Production of lactic acid wort-based beverages with mint essential oil addition in stirred bioreactor

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INTRODUCTION

Lactic acid fermented wort-based beverages are non-alcoholic, with low pH value (3.5-4.5) and produced by the fermentation of wort by lactic acid bacterial (LAB) strains. They can be classified as functional because of wort and LAB. Wort consists of many substances that are beneficial for human health such as: fibres (β-glucan and arabinoxylan), antioxidants (phenolic compounds and melanoidins), and vitamins (folate, riboflavin, pantothenic acid, pyridoxine and niacin). The beverages can be defined as probiotic if LAB are maintained alive in it until the time of consumption and present in significant numbers, at levels of at least 10^7 viable cells per milliliter. Despite the acknowledged health benefits of lactic acid fermented wort beverages, they are poorly accepted by consumers because of their sour or worty-like taste and aroma. Therefore, the main challenge for producers is to improve their sensorial characteristics. Mint (*Mentha piperita*) is used for flavoring different food and beverages and for treatment of different deceases in folk remedy. Therefore, mint essential oil is suitable for use in functional beverages production.

RESEARCH AIM

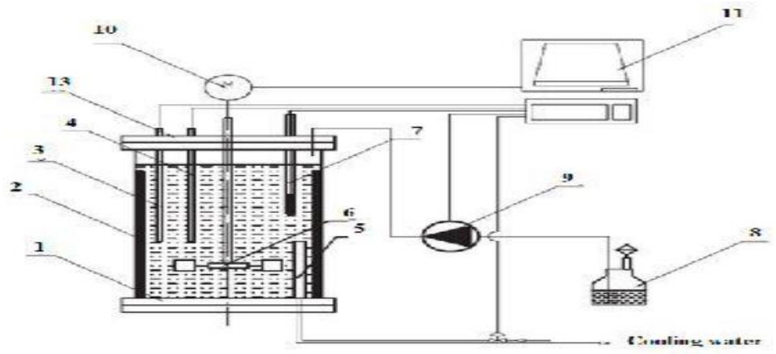
The aim of this study was to investigate the influence of mint essential oil addition in different concentration on the production of functional lactic acid wort-based beverages in stirred bioreactor. The changes in pH, concentration of viable LAB, phenolic compounds and antioxidant activity was determined in order to estimate the biological value of the beverages produced. The sensorial characteristics of the beverages were also described.

MATERIALS AND METHODS

Microorganisms– *Lacticaseibacillus rhamnosus* LBRC11, isolated from home-made cheese.

Wort production – 4.5 kg mixture of 60% Pilsen malt, 20% Vienna malt and 20% Caramel Munich II malt was milled and mixed with water at a ratio of 1:5. Mashing was conducted in laboratory Braumeister by increasing the temperature by 1°C/min and by maintaining rests at the following temperatures: 30 min at 50°C and 60 min at 77°C. Lautering and boiling (30 minutes without hop addition) were also conducted in the same Braumeister. After hot trub removal, the wort was autoclaved at 121 °C for 30 minutes. The wort extract was 11 % (w/w) and the pH was 5.30.

Fermentation - Wort was divided into 3 equal parts: with 0.025 % (v/v) mint essential oil, with 0.05 % (v/v) mint essential oil and a reference sample. 1.5 L of wort was placed in stirred bioreactor and inoculated with 2% of LAB suspensions to obtain initial concentration of 10^7 cells/ml. Fermentation was carried out at 25±1°C in stirred tank bioreactor.



1 - vessel with a geometric volume of 2 dm3; 2 - baffles; 3 - temperature electrode (thermometer); 4 - cooling/heating device (water jacket); 5 - an additional cooling/heating device; 6 - turbine stirrer; 7 - pH/Eh electrode; 8 - fermentation medium/inoculum/pH adjustment medium; 9 -peristaltic pump; 10 - stirrer drive; 11 – Sartorius A2 reference device;

Fig. 1 Stirred tank bioreactor

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Analytical methods and procedures

- ✓ Extract and pH according to EBC standard methods
- ✓ Determination of the number of viable LAB cells - pour plate method on LAPTg10–agar medium.
- ✓ Determination of Phenolic Compound Content with FC reagent and by the Glories methods - after dilution with methanol at a ratio of 1:5
- ✓ Determination of Antioxidant Potential - against the DPPH radical, by the FRAP method, by the ABTS method, by the CUPRAC method
- ✓ Sensory analysis – by descriptive analysis

RESULTS

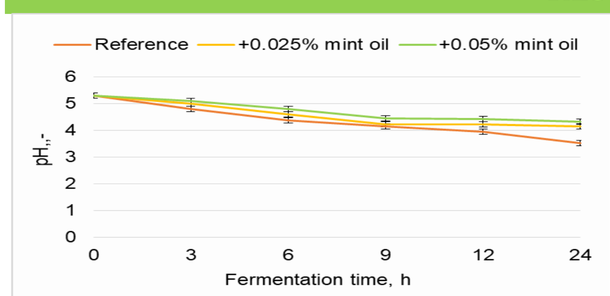

Figure 2. Changes in pH during fermentation

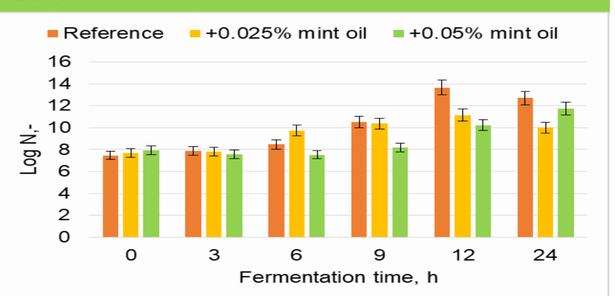

Figure 3. Changes in viable cell concentration during fermentation

	Reference		+0.025% mint essential oil		+0.05% mint	essential oil
	0h	24 h	0h	24 h	0h	24 h
TPC by FC method, mg/L	593	580	619	433	673	884
TPC by modified Glories method, mg/L	835	825	727	678	796	915
Phenolic acids, mg/L	187	194	153	135	178	117
Flavonoids, mg/L	110	110	74	58	97	48
AOA by DPPH method, μmol TE/L	1072	1756	1294	1712	2001	1634
AOA by FRAP method, μmol TE/L	1148	1373	998	1390	1538	2005
AOA by ABTS method, μmol TE/L	2304	2038	2601	2713	2709	2801
AOA by CUPRAC method, μmol TE/L	13692	3136	14247	3108	7923	13692

Table 1. Changes in phenolic compounds concentration and antioxidant activity of beverages produced without or with mint essential oil addition.

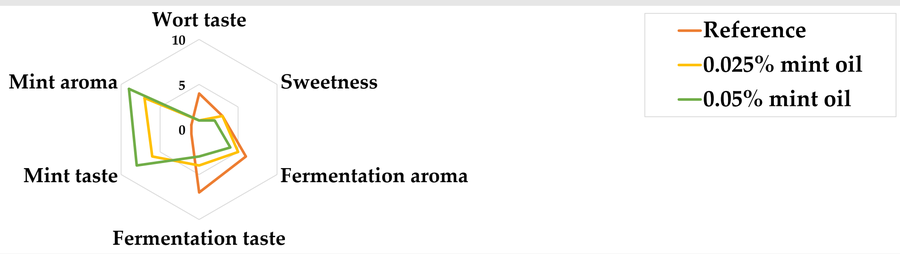

Fig. 4 Sensory analysis of beverages produced

CONCLUSIONS

Mint essential oil inhibited lactic acid fermentation but all the beverages produced can be classified as functional. The addition of mint essential oil in concentration 0.05 %(v/v) led to the highest total phenolic compounds concentration and antioxidant activities, measured by CUPRAC and FRAP method. The lower concentration of phenolic acids and flavonoids in beverages with mint essential oil can be ascribed to the chemical reaction between these wort phenols and mint essential oil compounds. The tasting panel preferred the reference sample, followed by the beverage with 0.025% (v/v) mint essential oil addition. The results obtained will be used for modeling of lactic acids fermentation with addition of mint essential oil for the production of functional wort-based beverages.