Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i4.2544

DEVELOPMENT AND SENSORY CHARACTERIZATION OF FINGER MILLET PROBIOTIC BEVERAGE

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ABSTRACT

Fermented millets have been included in traditional fermented foods across various cultures worldwide. Kefir is a different fermented product that is worth highlighting because it has special sensory, nutritional, and medicinal qualities as well as microbial activity. The aim of the present study was to develop a functional probiotic beverage from finger millet using kefir as a fermenting agent and to perform a sensory analysis of the obtained product. Kefir was obtained by growing grains in pasteurized milk. Three variations consisting of 5%, 10%, and 15% (w/w) finger millet powder were inoculated with 2% kefir grains and incubated at 25 °C for 4 hours. Sensory analysis was performed with 30 untrained panellists using a 9-point scale hedonic in the acceptance tests. The one- way ANOVA test was used to compare the differences between the means of the scores obtained, with the significance level of 5%. The samples prepared showed good acceptance by the panellists, and the sample T2 had the highest scores in the acceptance test. Additional research is required to examine the microbial viability, nutritional content, and shelf life of the low-fat version of the product. Furthermore, efforts should be made to enhance its acceptability.

Key words: Finger millet, functional food, kefir grains, probiotic

INTRODUCTION

The escalating demand for healthier food choices and the increasing awareness regarding the profound impact of diet on human well-being have served as powerful catalysts for the extensive development of a wide array of novel food products that are meticulously designed to provide precise and targeted health benefits to consumers. In the present landscape of the market, one can observe an impressive assortment of innovative functional foods that have garnered significant attention, with particular emphasis on the prominence of milk products and beverages in this category. Notably, probiotic microorganisms have emerged as a subject of intensive study and scrutiny due to the multitude of health advantages intricately linked to their consumption, thus positioning them as highly regarded and beneficial constituents in functional foods (Hassan et al., 2012). These live microorganisms, known as probiotics, have been defined by the Food and Agriculture Organization/World Health Organization (FAO/WHO) as entities that bestow health benefits upon the host when administered in optimal quantities (Sener et al., 2021).

As a longstanding tradition, probiotics have been revered as viable dietary microbial supplements that exert a favorable influence on the host's intricate intestinal system, thereby exhibiting the capacity to effectively assist the existing flora or replenish the colon in instances where bacterial levels are diminished as a result of medication, chemotherapy, or illness. Additionally, probiotics significantly contribute to the establishment of a robust and protective barrier within the gastrointestinal tract, effectively thwarting the entry of both commensal and pathogenic organisms. It is widely believed that the disruption or impairment of this pivotal barrier function is intricately involved in the development and progression of inflammatory bowel disease (IBD) (Ayub M. et al., 2021). To further bolster their appeal, the majority of probiotic foods available on the market are endowed with a host of essential nutrients such as fatty acids, vitamins, and various other bioactive compounds, effectively enhancing the body's innate resistance against pathogenic microbes (Quintana et al., 2022).

Among the expanse of available probiotic foods, kefir unquestionably stands as an indisputably popular dairy product that boasts an array of undeniable and unparalleled benefits when incorporated into one's diet. Derived from the milk of diverse animals, including goats, buffaloes, sheep, camels, and cows, kefir undergoes a transformative process of microbial fermentation, resulting in its distinctive and captivating properties. Extensive scientific research conducted over the course of recent decades has repeatedly highlighted and underscored the exceptional nutritional profile and consequential health advantages of kefir, ranging from its inherent antimicrobial and anticancer properties to its influential effects on the gastrointestinal tract, profound modulation of gut microbiota, remarkable cholesterol-lowering activity, and even its commendable anti-diabetic effects (Chen H. et al., 2018). Despite the plethora of milk-based probiotic foods currently permeating the global market, exploratory endeavours to venture into uncharted territories and diversify the substrates employed in their production have remained relatively limited.

It is worth noting that millets, an illustrious and vital group of cereal crops, have long occupied a prominent position within the agricultural landscapes of Asia and Africa's semiarid tropics, accounting for an astounding 97% of total millet production. One noteworthy member of this esteemed group is finger millet, also affectionately known as Ragi, which has asserted its significance as an essential cereal crop in India, particularly in the nation's semi-arid regions (Joshi D. et al., 2021). Distinguished by its distinctive reddish seed coat and naked caryopsis, finger millet possesses an extraordinary resilience against drought and other adverse weather conditions, thereby solidifying its reputation as a highly adaptable and robust crop (Karuppasamy P. et al., 2015).

Over the past few years, finger millet has witnessed an unprecedented surge in popularity, primarily attributable to its exceptional nutritional composition, which encompasses substantial quantities of dietary fiber, both soluble and insoluble, in addition to an impressive array of vital minerals, including calcium, phosphorus, and iron. Furthermore, finger millet stands as an abundant source of essential amino acids and polyphenols, all of which contribute to its unrivalled nutritional prowess (Karuppasamy P. et al., 2015). Scientific inquiry into the effects of regular finger millet consumption has conclusively demonstrated its remarkable ability to reduce the prevalence of Diabetes Mellitus, largely attributable to its high dietary fiber and polyphenol content. Remarkably, the outermost layer, or seed coat, of millet is entirely edible and encompasses a rich variety of phytochemicals, including phytates, polyphenols, tannins, trypsin inhibitor factors, and dietary fibres, which have garnered recognition as esteemed nutraceuticals. The polyphenols specifically present in finger millet contribute to the reduction of peptic inflammation and exhibit notable anti-ulcerative properties (Gyawali P. et al., 2021). Apart from its unrivalled nutrient density, finger millet serves as a remarkable source of oligosaccharides that function as prebiotics, actively fostering the growth and proliferation of beneficial microorganisms within the gastrointestinal ecosystem. Given these notable attributes and achievements, finger millet undoubtedly holds great promise as an exceptional and versatile substrate for the production of probiotic beverages, thereby enabling the convergence of health-promoting probiotics with the nourishing qualities of this remarkable cereal crop.

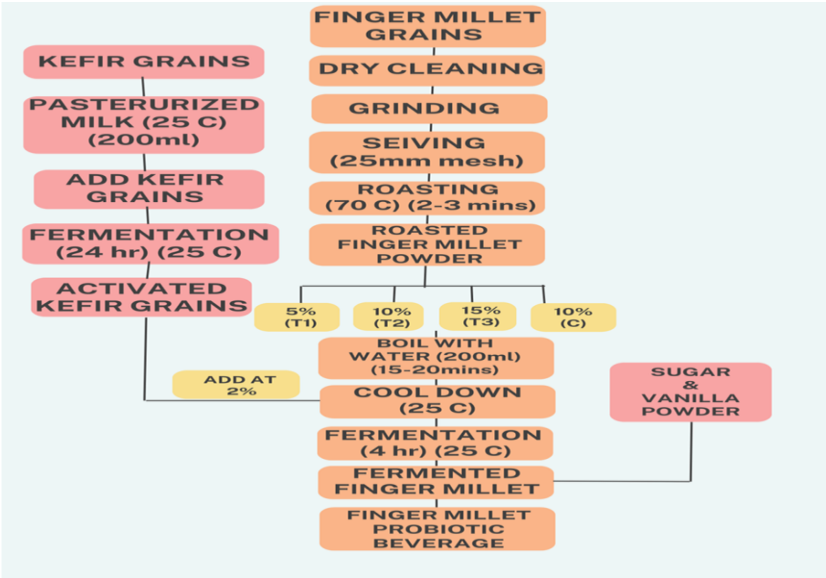
MATERIAL & METHODS

DEVELOPMENT OF FINGER MILLET PROBIOTIC BEVERAGE

Materials required: Pasteurized milk, Kefir grains, Finger millet grains, Vanilla powder, sugar and water.

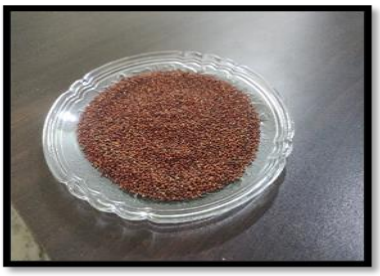
Table no.1 Formulation mixture for finger millet probiotic beverage

Sample No.	Finger Millet	Kefir Grains	Sugar	Vanilla Powder
T1	5%	2%	5%	2%
T2	10%	2%	7%	2%
T3	15%	2%	9%	2%
C	10%	-	5%	-



Flow diagram showing the process.

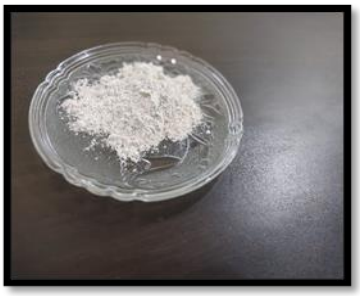
Treatment of milk for kefir grains activation



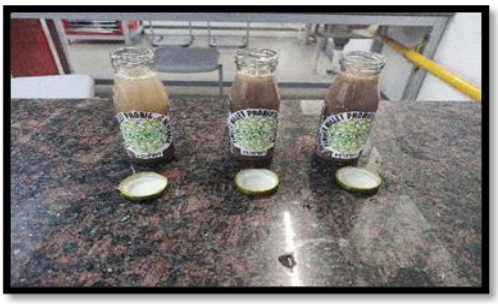
Procured finger millet

Roasting of finger millet

Activated kefir grains



Grounded finger millet



Filling into the bottles

SENSORY CHARACTERIZATION OF FINGER MILLET PROBIOTIC BEVERAGE

Untrained panellists evaluated the beverages using a nine-point hedonic scale ranging from "liked extremely" (9) to "disliked extremely" (1), as defined by Larmond 17. Prior to the examination, the panellists were given instructions and information on the assessment criteria. The samples were evaluated based on appearance, texture, sweetness, consistency, sourness, and overall acceptability. Thirty untrained panellists were chosen at random. The sensory evaluation was performed one day after the probiotic beverage was made.

Sensory evaluation of finger millet probiotic beverage

RESULTS & DISCUSSION

Sensory analysis:

To assess the impact of the chosen framework on sensory evaluation, a mean of responses was analysed. This evaluation considered sensory characteristics and overall preferences. The finger millet beverage, when inoculated with 2% kefir grains and fermented for 6 hours, exhibited a carbonated texture, dark colour, followed by a noticeable sourness and pleasant aroma. It was generally well-accepted by the participants. Another variation of the finger millet beverage, fermented for 4 hours with 2% kefir grains, displayed a smooth texture, appealing appearance, and colour, along with an enjoyable aroma and flavour. It received a higher mean score of 8, indicating a higher level of acceptability. On the other hand, the finger millet beverage inoculated with 2% kefir grains and fermented for 2 hours had a subtle appearance and texture, no noticeable sourness, and a lighter colour. However, it received the lowest acceptance rates, as the flavour and aroma could have been improved. The results of the sensory evaluation were analysed statistically, and it was found that the beverage fermented for 4 hours was the most preferred among all variations. Sensory parameters such as colour, taste, texture, flavour & overall acceptability showed significant results at $p<0.1$.

Table no.2 Mean sensory score for finger millet probiotic beverage.

Attributes	T1	T2	T3	C
Colour	7.166	7.53	7.2	4.73
Taste	7.73	7.93	7.33	4.56
Texture	7.93	7.76	7.33	4.43
Flavour	7.26	7.06	7.63	1.53
Overall acceptability	7.8	8.066	6.96	3.96

Table no 3. Effect of 4hrs of fermentation time on sensory attributes of probiotic beverage.

SENSORY ATTRIBUTES					
SAMPLE	**COLOUR**	**TASTE**	**TEXTURE**	**FLAVOUR**	**OVERALL ACCEPTANCE**
T1	7.5±1.3	7.8±0.73	8±0.69	1.3±1.26	7.8±0.84
T2	7.9±0.98	8.0±0.86	7.8±1.07	1.2±0.76	8±0.73
T3	7.3±0.97	7±1.15	7.3±0.93	1.4±1.66	7±1.26
C	4.9±2.42	4.5±2.01	4.5±2.02	1.6±1.65	4±2.48

ACCEPTANCE TEST

The panellists gave higher scores to the sample T2 than other samples prepared during the development of finger millet probiotic beverage for colour (7.53 vs 7.16; $p<0.01$), taste (7.93 vs. 7.73; $p=0.001$), texture (7.76 vs 7.93; $p=0.01$), flavour (7.06 vs 7.26; $p<0.01$) and overall acceptability (8.066 vs 7.8; $p=0.01$). Differences in the average scores were considered significant.
Greater frequency of scores above 5, corresponding to the term "indifferent", for the attributes (appearance, texture, flavour, and overall acceptability) was observed for the sample T2.

Table no.4 Sensory parameters t test

Varieties	Finger Millet%	Colour	Taste	Texture	Flavour	Overall acceptability
T1	5	7.166	7.73	7.93	7.26	7.8
T2	10	7.53	7.93	7.76	7.06	8.066
T3	15	7.2	7.33	7.33	7.63	6.96
	F value	2.44	3.903	3.38	3.8	6.43
	P value	0.0928*	0.024*	0.038*	0.026*	0.0126*

***p<0.1**
****p<0.05**

CONCLUSION

The objective of this research was to develop a kefir-fermented finger millet beverage. Functional beverages, which contain ingredients that enhance performance and provide health benefits, have gained popularity. Millet-based drinks, especially fermented ones, have become increasingly popular due to their nutritional advantages and health-promoting properties. The study revealed that the finger millet probiotic beverage is a suitable alternative to dairy probiotics, as it is cholesterol-free and contains health-enhancing components. This makes it a viable option for individuals who are lactose intolerant or have allergies to dairy products. The strains used in the finger millet beverage exhibited good viability without the need for additional nutrient supplementation. The research involved developing a probiotic beverage from finger millet fermented with kefir. Different concentrations of finger millet (5%, 10%, and 15%) were fermented with kefir grains at a consistent concentration of 2% for 4 hours. Non-dairy probiotic beverages have gained popularity as a substitute for traditional dairy products, particularly for individuals with lactose intolerance or milk allergies. They are also favoured by those following vegan or vegetarian diets. Extensive studies have linked probiotic products, including non-dairy beverages, to various health benefits. These beverages, rich in beneficial microorganisms, offer potential therapeutic effects that positively impact human health. One notable benefit is their effectiveness in treating diarrhoea by restoring the balance of gut microbiota and relieving gastrointestinal distress. Specific strains of beneficial bacteria introduced through these beverages can restore intestinal balance, reduce inflammation, and improve overall gut health. This can lead to a reduction in symptoms such as abdominal pain, bloating, and irregular bowel movements. Furthermore, probiotics have shown promise in their potential anti-carcinogenic properties. Certain strains have demonstrated the ability to inhibit the growth of cancer cells and protect against the development of certain types of cancer. The obtained probiotic beverage is a fermented product that can contribute to a healthy gut and favourable intestinal microflora. The study suggests that this product is suitable for all age groups and offers benefits for gut health, the cardiovascular system, and inflammatory bowel disease, among others. It can be particularly effective for individuals with milk allergies, sensitivities, lactose intolerance, and digestive issues. Therefore, this study concludes that kefir-fermented finger millet is an acceptable product that can provide significant value to the economy and has great potential in the field of nutrition.

REFERENCES

1. Admassu, S., Teamir, M., & Alemu, D. (2009). Chemical composition of local and improved finger Millet [Eleusine Corocana (L.) Gaetrtin] varieties grown in Ethiopia. *Ethiopian Journal of Health Sciences*, *19*(1).
2. Admassu, S., Teamir, M., & Alemu, D. (2009). Chemical composition of local and improved finger Millet [Eleusine Corocana (L.) Gaetrtin] varieties grown in Ethiopia. *Ethiopian Journal of Health Sciences*, *19*(1).
3. Ayub, M., Castro-Alba, V., & Lazarte, C. E. (2021). Development of an instant-mix probiotic beverage based on fermented quinoa with reduced phytate content. *Journal of Functional Foods*, *87*, 104831.
4. Begum, P. S., Madhavi, G., Rajagopal, S., Viswanath, B., Razak, M. A., & Venkataratnamma, V. (2017). Probiotics as functional foods: potential effects on human health and its impact on neurological diseases. *International Journal of Nutrition, Pharmacology, Neurological Diseases*, *7*(2), 23-33.
5. Budhwar, S., Sethi, K., & Chakraborty, M. (2020). Efficacy of germination and probiotic fermentation on underutilized cereal and millet grains. *Food Production, Processing and Nutrition*, *2*, 1-17.
6. Chaudhary, J. K., & Mudgal, S. (2020). Antidiabetic and hypolipidemic action of finger millet (Eleusine coracana)-enriched probiotic fermented milk: An in vivo rat study. *Food technology and biotechnology*, *58*(2), 192.
7. Chaudhary, J. K., & Mudgal, S. (2020). Antidiabetic and hypolipidemic action of finger millet (Eleusine coracana)-enriched probiotic fermented milk: An in vivo rat study. *Food technology and biotechnology*, *58*(2), 192.
8. Chaudhary, Jinal & Sreeja, V. (2020). Effect of incorporation of Finger millet (Eleusine coracana) on the antimicrobial, ACE inhibitory, antioxidant and antidiabetic potential of a milk millet composite probiotic fermented product. Indian Journal of Dairy Science. 73. 222-230. 10.33785/IJDS. 2020.v73i03.005.
9. Chavan, M., Gat, Y., Harmalkar, M., & Waghmare, R. (2018). Development of non-dairy fermented probiotic drink based on germinated and ungerminated cereals and legume. *LWT*, *91*, 339-344.
10. David, B. M., Michael, A., Doyinsola, O., Patrick, I., & Abayomi, O. (2014). Proximate composition, mineral and phytochemical constituents of Eleusine coracana (finger millet). *International Journal of Advanced Chemistry*, *2*(2), 171-174.
11. Dey, S., Saxena, A., Kumar, Y., Maity, T., & Tarafdar, A. (2022). Understanding the Antinutritional Factors and Bioactive Compounds of Kodo Millet (Paspalum scrobiculatum) and Little Millet (Panicum sumatrense). *Journal of Food Quality*, *2022*.
12. Di Stefano, E., White, J., Seney, S., Hekmat, S., McDowell, T., Sumarah, M., & Reid, G. (2017). A novel millet-based probiotic fermented food for the developing world. *Nutrients*, *9*(5), 529.
13. Fana Haile, S. A., & Fisseha, A. (2015). Effects of pre-treatments and drying methods on chemical composition, microbial and sensory quality of orange-fleshed sweet potato flour and porridge. *American Journal of Food Science and Technology*, *3*(3), 82-88.
14. Feyera, M., Dasa, F., & Kebero, K. (2021). Formulation and Quality Evaluation of Finger Millet Based Composite Food Products. *International Journal of Nutrition and Food Sciences*, *10*(3), 59-65.
15. Fred, O. H., Sheunda, P., Kibuka, J., Kumar, A., Rathore, A., Manyasa, E., & Ajaku, D. (2021). Characterization of finger millet germplasm for mineral.

16. Ganguly, S., Sabikhi, L., & Singh, A. K. (2019). Effect of whey-pearl millet-barley based probiotic beverage on Shigella-induced pathogenicity in murine model. *Journal of Functional Foods*, *54*, 498-505.
17. Gholami, Z., & Ansari, S. (2021). Effects of roasting conditions on physicochemical properties of the watermelon seed. *Iranian Journal of Chemistry and Chemical Engineering*, *40*(2), 615-626.
18. Gowda, N. N., Siliveru, K., Prasad, P. V., Bhatt, Y., Netravati, B. P., & Gurikar, C. (2022). Modern processing of Indian millets: a perspective on changes in nutritional properties. *Foods*, *11*(4), 499.
19. Gyawali, P. (2021). Production Trend, Constraints, and Strategies for Millet Cultivation in Nepal: A Study from Review Perspective. *International Journal of Agricultural and Applied Sciences*, *2*(1), 30-40.
20. Hasan, M. N., Sultan, M. Z., & Mar-E-Um, M. (2014). Significance of fermented food in nutrition and food science. *Journal of Scientific Research*, *6*(2), 373-386.
21. Hejazi, S. N. (2016). *Development of innovative probiotic finger millet-and amaranth-based weaning products*. McGill University (Canada).
22. Huang, J., Liu, W., Kang, W., He, Y., Yang, R., Mou, X., & Zhao, W. (2022). Effects of microbiota on anticancer drugs: Current knowledge and potential applications. *EBioMedicine*, *83*, 104197.
23. Jan, S., Kumar, K., Yadav, A. N., Ahmed, N., Thakur, P., Chauhan, D., & Dhaliwal, H. S. (2022). Effect of diverse fermentation treatments on nutritional composition, bioactive components, and anti-nutritional factors of finger millet (Eleusine coracana L.). *Journal of Applied Biology and Biotechnology*, *10*(1), 46-52.
24. Khurana, H. K., & Kanawjia, S. K. (2007). Recent trends in development of fermented milks. *Current Nutrition & Food Science*, *3*(1), 91-108.
25. Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S., Singh, S., ... & Yadav, R. (2016). Nutraceutical value of finger millet [Eleusine coracana (L.) Gaertn.], and their improvement using omics approaches. *Frontiers in plant science*, *7*, 934.
26. Kaur, L., & Shah, S. (2022). Production of bacterial cellulose by Acetobacter tropicalis isolated from decaying apple waste. *Asian Journal of Chemistry*, *34*(2), 453-458.
27. Kaur, L., & Shah, S. (2022). Screening and Characterization of Cellulose-Producing Bacterial Strains from Decaying Fruit Waste. Int J Food Nutr Sci;11:8-14.
28. Kaur L., (2018) Influence of height and weight on physical fitness index of amateur gymers of age 17 years. Int Res J Eng Technol,5,3236-40.
29. Verma,S & Kaur,L. . (2018). Identification Of Waste Utilizing Bacteria From Fruit Waste. Global Journal for Research Analysis Volume-7(6, June).66.
30. Łopusiewicz, Ł., Drozłowska, E., Trocer, P., Kwiatkowski, P., Bartkowiak, A., Gefrom, A., & Sienkiewicz, M. (2020). The effect of fermentation with kefir grains on the physicochemical and antioxidant properties of beverages from blue lupin (Lupinus angustifolius L.) seeds. *Molecules*, *25*(24), 5791.
31. Maity, C., Bagkar, P., Dixit, Y., Tiwari, A., & Gupta, A. K. (2020). Process and storage stability of Bacillus coagulans LBSC in food matrices and appraisal of calorific restriction. *Applied Food Biotechnology*, *8*(1), 57-69.
32. Makokha, A. O., Oniang'o, R. K., Njoroge, S. M., & Kamar, O. K. (2002). Effect of traditional fermentation and malting on phytic acid and mineral availability from sorghum (Sorghum bicolour) and finger millet (Eleusine coracana) grain varieties grown in Kenya. *Food and nutrition bulletin*, *23*(3_suppl1), 241-245.
33. Mbithi-Mwikya, S., Van Camp, J., Yiru, Y., & Huyghebaert, A. (2000). Nutrient and antinutrient changes in finger millet (Eleusine coracan) during sprouting. *LWT-Food Science and Technology*, *33*(1), 9-14.
34. Meena, L & Buvaneswaran, Malini & Byresh, T & C K, Sunil & Rawson, Ashish & Venkatachalapathy, Natarajan. (2022). Ultrasound Treated-Freeze dried white finger millet-based probiotic beverage powder: Effect on proximate, colorimetric, and technological properties.

35. Molinos, A. C., Gálvez, A., Raj, A., Chauhan, A., Gupta, A. D., Chye, F. Y., ... & Bira, Z. M. (2016). Indigenous Fermented Foods of south Asia. *Indigenous Fermented Foods of South Asia*, *7*(1).
36. Mridula, D., & Sharma, M. (2015). Development of non-dairy probiotic drink utilizing sprouted cereals, legume and soymilk. *LWT-Food Science and Technology*, *62*(1), 482-487.
37. Owheruo, J. O., Ifesan, B. O., & Kolawole, A. O. (2019). Physicochemical properties of malted finger millet (Eleusine coracana) and pearl millet (Pennisetum glaucum). *Food science & nutrition*, *7*(2), 476-482.
38. Ragaee, S., Abdel-Aal, E. S. M., & Noaman, M. (2006). Antioxidant activity and nutrient composition of selected cereals for food use. *Food chemistry*, *98*(1), 32-38.
39. Ratra, S., Kaur, L., & Thukral, B. (2016). Effect of Aloe vera and wheat grass juice as an edible coating to prolong the shelf life of bananas. International Research Journal of Engineering and Technology, 3(5), 2648– 2655.
40. Reddy, B. H. R., Thankachan, P., Hatakayama, M., Hiremath, N., Moretti, D., Nanjareddy, Y. A., ... & Sreeman, S. M. (2022). A Natural Low Phytic Acid Finger Millet Accession Significantly Improves Iron Bioavailability in Indian Women. *Frontiers in Nutrition*, 1046.
41. Sharma, S. (2023). Effect of germination on the physicochemical and anti-nutritional properties of finger millet (Eleusine coracana), pearl millet (Pennisetum glaucum), and sorghum (Sorghum bicolor).
42. Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger millet (Ragi, Eleusine coracana L.): a review of its nutritional properties, processing, and plausible health benefits. *Advances in food and nutrition research*, *69*, 1-39.