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Bioprocess optimization of lactic acid fermentation of black carrots using functional starter culture

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In India, black carrot (*Daucus carota* spp. *sativus*) is underutilized and do not find much consumer acceptance as a vegetable. Despite its probiotic, anticarcinogenic and antioxidant properties, it is neither evaluated analytically nor characterized biologically. The present study has been done in the Department of Microbiology, Punjab Agricultural University, and Ludhiana to carry out the fermentation of black carrots in a natural and traditional way for the production of lactic acid beverage. From the cultural, morphological and physiological characteristics, three strains viz. *Bacillus*, *Lactobacillus casei* and *Lactobacillus plantarum* has been isolated. During fermentation, microorganisms convert the chemical composition of raw material so improve the bioavailability of minerals, trace elements and reduce the content of non-digestible materials like cellulose, hemicelluloses, polygalacturonic acid, thus lowers down the chances of mutagenicity of intestines. The physicochemical characteristics of black carrots: water (1:3) has been found to be of pH 3.1, TSS 3.4•B, acidity 0.47%, total sugars 2.82% and reducing sugars 2.34%. The traditional beverage has been found to be enriched in nutraceuticals with ascorbic acid content of 4800, total phenols 396 and β -carotene 0.0829 ppm. The fermented product was bottled, stored at refrigerated temperature and was acceptable up to six months. The results indicated that nutraceutical rich black carrot beverage could be successfully utilized to develop functional beverages with improved quality and shelf life. There is a dearth of information on the survival of pathogenic microorganisms in relation to the fermented lactic acid beverage. With no sensorial defects in fermented beverage, the microbiological analysis has revealed the presence of pathogens, *Aeromonas hydrophila*, *Citrobacter freundii*, *Enterobacter cloacae*, *Klebsiella pneumonia* (strain HM2, accession number KF551984)) and *Cronobacter sakazakii* (strain WJ2275, accession number KF551983) during the fermentation. Though natural and traditional fermentation is a health boon but during fermentation, apart from beneficial flora a few pathogenic bacteria has been found to persist and proliferated in fermented ready to serve beverage. Hence, the study concludes that the safety of traditionally acidified black carrot beverage requires mandatory investigation of growth and survival potential of pathogenic bacteria in stored and fermenting black carrot beverage. The probiotic functional *consortia* as starter culture has also been developed during the course of this study which ascertain the safety of natural lactic acid fermentation, and hence ensures a microbiological safe reputation of the traditionally fermented vegetable product.

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