Malolactic fermentation of bilberry juices for reduced sourness

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In Sweden, bilberries grow in large numbers and cover around 11 % of the Swedish forests, resulting in large quantities of around 400 thousand tons per year. Currently most of the berries are picked, frozen and exported for extraction of high-valued bio-products which are used in, e.g. cosmetics and health supplements. In order, to increase the usage of bilberries in food and beverages in Sweden and in the rest of the world, new sustainable processing methods are needed. One aspect that impacts the relatively low use of bilberries in foods and beverages is the sourness of the berry. Even though the relatively high sugar content in the berries, the sourness is prominent. Amongst other things, the sourness is linked to the high content of L-malic acid. Malolactic fermentation (MLF) is often used as a secondary fermentation in the wine industry to convert L-malic acid to L-lactic acid and in turn give rise to a more pleasant aroma profile. Another aspect preventing good use of bilberries in food and beverages is the short shelf-life during storage above the freezing point. Addition of starter cultures with antimicrobial properties could be one way to increase the shelf-life.

We have evaluated five different lactic acid bacteria (LAB) starter cultures all obtained from Sacco S.R.L. (Italy) primarily on their ability to perform MLF in heat-treated bilberry juices. The strains were directly added to heat-treated bilberry juice and the fermentation at 25 °C lasted up to 14 days with frequent measurements of L-malic and L-lactic acid contents using enzymatic assays. The pH and total sugar content were also monitored. Only the two of the strains, both Lactoplantibacillus plantarum strains were successful in performing MLF under these conditions, and in these fermentations L-malic acid was converted to an equimolar ratio of L-lactic acid without any consumption of sugar. The fermentation was repeated using the best performing L. plantarum strain. Nutritional analysis of all organic compounds confirmed the observations and showed that no citric acid was consumed which further support that the conversion of L-malic acid into L-lactic acid is indeed resulted from MLF.

Metagenome sequencing revealed a great microbial diversity in fermented samples despite an initial heat-treatment. Therefore, bilberry juices, with or without addition of starter culture, were subjected to microbial quantification, during fermentations as well as after prolonged storage at 4°C and 25 °C: Throughout the 14 days of fermentation, we could detect a ten-fold reduction in number of culturable LAB, and limited growth in any samples except in the non-heated control. After prolonged storage, growth was observed for spoilage microorganisms although with a high variability between samples, and with no indication that this particular strain has any antimicrobial properties. Moreover, the number of added LAB eventually dropped to unculturable levels.

To conclude, we have identified one starter culture very efficient in reducing the sourness of bilberries through MLF, but to increase the shelf-life, other actions are required.