

Metabolome analysis of traditional kombucha and evaluation of its blending with black carrot juice

Priya Katyal^{1,*}, Gurleen Kaur¹, Heena Sharma² and Simranpreet Kaur Natt¹

¹Department of Microbiology, Punjab Agricultural University, Ludhiana 141 004, India

²Dairy Technology Division, National Dairy Research Institute, Karnal 132 001, India

Kombucha is a millennial beverage with great potential due to its functional claims and is prepared by fermentation of sweetened tea with symbiotic culture of bacteria and yeast (SCOBY). While its fermentation process has been extensively studied, blending kombucha with vegetable juices remains underexplored. In the present study, black carrot juice was incorporated into kombucha to enhance its physicochemical and sensory properties. Response surface methodology (RSM) optimization identified a formulation containing 20% black carrot juice and 1% spice mixture as the most effective, yielding maximum antioxidant activity (84.36%) and the highest sensory score (8.64). Additionally, metabolomic profiling of traditional kombucha, conducted using a gas chromatography–mass spectrometry (GC-MS) approach, revealed a diverse range of bioactive metabolites, including the novel detection of erythrono-1,4-lactone. These findings highlight the nutritional superiority of black carrot-blended kombucha and the therapeutic potential of kombucha in general.

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The Maillard reaction, decarboxylation and deamination of amino acids, hydrolysis of glycosides, and oxidative degradation of carotenoids, have been reported to produce the final metabolome constituents of the finished product^{7,8}. Metabolome analysis can provide important insights into the types of metabolites produced in fermented products, which can be exploited for potential health benefits. Drinking kombucha is said to improve overall health, treat gastrointestinal disorders, prolong life, and exhibit immunomodulatory, antihypertensive, hypocholesterolemic, hypoglycemic, antiproliferative and antimicrobial properties, as well as contain phenolic antioxidants that scavenge harmful free radicals⁹.

Various studies have either used fruits, vegetables or herbs to create a direct infusion or have added them to cause a second fermentation, which improves the beverage's bioactive chemical profile while also promoting flavouring and consumer acceptability¹⁰. Red grape juice kombucha beverage has been reported to have higher levels of phenolics, anthocyanins and antioxidants¹¹. Kombucha prepared from snake fruit juice and fermented for 14 days was found to have strong anti-diabetic properties in an *in vivo* study¹².

The present study focuses on fermenting kombucha and enhancing its functionality by supplementing it with juice from black carrots (*Daucus carota*) and adding salt and