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HOW LACTIC ACID BACTERIA CAN IMPROVE ORGANOLEPTIC PROPERTIES OF PLANT-BASED FOOD THROUGH FERMENTATION?

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Targeted audience: Food (non food) processors, Consumers (and citizens), Students, Researchers, Cook chiefs, restaurants and collective catering

Are you able to make an oral presentation in English?: Yes

Prefered language for oral presentation: English

Summary: A Western diet containing 50% of plant-based protein is healthier and would help to reduce the environmental impacts of food systems to contribute to meeting worldwide protein needs. However, few consumers do like plant-based protein food, 25% of consumers do like taste of soy products. Fermentation by lactic acid bacteria (LAB) is a sustainable and an inexpensive process for the preservation or raw material that can also modify taste. In this work, we screened 278 LAB in order to select strains of interest to ferment soy juice. Our findings showed that the ability of LAB to ferment soy juice is both species- and strain-dependent. We also found that some strains can improve organoleptic properties of fermented soy juices, and the study highlights the diversity of metabolic profiles of LAB in soy juice fermentation. In conclusion, specific LAB can improve plant-based product fermentation rates, organoleptic properties and thus help to promote plant-based proteins in our diet.

Background: Protein source in Western diets is mainly composed of animal-based protein (60% versus 40% plant-based protein, FAOSTAT 2018). A more balanced diet containing 50% of plant-based protein is healthier and would help to reduce the environmental impacts of food systems to contribute to meeting worldwide protein needs (Springmann et al., 2018). In this context, soy juice can be an alternative to animal milk. However, soy “beany” and “green” off-flavors limit their consumption (Kaneko et al., 2011). Fermentation is sustainable and inexpensive for raw material preservation. The fermentation of soy juice by lactic acid bacteria (LAB) to produce a yogurt-type product can help to improve the organoleptic properties of fermented soy products (Mital and Steinkraus, 1979; Siroli et al., 2019). Soy juice fermentation is however complex and depends on several parameters: the soy juice composition, the LAB strains used as a starter and the fermentation parameters applied.

Core messages and conclusions: This contribution will present the ability of 278 LAB from 24 species to ferment an organic soy juice containing 5.5 g/L of sucrose, 0.9 g/L of raffinose and 3.1 g/L of stachyose. The fermented soy juices (FSJs) produced were evaluated for their odor by a panel of 10 to 14 judges. The FSJs with odors deemed to be acceptable were characterized by targeted metabolomics. Within 10 h of fermentation, 159 (57 % of the strains) were able to ferment the soy juice from a pH value of 7.2 until a value of pH < 6. The FSJs exhibited a remarkable diversity of odors. Indeed, 164 specific odors were identified among 115 FSJs. The odor of *Streptococcus thermophilus* FSJs was more frequently associated with “nuts”, “soy”, “fresh”, “caramel”, “almond”, “yogurt” and “hay” descriptors ($p < 0.001$), whereas the odor of *Lactococcus lactis* FSJs odors was associated with “soy sauce”, “black bread”, “cabbage” and “broth” descriptors ($p < 0.001$). In addition, peculiar strains belonging to three different species: *Lactobacillus pentosus, Lactobacillus plantarum* and *Lactococcus lactis* produced “floral” odors ($p < 0.001$). FSJs made from 46 strains had odors deemed to be acceptable. The 27 *S. thermophilus* FSJs differed from the 18 *Lactobacillus* and one *Lactococcus* FSJs by

a higher content in residual sucrose (1.1 ± 0.1 versus 0.3 ± 0.1 g/L) and lactic acid (3.0 ± 0.1 g/L versus 2.2 ± 0.1 g/L), a lower content in acetic acid (0.03 ± 0.01 versus 0.11 ± 0.01 g/L) and a lower pH (4.9 ± 0.1 versus 5.5 ± 0.1). Thirty-five volatile compounds were identified. Groups of FSJs were distinguished by hierarchical clustering as a function of their volatile compound profiles. The controls, i.e. non-fermented soy juices formed a separate group from all other FSJs. The “off-flavors” perceived in non-fermented soy juices ($p < 0.1$), described as “green” and “hay”, must be due to compounds such as hexanal and 2-pentylfuran (Kobayashi et al., 1995). Our results confirmed that fermentation can reduce the concentration of hexanal and 2-pentylfuran in a strain- and species-specific manner, as previously reported (Figure 1, Blagden and Gilliland, 2005). Unexpectedly, only six of the *S. thermophilus* strains tested significantly reduced the hexanal content, and surprisingly, four *S. thermophilus* strains increased hexanal levels in SJ (Figure 1). Most *S. thermophilus* strains were distinguished from most *Lactobacillus*/ *Lactococcus* by distinct metabolites as aldehydes, alcohols and ketones, including 2,3-butanedione present in its FSJs (also called diacetyl, with a butter-related flavour, Figure 2). The “sour”, “acid”, “cheese” and “sorrel” odors may have been due to higher concentrations of acetic, butanoic and pentanoic acids in the corresponding FSJs. FSJ produced using a strain of *L. plantarum* differed from all other FSJs because of its marked floral/hyacinth odor, which was probably related to the high phenylethan-1-ol level detected in its FSJ (Figure 2).

Suggested readings and/or references to your work:

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Image 1:

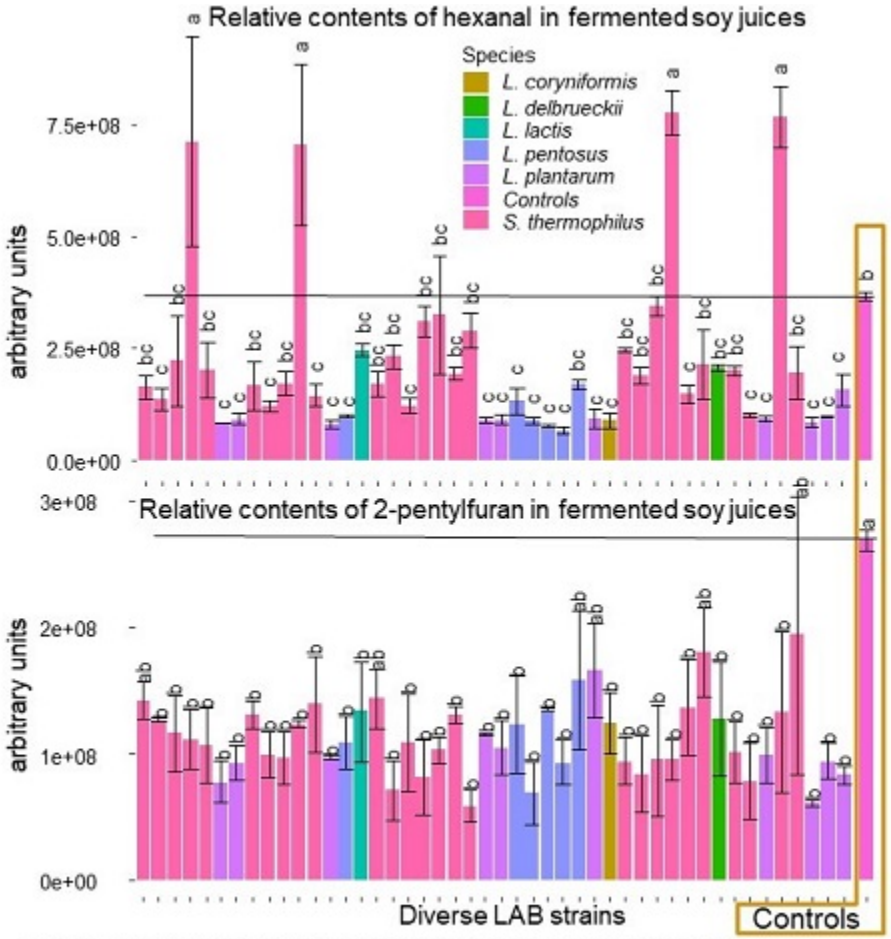

Figure 1. Relative amounts of two compounds involved in off-flavors in soy juices fermented by 46 strains of lactic acid bacteria: means of duplicates for hexanal and 2-pentyl furan. Controls are unfermented soy juice. Letters indicate statistical differences from a Tukey test with an alpha error of 0.1.

Image 2:

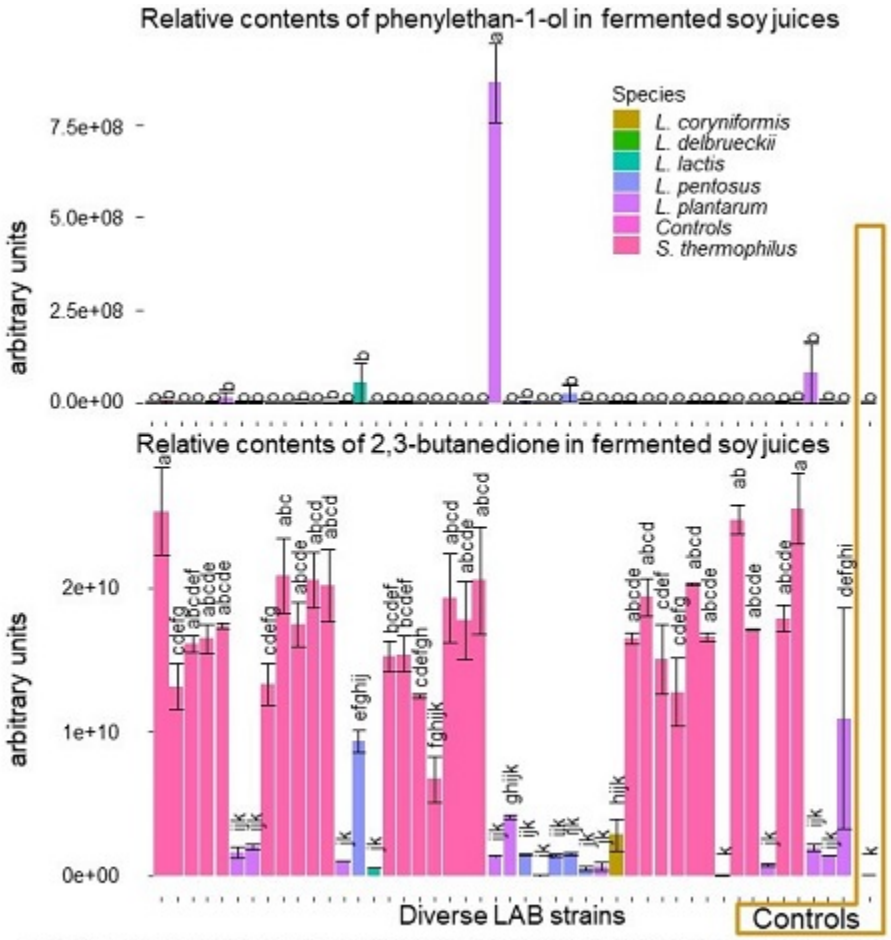

Figure 2. Relative amounts of two compounds involved in hedonic-flavors in soy juices fermented by 46 strains of lactic acid bacteria: means of duplicates for phenylethan-1-ol and 2,3-butanedione. Controls are unfermented soy juice. Letters indicate statistical differences from a Tukey test with an alpha error of 0.1.

Disclosure of Interest: None Declared

Keywords: lactic fermentation, plant-based food, sensory evaluation, volatile compound