

# Exploring the Scope of Probiotics to Combat Infectious and Nutritional Challenges across Africa

*Laverdure Tchamani Piame*

## ABSTRACT

### Context and objectives:

Probiotics are garnering significant interest for the prevention and management of infectious and nutritional diseases in Africa, a continent where malnutrition, HIV, and respiratory or diarrheal infections remain formidable challenges. However, clinical data regarding the use of specific probiotic strains in African populations are rarely synthesized. This review aims to provide a thorough overview of the current state of knowledge on probiotic applications for human health in Africa.

### Search strategy

A targeted literature search was conducted in PubMed, Scopus, and Web of Science using MeSH terms and free-text keywords on November 2025, with priority given to randomized controlled trials and pilot studies conducted in African populations

### Clinical evidence and health impacts

The evidence demonstrates that specific probiotic strains significantly reduce the duration and severity of acute infantile diarrhea and promote the restoration of beneficial gut microbiota in malnourished children. Furthermore, probiotics show promise in modulating systemic immunity and managing urogenital infections. However, their impact on anthropometric growth and respiratory infections remain modest and inconsistent across studies. Notably, a critical finding suggests that certain strains might increase HIV vulnerability by elevating activated endocervical CD4<sup>+</sup> receptors.

**Future Outlook:** Probiotics represent a potent, low-cost therapeutic avenue for Africa, yet current data are insufficient to support generalized clinical guidelines.

**Key-words:** Probiotics, Infectious diseases, Nutritional diseases, Africa.

[GJMEDPH 2026; Vol. 15, issue 4 | OPEN ACCESS](#)

**1\*Corresponding:** Laverdure Tchamani Piame, ORCID: <https://orcid.org/0000-0003-2247-1084>, School of Biomedical Sciences, Faculty of Medicine and Health Sciences, Walter Sisulu University, Mthatha, South Africa; [ltchamanipiame@wsu.ac.za](mailto:ltchamanipiame@wsu.ac.za)

**Conflict of Interest—none | Funding—none**

© 2026 The Authors | Open Access article under CC BY-NC-ND 4.0

## INTRODUCTION

The African continent stands at a pivotal crossroads in its quest to improve public health outcomes. Defined by a complex interplay of nutritional challenges, a high burden of infectious diseases, and disparities in access to quality healthcare, Africa requires innovative, context-specific solutions to safeguard the well-being of its people.<sup>1</sup> Within this landscape, probiotics defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host, have emerged as a promising avenue for enhancing human health.<sup>2,4</sup>

Pioneering research into the role of gut bacteria in health and longevity has strongly fueled the probiotic concept.<sup>5</sup> Since then, there has been a surge of interest in identifying novel probiotic strains with specific functional properties and unraveling their mechanisms of action. Probiotics exert their effects by modulating the gut microbiota, enhancing intestinal barrier integrity, fine-tuning the immune system, and reducing systemic inflammation.<sup>6</sup> However, studies evaluating the impact of probiotics on chronic conditions (such as diabetes, obesity, and gout) suggest that meaningful interventions should be personalized, as various factors must be considered to optimize probiotic efficacy.<sup>7,9</sup> Probiotics have proven effective in preventing and treating diarrheal diseases, a leading cause of mortality among young children.<sup>9,11</sup> They also show promise in improving nutritional status, bolstering immune function, and lowering the risk of various infections. Furthermore, probiotics may play a role in mitigating the adverse effects of antibiotic use, a growing concern in Africa due to rising antimicrobial resistance.<sup>12</sup> These microorganisms offer the advantage of being a renewable resource, generally devoid of major side effects, and suitable for preventive use, particularly in contexts where infectious diseases and malnutrition simultaneously persist, as in Africa.<sup>1</sup>

A large-scale study on the gut microbiome of

African populations (South Africa, Burkina Faso, Ghana, and Kenya) revealed significantly higher bacterial diversity compared to highly industrialised populations. This microbiome is characterized by a predominance of *Prevotella* and *Spirochaetes* genera, contrasting with the *Bacteroides* enrichment typical of Western populations.<sup>13</sup> Beyond biological hurdles, high poverty levels limit access to commercial probiotics for the majority.<sup>14</sup> In response, many researchers have proposed using abundant and accessible local food matrices, defined here as the complex nutrient structures of traditional staples such as fermented cereals or tubers, to bring local or generic probiotics to the masses.<sup>15,18</sup>

This review aims to provide a comprehensive overview of the current state of knowledge regarding probiotic applications for human health in Africa. It examines the evidence supporting probiotic use across various health issues, discusses the challenges and opportunities for implementation, and formulates recommendations for future research and policy to enhance the health and well-being of African populations.

## Use of previous studies on the clinical evidence for probiotics in African populations

A targeted search was conducted using the reference databases PubMed, Scopus, and Web of Science. To identify the most relevant studies, MeSH descriptors and free-text keywords were combined using the Boolean operators AND and OR. The search strategy, adapted for each database, included the following terms: ("probiotics" OR "lactic acid bacteria" OR "*Saccharomyces boulardii*" OR "fermented foods" OR "yog\*") AND ("Africa" OR "Sub-Saharan Africa" OR a list of African countries) AND ("infectious diseases" OR "gastrointestinal disease" OR "diarrhea" OR "HIV" OR "malnutrition"). Inclusion criteria prioritized randomized controlled trials and pilot studies conducted specifically in human

populations in Africa, as well as studies exploring the probiotic potential of local food matrices. In contrast, case reports and studies focusing on strains without clinical application in African populations were excluded. Data synthesis was performed using a thematic narrative approach, structured around key public health areas: prevention of childhood diarrhea, immune modulation, management of urogenital infections, and challenges related to HIV.

### Probiotic Applications for Health in Africa

#### *Framework for Probiotic Use in Africa*

In many African countries, the regulatory framework governing probiotic use is poorly structured or altogether ignored. In more developed nations like South Africa, the purchase of probiotic products is overseen by pharmacists, who are tasked with ensuring patient safety.<sup>19</sup> Although probiotics are not subject to SAHPRA (South African Health Products Regulatory Authority) approval, their marketing should ideally be based on proven scientific evidence. Despite significant growth in probiotic consumption across the continent over the last decade,<sup>19,20</sup> the efficacy of these products is supported by only a handful of clinical trials conducted specifically on African populations.

#### *Probiotics and Childhood Health: Prevention and Treatment of Acute Infantile Diarrhea*

Infantile diarrhea remains a major cause of malnutrition, morbidity, and mortality among young children in Africa, where access to clean water and optimal hygiene is often precarious.<sup>11</sup> Several African clinical trials have shown that daily intake of specific probiotic strains can reduce the duration and severity of diarrheal episodes.<sup>21,23</sup> For instance, Kambale et al.<sup>21</sup> reported in the Democratic Republic of Congo that the combination of *Lactocaseibacillus rhamnosus* GG and *Limosilactobacillus reuteri* DSM 17938 significantly decreased the average treatment duration in children with severe acute malnutrition (4.11 days versus 6.68 days in the

placebo group) and halved the risk of recurrent diarrhea. These findings align with observations in Botswana by Pernica et al.<sup>22</sup>, where *L. reuteri* DSM 17938 led to a marked reduction in recurrent diarrhea episodes in malnourished children. Meta-analyses of studies conducted outside Africa (Asia and Latin America) confirm the efficacy of lactobacilli and bifidobacteria in preventing infectious diarrhea in children.<sup>24,25</sup> These works emphasize the importance of selecting robust strains capable of surviving gastric acidity and temporarily colonizing the intestinal mucosa.

#### *Impact on Growth and Development in Malnourished Children*

Severe acute malnutrition (SAM) hinders cognitive and physical development while increasing vulnerability to infections.<sup>26</sup> In the Manyara region of Tanzania, Klingenberg et al.<sup>27</sup> found that a consortium of *Lactobacillus acidophilus*, *Bifidobacterium bifidum*, and *Bifidobacterium longum* did not significantly improve anthropometric parameters but did promote a higher proportion of fecal bifidobacteria. The dominance of bifidobacteria in the gut microbiota of newborns, particularly *Bifidobacterium longum* subsp. *infantis*, *B. bifidum*, and related species, is recognized as a hallmark of neonatal health and well-being. These bacteria efficiently degrade human milk oligosaccharides (HMOs), which infants are unable to digest, thereby producing beneficial metabolites such as short-chain fatty acids (SCFAs). Their abundance also contributes to a reduction in Enterobacteriaceae colonization, decreases intestinal permeability, and promotes the development of the immune system.<sup>27</sup> In Uganda, Castro-Mejía et al.<sup>26</sup> demonstrated that daily supplementation with *L. rhamnosus* GG and *B. animalis* subspecies, *lactis* BB12 reduced diarrhea treatment duration by 26% in children aged 6-59 months with SAM, while improving intestinal bacterial diversity and partially restoring beneficial families like Lachnospiraceae. These observations are corroborated by data from Amadi et al.<sup>28</sup> in

Nigeria, where probiotic strains from traditional yogurt accelerated nutritional recovery and reduced markers of systemic inflammation. However, a study by Benedikte Grenov et al.<sup>29</sup> showed a significant 26% reduction in diarrhea days during the outpatient phase, though no significant difference was observed during hospitalization. By reducing the duration or incidence of diarrhea, probiotics help lower the risk of malnutrition. Indeed, diarrhea leads to dehydration (mineral loss), maldigestion (insufficient nutrient absorption), and reduced brain growth rates in children under five.

#### *Modulation of the Infant Immune System*

The infant immune system undergoes critical maturation after birth, influenced by genetic, developmental, and environmental factors (diet, microbiota, pathogen exposure). This nascent immunity can be modulated by commensal flora or probiotic supplements. Sybesma et al.<sup>30</sup> in Uganda observed that yogurt enriched with *L. rhamnosus* yoba 2012 and *Streptococcus thermophilus* significantly increased urinary hippurate levels, an indicator of increased colonic fermentation and immune maturation. In African contexts, this immunomodulatory effect is particularly relevant for endemic diseases like Malaria and HIV. Although data remain limited, results from children with Malaria/HIV coinfection suggest that certain *Lactobacillus* strains might mitigate cytokine storms and improve survival. The symbiosis between *Streptococcus thermophilus* C106 and *L. rhamnosus* (GR-1 or Yoba 2012) not only outcompetes invading pathogens but also boosts the immune system by inducing IgA secretion and improving intestinal barrier function. *S. thermophilus* has shown a significant ability to inhibit the adhesion and invasion of enteroinvasive *Escherichia coli* in HT29 and Caco-2 cells.<sup>31</sup> These strains also contribute to increased transepithelial resistance and the phosphorylation of cytoskeleton and tight junction proteins (occludin, claudins, ZO-1), a vital mechanism for maintaining barrier integrity.<sup>32,33</sup> An intact intestinal barrier is

fundamental to preventing the translocation of bacterial inflammatory mediators like lipopolysaccharides into the bloodstream.

#### *Probiotics and Infections*

Infections, ranging from urogenital and respiratory to chronic viral infections like HIV/AIDS, are major public health challenges in Africa.

#### **Urogenital Infections**

Urogenital imbalances are primarily responsible for the proliferation of pathogens. The combination of *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14 has proven effective in restoring a healthy vaginal microbiota. In Rwanda, a pilot study by McMillan et al.<sup>34</sup> found that women in a placebo group were significantly more likely to give birth prematurely compared to those taking these probiotics. In Soweto, South Africa, clinical studies<sup>20,35</sup> established a link between vaginal probiotic supplementation and modest increase in cure rates for bacterial vaginosis, although colonization was not persistent. These results align with the findings from Canada and Portugal, where intravaginal probiotics helped restore a microbiota dominated by *L. crispatus* or *L. jensenii*.<sup>36</sup> The mechanisms involve pH regulation via lactic acid, biofilm formation, and competitive inhibition of pathogens.<sup>37,38</sup> However, clinical responses vary based on population, dosage form, and baseline microbiota.

#### **Respiratory Infections**

Data on probiotics for respiratory infections in Africa remain scarce. A recent study in southwestern Uganda involving children aged 3-6 showed a progressive but non-significant decline in respiratory symptoms among those consuming local probiotic yogurt.<sup>30</sup> While these results suggest potential benefits, they remain modest. In contrast, research in Europe, Asia, and America has advanced further, demonstrating that strains such as *Lactobacillus casei* and *Bifidobacterium animalis* subspecies, *lactis* can reduce the frequency and severity of



respiratory infections in children.<sup>39,40</sup> Experts still urge caution and call for more rigorous, targeted studies before recommending generalized use.<sup>41</sup>

### Probiotics and HIV Infection

Probiotic supplementation has shown significant effects in treating diseases that induce dysbiosis<sup>7</sup> There is a known positive correlation between dysbiosis and HIV infection.<sup>42</sup> In Africa, where HIV prevalence is high, there is a stark lack of data on probiotic effects. One study by Hemmerling et al.<sup>43</sup> found that *L. crispatus* consumption might actually increase vulnerability by raising the levels of activated endocervical CD4<sup>+</sup> receptors.

Conversely, studies outside Africa suggest probiotics restore intestinal barrier integrity and reduce bacterial translocation.<sup>44,45</sup> Work by Falasca et al.<sup>46</sup> also showed improved immunological parameters, such as increased CD4<sup>+</sup> and CD56<sup>+</sup> cell counts, in HIV patients. These results highlight a promising avenue for improving HIV management in Africa through appropriate strategies like accessible local food matrices.

**Table 1:** African clinical trials on the use of probiotics in human health

| Reference                         | Country / Region                          | Study type                             | Target population                                    | Probiotic(s) used                                                                                                        | Application domain                                            | Key observations                                                                                                                                                                                                     |
|-----------------------------------|-------------------------------------------|----------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hemmerling et al. <sup>43</sup>   | Umlazi (South Africa)                     | Phase 2 RCT                            | Cisgender women aged 18-23 years (Nugent score 4-10) | LACTIN-V ( <i>Lactobacillus crispatus</i> CTV-05)                                                                        | Bacterial vaginosis related to HIV susceptibility             | Significant increase in vaginal colonization by <i>L. crispatus</i> after 4 weeks. Persistence of <i>L. crispatus</i> in 26% of participants after 8 weeks. Increased levels of activated endocervical CD4+ T cells. |
| Klingenberg et al. <sup>27</sup>  | Tanzania (Manyara region)                 | RCT                                    | Healthy infants ( $\geq 2$ kg)                       | <i>Lactobacillus acidophilus</i> , <i>Bifidobacterium bifidum</i> , <i>Bifidobacterium longum</i> subsp. <i>infantis</i> | Prophylaxis (Prevention of neonatal infections and dysbiosis) | No significant clinical effect observed. Increased bifidobacteria levels in stool samples of probiotic recipients.                                                                                                   |
| Sybesma et al. <sup>30</sup>      | Uganda (Sheema District)                  | RCT                                    | Children aged 3-6 years                              | <i>L. rhamnosus</i> yoba 2012 and <i>Streptococcus thermophilus</i>                                                      | Respiratory and urinary tract infections                      | Non-significant reduction in respiratory symptoms. Significant increase in urinary hippurate levels. Favorable modulation of the microbiome and immune system.                                                       |
| Kambale et al. <sup>21</sup>      | Kadutu (Democratic Republic of the Congo) | RCT                                    | Children aged 6-24 months                            | <i>Lactocaseibacillus rhamnosus</i> GG and <i>Limosilactobacillus reuteri</i> DSM 17938                                  | Severe acute malnutrition (SAM)                               | Reduction of treatment duration by approximately 2 days. Lower risk of diarrhea in the probiotic group. More than 50% of children achieved nutritional recovery by week 6.                                           |
| Pernica et al. <sup>23</sup>      | Gaborone (Botswana)                       | Multicenter RCT                        | Children aged 2-60 months                            | <i>Lactobacillus reuteri</i> DSM 17938                                                                                   | Acute diarrhea                                                | No significant effect on recurrent diarrhea. Reduction in pathogenic species ( <i>Shigella</i> , <i>Campylobacter</i> , enterotoxigenic <i>Escherichia coli</i> , <i>Cryptosporidium</i> ).                          |
| Brett et al. <sup>47</sup>        | Abidjan (Côte d'Ivoire)                   | RCT                                    | School-aged children                                 | 1. Probiotic fermented yogurt                                                                                            | Modulation of physiological stress                            | Salivary cortisol levels significantly reduced. Possible dose-response effect: more regular consumption associated with lower cortisol levels.                                                                       |
| Castro-Mejía et al. <sup>26</sup> | Kampala (Uganda)                          | Prospective, randomized, double-blind, | Children aged 6-59 months (58% male;                 | <i>Lactobacillus rhamnosus</i> GG and <i>Bifidobacterium animalis</i> subsp. <i>lactis</i> BB-12                         | SAM and intestinal microbiota                                 | Approximately 26% reduction in days with diarrhea in the probiotic group. Decrease in cumulative diarrhea when probiotics                                                                                            |

|                               |                       |                          |                                                              |                                                                                                                                                                               |                                             |                                                                                                                                             |
|-------------------------------|-----------------------|--------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
|                               |                       | placebo-controlled study | 14% HIV-positive; 66% with edematous SAM; 61% with diarrhea) |                                                                                                                                                                               | restoration                                 | were detected. Increase in $\alpha$ -diversity.                                                                                             |
| Happel et al. <sup>20</sup>   | Soweto (South Africa) | RCT                      | Sexually active women with vaginal infection                 | 2. <i>L. acidophilus</i> , <i>L. rhamnosus</i> , <i>B. bifidum</i> , <i>B. longum</i>                                                                                         | Bacterial vaginosis                         | One-month cure rate observed. No persistent vaginal colonization detected.                                                                  |
| Grenov et al. <sup>29</sup>   | Kampala (Uganda)      | RCT                      | Children aged 6-59 months with SAM                           | <i>Bifidobacterium animalis</i> subsp. <i>lactis</i> (BB-12) and <i>Lactobacillus rhamnosus</i>                                                                               | Severe acute malnutrition (SAM)             | During hospitalization: non-significant reduction in days with diarrhea. Outpatient phase: significant 26% reduction in days with diarrhea. |
| Marcotte et al. <sup>35</sup> | Soweto (South Africa) | RCT                      | Sexually active women aged 18-40 years                       | 3. <i>L. rhamnosus</i> DSM 14870 and <i>L. gasseri</i> DSM 14869                                                                                                              | Bacterial vaginosis                         | Higher cure rate in the probiotic group (42%) compared with the control group (36%).                                                        |
| McMillan et al. <sup>34</sup> | Rwanda                | Pilot assessment         | Healthy pregnant women aged 18-55 years                      | 4. <i>Lactobacillus rhamnosus</i> GR-1 and <i>Lactobacillus reuteri</i> RC-14                                                                                                 | Pregnancy duration                          | Women in the placebo group were significantly more likely to deliver preterm.                                                               |
| Pernica et al. <sup>22</sup>  | Gaborone (Botswana)   | Randomized pilot study   | Children aged 2-60 months                                    | <i>Lactobacillus reuteri</i> DSM 17938                                                                                                                                        | Diarrhea; children with severe malnutrition | Reduced risk of recurrent diarrhea.                                                                                                         |
| Kerac et al. <sup>48</sup>    | Malawi                | RCT                      | Children aged 5-168 months                                   | <i>Pediococcus pentosaceus</i> 5-33:3, <i>Leuconostoc mesenteroides</i> 32-77:1, <i>Lactobacillus paracasei</i> ssp. <i>paracasei</i> 19, <i>Lactobacillus plantarum</i> 2362 | Severe acute malnutrition (SAM)             | No significant nutritional recovery. HIV-positive children showed worse overall outcomes.                                                   |
| Lei et al. <sup>49</sup>      | Northern Ghana        | RCT                      | Children with a mean age of 17.4 months                      | <i>Weissella confusa</i> and <i>Lactobacillus fermentum</i>                                                                                                                   | Diarrhea and infectious diseases            | No significant effect on stool frequency. Fermented cereal (KSW) associated with improved well-being after 14 days.                         |



|  |  |  |  |  |  |                                                 |
|--|--|--|--|--|--|-------------------------------------------------|
|  |  |  |  |  |  | Reduced risk of antibiotic-associated diarrhea. |
|--|--|--|--|--|--|-------------------------------------------------|

### Probiotic-Fortified African Fermented Foods as Carriers

Traditional African fermented foods constitute complex, culturally embedded biological matrices that offer a unique potential as natural carriers of functional probiotics for human health. These products, derived from the fermentation of cereals (maize, sorghum, millet), dairy products, tubers, and fruits, harbour rich microbial ecosystems dominated by lactic acid bacteria (*Lactobacillus*, *Limosilactobacillus*, *Pediococcus*, *Weissella*, *Leuconostoc*) and yeasts (*Saccharomyces*, *Candida*, *Kluyveromyces*), which play a central role in food preservation, improvement of nutrient bioavailability, and the production of bioactive metabolites.<sup>7,16,17,50</sup> Iconic products such as *ogi*, *mahewu*, *kenkey*, *injera*, *togwa*, *amasi*, *nunu* and *kwete* therefore represent microbial ecosystems that are naturally compatible with the integration of selected probiotic strains, making these foods biologically coherent and culturally acceptable vehicles for large-scale probiotic delivery in African populations.<sup>1,51</sup>

The probiotic fortification of these fermented matrices fits within a broader strategy of bio-functionalisation of traditional foods, allowing nutritional benefits, sensory acceptability and targeted physiological effects to be combined within a single dietary system. Several studies have demonstrated that probiotic strains such as *Lactobacillus rhamnosus*, *Lactobacillus plantarum*, *Lactobacillus fermentum* and *Bifidobacterium lactis* exhibit high viability in African fermented food matrices, with good stability during storage and enhanced resistance to simulated gastrointestinal conditions.<sup>16,17,52-54</sup> The integration of *Lactobacillus rhamnosus* yoba 2012 into locally fermented beverages in East Africa provides a compelling illustration of this potential, showing benefits not only in terms of probiotic functionality but also food safety, particularly through the reduction of aflatoxin contamination, thereby strengthening the overall health value of the product.<sup>55,56</sup> These

findings clearly indicate that African fermented foods should not be viewed as simple technological carriers, but rather as functional biological ecosystems capable of enhancing probiotic efficacy.

From a physiological perspective, probiotic-enriched fermented foods represent a strategic tool for gut microbiota modulation, reinforcement of mucosal immunity, and regulation of inflammatory processes, particularly in contexts characterised by malnutrition, enteric infections and the rapid nutritional transition towards non-communicable metabolic diseases.<sup>3,4,7,16,53</sup> Regular intake of probiotics through culturally integrated food matrices enables beneficial transient colonisation, promoting microbial balance, short-chain fatty acid production, regulation of intestinal permeability and modulation of systemic immune responses.<sup>8,57</sup> In the African context, this approach offers a major advantage over conventional pharmaceutical formulations, as it relies on accessible, culturally embedded and economically sustainable foods, thereby enhancing its potential impact at the community level.

Nevertheless, the development of these foods as functional probiotic carriers remains constrained by several scientific and structural challenges, including microbiological standardisation, genomic characterisation of local strains, clinical validation of health effects and harmonisation of regulatory frameworks.<sup>58,59</sup> Most traditional African fermentations still rely on spontaneous microbial processes, leading to high microbial and functional variability, which limits the reproducibility of observed probiotic effects.<sup>1,51,59</sup> However, the emergence of African microbial biobanks, the expansion of omics approaches (metagenomics, transcriptomics, metabolomics) and the development of functionally characterised autochthonous strains are paving the way for a new generation of African probiotic fermented foods that are scientifically validated, clinically relevant and

adapted to local socio-economic realities.<sup>58,60</sup>

### Challenges and Future Perspectives

The translation of probiotic research into effective health interventions in Africa remains constrained by structural, scientific, and regulatory limitations. Traditional fermented foods largely rely on spontaneous fermentation, leading to high microbial variability and limited reproducibility, which undermines product consistency and the reliability of probiotic health claims. In parallel, the clinical evidence base remains fragmented, with few large-scale, well-controlled trials conducted in African populations, restricting the formulation of robust, context-specific public health recommendations.

Biological efficacy is further limited by technological issues pertaining to probiotic stability during processing, storage, and gastrointestinal transit, while market expansion, standardisation, and consumer protection are hampered by disjointed regulatory frameworks and inadequate quality-control systems. A coordinated approach based on the creation of genomically characterised autochthonous strains, defined starting cultures tailored to regional food matrices, and the incorporation of multi-omics techniques to elucidate host-microbe-diet interactions is necessary to overcome these obstacles.

Future advancements will rely on integrating probiotic innovation into community-centered,

culturally grounded food systems that are backed by stringent clinical validation and standardised regulatory frameworks. African fermented foods have the potential to transform from traditional dietary habits into scalable, scientifically validated platforms for microbiome-based public health interventions, promoting disease prevention and nutritional resilience throughout the continent.

### Conclusion

Probiotics are emerging as a promising strategy for enhancing public health in Africa, particularly regarding infantile diarrhea, immune modulation, and urogenital or respiratory infections. Clinical trials demonstrate their ability to reduce the severity of diarrhea in malnourished children and restore a beneficial microbiota. However, their impact on anthropometric growth and respiratory infections remain modest and inconsistent. Notably, some consumption might increase HIV vulnerability in certain contexts. Promoting probiotic use across the continent requires a strategy built on three pillars: education and awareness, robust regulatory frameworks, and tailored research to integrate beneficial strains into local foods. These efforts must be coupled with large-scale multicentric clinical trials that account for the diversity of African comorbidities (HIV, malnutrition, malaria) to produce evidence-based recommendations for public health policy.

## REFERENCES

1. Franz CM, Huch M, Seifert S, Kramlich J, Bub A, Cho GS, et al. Influence of a probiotic *Lactobacillus casei* strain on the colonisation with potential pathogenic streptococci and *Staphylococcus aureus* in the nasopharyngeal space of healthy men with a low baseline NK cell activity. *Med Microbiol Immunol*. 2015;204(4):527-38.
2. Veiga P, Suez J, Derrien M, Elinav E. Moving from probiotics to precision probiotics. *Nat Microbiol*. 2020;5(7):878-80.
3. Tchamani Piamé L, Yako YY. Impact of Single and Multi-Strain Probiotic Supplementation on Glycaemic Control in Type 2 Diabetic Patients: A Comparative Meta-Analysis. *Applied Biosciences*. 2026;5(1):6.
4. Tchamani Piamé L, Yako YY. A Systematic Review of the Effects of *Saccharomyces boulardii* on Diabetes Mellitus in Experimental Mice Models. *Encyclopedia*. 2026;6(1):14.
5. Tong S, Zhang P, Cheng Q, Chen M, Chen X, Wang Z, et al. The role of gut microbiota in gout: Is gut microbiota a potential target for gout treatment. *Frontiers in Cellular and Infection Microbiology*. 2022;12:1051682.
6. Obafemi YD, Oranusi SU, Ajanaku KO, Akinduti PA, Leech J, Cotter PD. African fermented foods: overview, emerging benefits, and novel approaches to microbiome profiling. *NPJ Sci Food*. 2022;6(1):15.
7. Piamé LT. Potential of Non-Dairy Probiotic Beverages to Modulate Gut Microbiota and Improve Management of Non-Communicable Diseases. *Novel Research in Microbiology Journal*. 2025:15.
8. Tchamani Piamé L. Bioactive Metabolites from Yeasts Presumptively Qualified as Safe as Functional Agents in the Management of Type 2 Diabetes. *Applied Microbiology*. 2025;5(3):84.
9. Tenorio-Jimenez C, Martinez-Ramirez MJ, Gil A, Gomez-Llorente C. Effects of Probiotics on Metabolic Syndrome: A Systematic Review of Randomized Clinical Trials. *Nutrients*. 2020;12(1):124.
10. Ndu IK, Asinobi IN, Ekwochi U, Nduagubam OC, Amadi OF, Okeke IB, et al. The bacterial profile and sensitivity patterns of isolates from medical equipment and surfaces in the Children's emergency room of a Nigerian hospital: The bacterial profile and sensitivity patterns of isolates from medical equipment and surfaces. *Medical Science and Discovery*. 2019;6(9):192-7.
11. Guarino A, Guandalini S, Lo Vecchio A. Probiotics for Prevention and Treatment of Diarrhea. *J Clin Gastroenterol*. 2015;49 Suppl 1:S37-45.
12. Tadesse BT, Ashley EA, Ongarello S, Havumaki J, Wijegoonewardena M, Gonzalez IJ, et al. Antimicrobial resistance in Africa: a systematic review. *BMC Infect Dis*. 2017;17(1):616.
13. Traore SI, Bilen M, Cadoret F, Khelaifia S, Million M, Raoult D, et al. Study of Human Gastrointestinal Microbiota by Culturomics in Africa. *Med Sante Trop*. 2019;29(4):366-70.
14. Anukam K, Reid G. Providing Probiotics to Sub-Saharan Africa: Ethical Principles to Consider. *Journal of Complementary & Integrative Medicine*. 2005;2(1).
15. Piamé LT, Kaktcham PM, Kouam EMF, Techeu UDF, Ngouenam RJ, Ngoufack FZ. Low-cost dehydrated starter production: Protective effect of maize-based carrier materials and its application in a Cameroonian maize-based traditional fermented beverage (Sha'a). *Journal of Agriculture and Food Research*. 2024;15:100942.
16. Foko Kouam EM, Tchamani Piamé L, Kouteu SS, Temgoua J-B, Zambou Ngoufack F, Kaktcham PM. Probiotic characterisation of *Lactiplantibacillus plantarum* LO3 and use in the development of a golden apple-based non-dairy probiotic beverage. *Systems Microbiology and Biomanufacturing*. 2024;4(3):869-81.
17. Marius FKE, Marie KP, Blandine M, Laverdure TP, Daquain FTU, François ZN. Development of a non-dairy probiotic beverage based on sorrel and pineapple juices using *Lactocaseibacillus paracasei* 62L. *Journal of Agriculture and Food Research*. 2023;14:100688.
18. Cinthia Karla Rodrigues do Monte Guedes AFLdM, Joyce Ramos da Silva, Emanuele Batista Barbosa da Santos, Eveline Cássia Meira dos Stamford, Thayza Cristina Montenegro Stamford, Tânia Lúcia Montenegro. Development of vegetal probiotic beverage of passion fruit (*Passiflora edulis* Sims), yam (*Dioscorea cayenensis*) and *Lactocaseibacillus casei*. *Food Science and Technology*. 2021;41:619-26.
19. Kim Y. Use of probiotics in community pharmacy in South Africa: a survey of pharmacist attitudes, perceptions and knowledge.
20. Happel AU, Singh R, Mitchev N, Mlisana K, Jaspan HB, Barnabas SL, et al. Testing the regulatory framework in South Africa - a single-blind randomized pilot trial of commercial probiotic supplementation to standard therapy in women with bacterial vaginosis. *BMC Infect Dis*. 2020;20(1):491.
21. Kambale RM, Ntagazibwa JN, Kasengi JB, Zigashane AB, Francisca IN, Mashukano BN, et al. Probiotics for children with uncomplicated severe acute malnutrition (PruSAM study): A randomized controlled trial in the Democratic Republic of Congo. *Am J Clin Nutr*. 2023;117(5):976-84.
22. Pernica JM, Steenhoff AP, Mokomane M, Moorad B, Lechiile K, Smieja M, et al. Rapid enteric testing to permit targeted antimicrobial therapy, with and

- without *Lactobacillus reuteri* probiotics, for paediatric acute diarrhoeal disease in Botswana: a pilot, randomized, factorial, controlled trial. *PLoS One*. 2017;12(10):e0185177.
23. Pernica JM, Arscott-Mills T, Steenhoff AP, Mokomane M, Moorad B, Bapabi M, et al. Optimising the management of childhood acute diarrhoeal disease using a rapid test-and- treat strategy and/or *Lactobacillus reuteri* DSM 17938: a multicentre, randomised, controlled, factorial trial in Botswana. *BMJ Glob Health*. 2022;7(4).
  24. Wanyama H, Akhtar TS, Abbas S. Probiotic use reduces the incidence of antibiotic-associated diarrhea among adult patients: a meta-analysis. *Gastroenterology Review/Przegląd Gastroenterologiczny*. 2025;20(1):5-16.
  25. Amalia N, Orchard D, Francis KL, King E. Systematic review and meta-analysis on the use of probiotic supplementation in pregnant mother, breastfeeding mother and infant for the prevention of atopic dermatitis in children. *Australas J Dermatol*. 2020;61(2):e158-e73.
  26. Castro-Mejia JL, O'Ferrall S, Krych L, O'Mahony E, Namusoke H, Lanyero B, et al. Restitution of gut microbiota in Ugandan children administered with probiotics (*Lactobacillus rhamnosus* GG and *Bifidobacterium animalis* subsp. *lactis* BB-12) during treatment for severe acute malnutrition. *Gut Microbes*. 2020;11(4):855-67.
  27. Klingenberg C, Justine M, Moyo SJ, Lohr IH, Gideon J, Mdoe P, et al. Home administration of a multistrain probiotic once per day for 4 weeks to newborn infants in Tanzania (ProRIDE): a double-blind, placebo-controlled randomised trial. *Lancet Glob Health*. 2025;13(6):e1082-e90.
  28. Amadi LO, Okpara JC, Ugboma JC. Molecular characterization and detection of antibiotic resistant genes of bacteria isolated from yoghurt in Port Harcourt Metropolis, Nigeria. *Journal of Food Safety and Hygiene*. 2022;8(4):250-63.
  29. Grenov B, Lanyero B, Nabukeera-Barungi N, Namusoke H, Ritz C, Friis H, et al. Diarrhea, Dehydration, and the Associated Mortality in Children with Complicated Severe Acute Malnutrition: A Prospective Cohort Study in Uganda. *J Pediatr*. 2019;210:26-33 e3.
  30. Sybesma W, Westerik N, Dalukdeniya C, Tumuhimbise J, Gregorowitsch E, Garssen J, et al. Effects of probiotic yogurt on relative respiratory tract infections, urine, saliva biomarkers, and fecal bacterial load in Ugandan children: a randomized controlled trial. *Sci Rep*. 2025;15(1):9478.
  31. Finamore A, Ambra R, Nobili F, Garaguso I, Raguzzini A, Serafini M. Redox Role of *Lactobacillus casei* Shirota Against the Cellular Damage Induced by 2,2'-Azobis (2-Amidinopropane) Dihydrochloride-Induced Oxidative and Inflammatory Stress in Enterocytes-Like Epithelial Cells. *Front Immunol*. 2018;9:1131.
  32. Chelakkot C, Choi Y, Kim D-K, Park HT, Ghim J, Kwon Y, et al. Akkermansia muciniphila-derived extracellular vesicles influence gut permeability through the regulation of tight junctions. *Experimental & molecular medicine*. 2018;50(2):e450-e.
  33. Groschwitz KR, Wu D, Osterfeld H, Ahrens R, Hogan SP. Chymase-mediated intestinal epithelial permeability is regulated by a protease-activating receptor/matrix metalloproteinase-2-dependent mechanism. *American Journal of Physiology-Gastrointestinal and Liver Physiology*. 2013;304(5):G479-G89.
  34. McMillan A, Rulisa S, Gloor GB, Macklaim JM, Sumarah M, Reid G. Pilot assessment of probiotics for pregnant women in Rwanda. *PLoS One*. 2018;13(6):e0195081.
  35. Marcotte H, Larsson PG, Andersen KK, Zuo F, Mikkelsen LS, Brandsborg E, et al. An exploratory pilot study evaluating the supplementation of standard antibiotic therapy with probiotic lactobacilli in south African women with bacterial vaginosis. *BMC Infect Dis*. 2019;19(1):824.
  36. Borges S, Teixeira P. *Pediococcus pentosaceus* SB83 as a potential probiotic incorporated in a liquid system for vaginal delivery. *Beneficial microbes*. 2014;5(4):421-6.
  37. Russo R, Superti F, Karadja E, De Seta F. Randomised clinical trial in women with Recurrent Vulvovaginal Candidiasis: Efficacy of probiotics and lactoferrin as maintenance treatment. *Mycoses*. 2019;62(4):328-35.
  38. Reid G, Jass J, Sebulsky MT, McCormick JK. Potential uses of probiotics in clinical practice. *Clin Microbiol Rev*. 2003;16(4):658-72.
  39. Jespersen L, Tarnow I, Eskesen D, Morberg CM, Michelsen B, Bugel S, et al. Effect of *Lactobacillus paracasei* subsp. *paracasei*, L. casei 431 on immune response to influenza vaccination and upper respiratory tract infections in healthy adult volunteers: a randomized, double-blind, placebo-controlled, parallel-group study. *Am J Clin Nutr*. 2015;101(6):1188-96.
  40. Guo H, Xiang X, Lin X, Wang Q, Qin S, Lu X, et al. Oropharyngeal probiotic ENT-K12 as an effective dietary intervention for children with recurrent respiratory tract infections during cold season. *Frontiers in Nutrition*. 2022;9:900448.
  41. de Araujo GV, de Oliveira Junior MH, Peixoto DM, Sarinho ESC. Probiotics for the treatment of upper and lower respiratory-tract infections in children: systematic review based on randomized clinical trials. *Jornal de pediatria*. 2015;91(5):413-27.
  42. Zhang Y, Andreu-Sanchez S, Vadaq N, Wang D, Matzaraki V, van der Heijden WA, et al. Gut dysbiosis associates with cytokine production capacity in viral-suppressed people living with HIV.

- Front Cell Infect Microbiol. 2023;13:1202035.
43. Hemmerling A, Mitchell CM, Demby S, Ghebremichael M, Elsherbini J, Xu J, et al. Effect of the vaginal live biotherapeutic LACTIN-V (*Lactobacillus crispatus* CTV-05) on vaginal microbiota and genital tract inflammation among women at high risk of HIV acquisition in South Africa: a phase 2, randomised, placebo-controlled trial. *The Lancet Microbe*. 2025;6(6).
  44. D'Angelo C, Reale M, Costantini E. Microbiota and Probiotics in Health and HIV Infection. *Nutrients*. 2017;9(6).
  45. Armstrong AJS, Quinn K, Fouquier J, Li SX, Schneider JM, Nusbacher NM, et al. Systems Analysis of Gut Microbiome Influence on Metabolic Disease in HIV-Positive and High-Risk Populations. *mSystems*. 2021;6(3):10.1128/msystems.01178-20.
  46. Falasca K, Vecchiet J, Ucciferri C, Di Nicola M, D'Angelo C, Reale M. Effect of Probiotic Supplement on Cytokine Levels in HIV-Infected Individuals: A Preliminary Study. *Nutrients*. 2015;7(10):8335-47.
  47. Brett BE, Koko BK, Doumbia HOY, Koffi FK, Assa SE, Zahe K, et al. Salivary biomarkers of stress and inflammation in first graders in Cote d'Ivoire: Effects of a probiotic food intervention. *Psychoneuroendocrinology*. 2021;129:105255.
  48. Kerac M, Bunn J, Seal A, Thindwa M, Tomkins A, Sadler K, et al. Probiotics and prebiotics for severe acute malnutrition (PRONUT study): a double-blind efficacy randomised controlled trial in Malawi. *Lancet*. 2009;374(9684):136-44.
  49. Lei V, Friis H, Michaelsen KF. Spontaneously fermented millet product as a natural probiotic treatment for diarrhoea in young children: an intervention study in Northern Ghana. *International journal of food microbiology*. 2006;110(3):246-53.
  50. Tamang JP, Watanabe K, Holzapfel WH. Diversity of microorganisms in global fermented foods and beverages. *Frontiers in microbiology*. 2016;7:377.
  51. Oguntoyinbo FA, Narbad A. Multifunctional properties of *Lactobacillus plantarum* strains isolated from fermented cereal foods. *Journal of Functional Foods*. 2015;17:621-31.
  52. Tchamani Piame L, Kaktcham PM, Foko Kouam EM, Fotso Techeu UD, Ngouénam RJ, Zambou Ngoufack F. Technological characterisation and probiotic traits of yeasts isolated from Sha'a, a Cameroonian maize-based traditional fermented beverage. *Heliyon*. 2022;8(10):e10850.
  53. Marco ML, Heeney D, Binda S, Cifelli CJ, Cotter PD, Foligné B, et al. Health benefits of fermented foods: microbiota and beyond. *Current opinion in biotechnology*. 2017;44:94-102.
  54. Shori AB, Baba AS, Muniandy P. Potential health-promoting effects of probiotics in dairy beverages. Value-added ingredients and enrichments of beverages. 2019:173-204.
  55. Huybregts L, Le Port A, Becquey E, Zongrone A, Barba FM, Rawat R, et al. Impact on child acute malnutrition of integrating small-quantity lipid-based nutrient supplements into community-level screening for acute malnutrition: a cluster-randomized controlled trial in Mali. *PLoS Medicine*. 2019;16(8):e1002892.
  56. Emadi A, Eslami M, Yousefi B, Abdolshahi A. *In vitro* strain specific reducing of aflatoxin B<sub>1</sub> by probiotic bacteria: a systematic review and meta-analysis. *Toxin Reviews*. 2022;41(3):995-1006.
  57. Valdés-Varela L, Gueimonde M, Ruas-Madiedo P. Probiotics for prevention and treatment of *Clostridium difficile* infection. Updates on *Clostridioides difficile* in Europe: Advances in Microbiology, Infectious Diseases and Public Health Volume 18. 2024:101-16.
  58. Marco ML, Sanders ME, Gänzle M, Arrieta MC, Cotter PD, De Vuyst L, et al. The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on fermented foods. *Nature Reviews Gastroenterology & Hepatology*. 2021;18(3):196-208.
  59. Morelli L, Capurso L. FAO/WHO guidelines on probiotics: 10 years later. *Journal of clinical gastroenterology*. 2012;46:S1-S2.
  60. Tamang JP, Lama S. Probiotic properties of yeasts in traditional fermented foods and beverages. *Journal of Applied Microbiology*. 2022;132(5):3533-42.