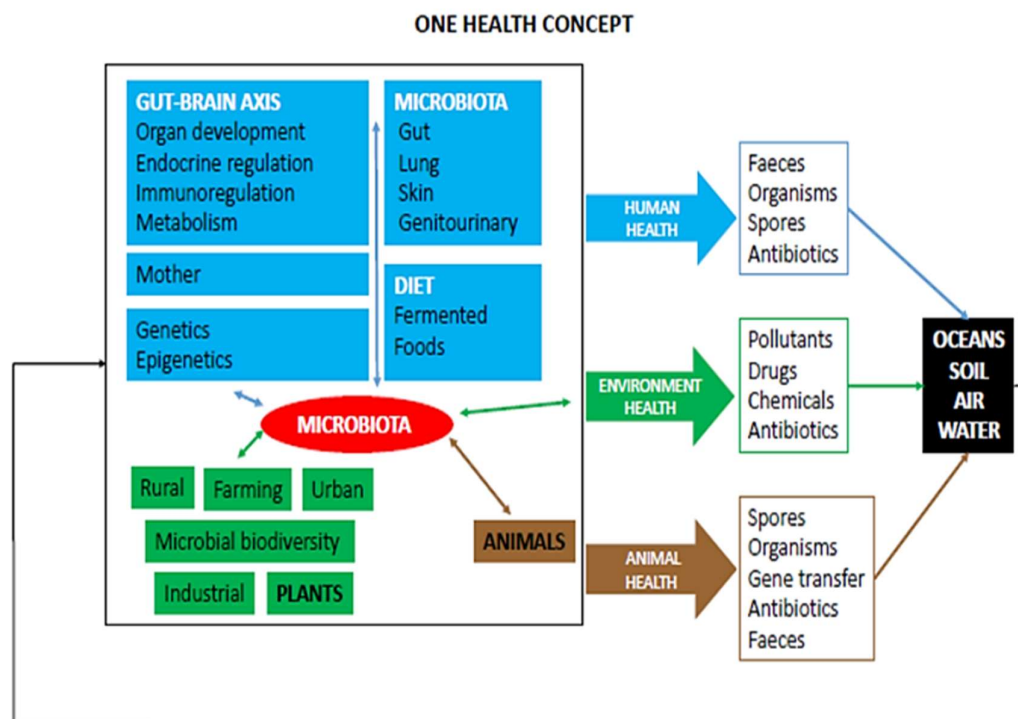


Figure 1. A general picture of the One Health concept as a multidisciplinary effort.

Having an active and natural variety of microorganisms in the gut may improve general health. The good healthy bacteria make food more digestible through their own enzymes, increase vitamin synthesis, preserve nutrients, help reduce sweet cravings, keep the immune system and benefit the gut overall wellness. Research on the health benefits of probiotics is still emerging and mainly from food and beverage industry and their commercial interests while strong independent scientific evidence to support specific uses of probiotics for most health conditions is still inadequate.

Serious disorders such as obesity, anorexia, irritable bowel syndrome (IBS), autism and posttraumatic stress disorder (PTSD) – that have been thought to be solely psychological – share a common symptom: a hypersensitivity to gut stimuli. Autism (ASD, autism spectrum disorder), usually linked with dreadful gut concerns, may heal with many fermented foods (e.g. fermented raw coconut milk).

One Health and Ecosystems

A complete understanding of human several microbiomes in various body mucosa and surfaces is dependent on the evolutionary perspective. The coevolution of humans and development of microbiota generated host-specific microbiome structures and gut homeostasis with physiologic, metabolic and antigenic diversity [33].

There is an increase connectivity between humans, domestic pets, wildlife, farm animals, and real-world issues such as sanitation, economics and food security. Ecosystems and landscapes and a One Health paradigm, including social-ecological holistic systems approaches, becomes increasingly important [34][35].

Fermentation as a human ecological process begins with the symbiotic human relationship with the microbial habitat [36]. Lifestyle, well-being and even survival of humans have been connected to single-celled microorganisms' fungi (yeasts) and bacteria on fermentation ecosystems [37]. The concept of a whole ecosystem is unpopular and many have abandoned the idea that ecosystems have boundaries [38]. In future the ecology of human nutrition may be studied on fermentation ecosystems models.

Conclusions

All life systems are inevitably connected with ecological processes, and the original culture complexity which prevails the longest are those that mimic the dynamics of ecosystems.

Fermented food microbiology is an excellent model that visions into the dynamics that shape the human microbiota in different body sites. Perceiving microbial community's interactions will help revealing, via a holistic approach, the unknown secrets of the human microbiome and interactions greatly influencing multiple forms of human health, nutrition and well-being.

It is not easy to apply the interdisciplinary research and education required by the One Health approach due to its complexity but the associated human-animal-environmental health threats and risks demand that many challenges and handicaps are surpassed.

Further research is needed to clarify the relevance, and potentially the necessity, of certain fermented foods and beverages for the humanity and advocacy for inclusion into dietary guidelines.

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