ABSTRACT

Iron deficiency Anaemia (IDA) is a public health problem with significant implications for human health, affecting millions globally. Recent research underscores the critical role of iron in various physiological functions, is possible by naturally increasing the iron content and its bioavailability in the diets to address IDA in vulnerable populations. This investigation is a designated attempt to extensively propagate the use of edible seaweeds by incorporating nutrient-dense ingredients in effective combinations to enhance iron bioaccessibility in daily diets. Four underexploited seaweeds *Ulva lactuca*, *Ulva reticulata*, *Gracilaria edulis*, and *Sargassum polycystum* were procured from the Gulf of Mannar and Palk Bay, which is a reserve for more than 850 recorded marine algal species. The nutritional and heavy metal analyses were carried out as per the AOAC standard protocols. *Ulva lactuca* was identified as a good source of iron, prompting the formulation, standardisation and evaluation of an *Ulva* based probiotic beverage. Whey was used for the probiotic base and oranges as a source of vitamin C. Palm jaggery, and processed seaweed extract were added and the sensory evaluation was performed using a 9-point Hedonic Scale, demonstrating favourable consumer acceptance. The beverage's physical, nutritional, and nutraceutical profiles were assessed, revealing notable radical scavenging activity via DPPH and FRAP assays. The identification of bioactive compounds was conducted using GC-MS/MS, while *in silico* ADME profiles of abundant bioactive compounds were analyzed with the SWISS ADME tool. The probiotic potential and antimicrobial activity of *Lactobacillus reuteri* OP389067 were evaluated, alongside a shelf-life determination. *In vitro* bioavailability studies using the Caco-2 cell model indicated effective iron absorption, in the presence of ascorbic acid, highlighting the beverage's potential as a bioavailable source of iron. From the foregoing results, it is evident that *U. Lactuca* based probiotic beverage was nutrient-rich and the probiotic strain *L. reuteri* OP389067 demonstrated probiotic potentials and antibiotic susceptibility and activity against common food-borne bacteria. The nutrient and nutraceutical potentials of the developed probiotic beverage showed prominent antioxidant properties and bioactive compounds, catering to the therapeutic attributes of the beverage. The favourable ferritin uptake in the presence of ascorbic acid observed in the *in vitro* bioavailability study of Iron using the Caco-2 cells positively infers that *Ulva lactuca* based probiotic beverage exhibit significant nutritional and therapeutic attributes and could be used as a potential food supplement in IDA management.