

## INTRODUCTION

Functional beverages should at least be a thorough source of the bioactive components like dietary fibre, vitamins, minerals, carotenoids, fatty acids, prebiotics, probiotics, phytochemicals, enzymes and antioxidants and do not contain more than 1.2% v/v ethanol. Sweet wort (source of fibres ( $\beta$ -glucan and arabinoxylan), antioxidants (phenolic compounds and melanoidins), and vitamins (folate, riboflavin, pantothenic acid, pyridoxine and niacin)), lemon essential oil (source of antioxidants) and the only one yeast species with probiotic properties – *Saccharomyces boulardii* can be used for functional beverages production.

## RESEARCH AIM

The aim of this study was to evaluate the effects of the addition of lemon essential oil on the dynamics of wort fermentation with a probiotic *S. boulardii* strain. The phenolic compounds content and the antioxidant activity of the beverages produced were examined. The sensorial characteristics of the produced functional beverages were also described.

## MATERIALS AND METHODS

**Microorganisms** - *Saccharomyces cerevisiae* var. *boulardii* Y1, which was isolated from spontaneously fermented oat milk.

**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 12.4 % (w/w) and the pH was 5.30.

**Fermentation** - 200 cm<sup>3</sup> of wort (with and without 0.05% (v/v) lemon essential oil) was placed into bottles and inoculated with a 2 ml yeast suspension with an initial concentration of 2.10<sup>7</sup> CFU/cm<sup>3</sup>. The bottles were incubated at a constant fermentation temperature of 10°C for 5 days.

### Analytical procedures

- ✓ *Fermentation parameters* - original and apparent extract, and ethanol were measured according to EBC standard methods.
- ✓ *Determination of the number of viable yeast cells* – spread plate method on malt-agar medium.
- ✓ *Phenolic content*. – with FC reagent and by the Glories methods after dilution with methanol in ratio 1:10
- ✓ *Antioxidant activity* – by DPPH and FRAP methods
- ✓ *Sensory analysis* – by descriptive method.

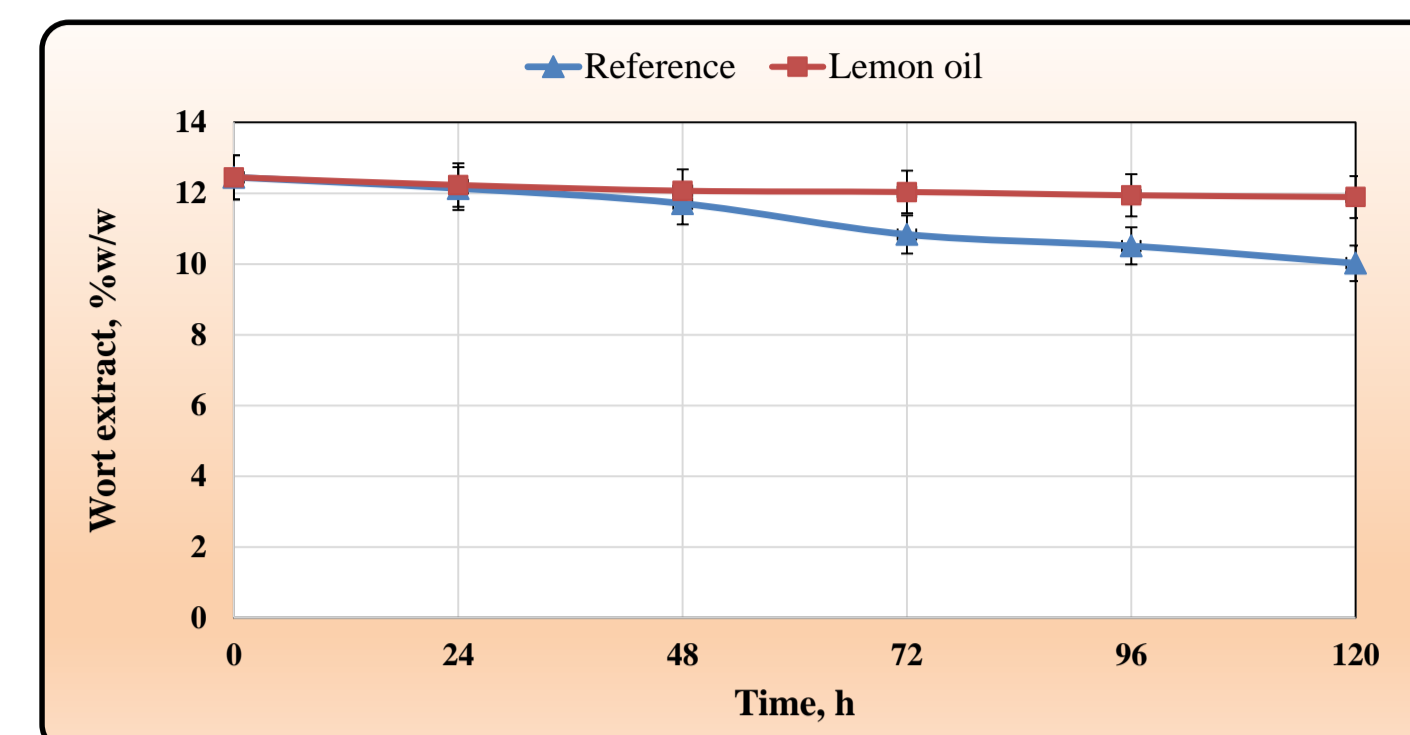
## CONCLUSIONS

Probiotic yeast strain *Saccharomyces cerevisiae* var. *boulardii* Y1 was used for the production of a wort-based functional drink with and without lemon essential oil. The beverage with essential oil can be classified as functional because its alcohol concentration was below 1.2%(v/v) and the concentration of viable cells was higher than 10<sup>9</sup> cells/cm<sup>3</sup>. The combination of essential oil and the probiotic yeast strain resulted in beverages with higher biological value than the beverage produced with the probiotic strain alone. Moreover, the lemon taste and aroma of beverage with lemon essential oil was well accepted by the tasting panel.

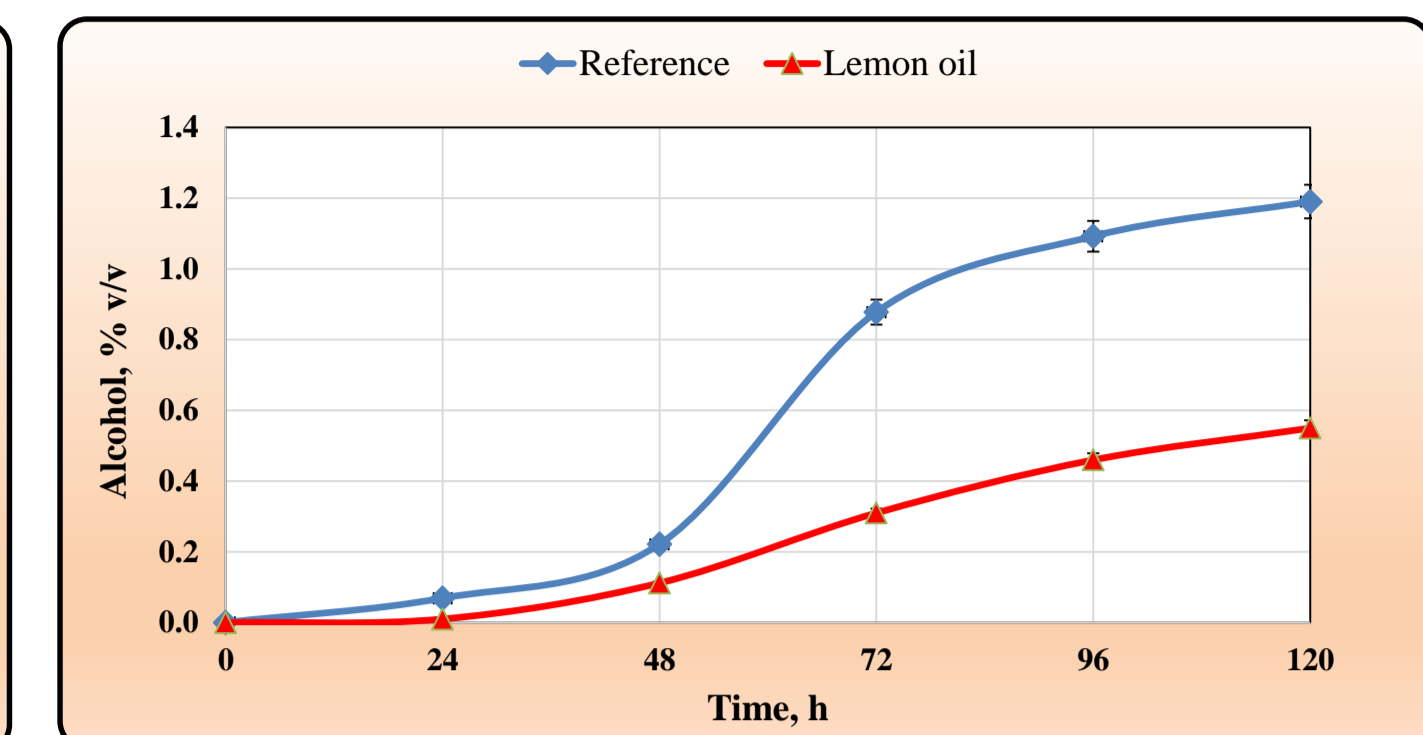
## ACKNOWLEDGMENTS

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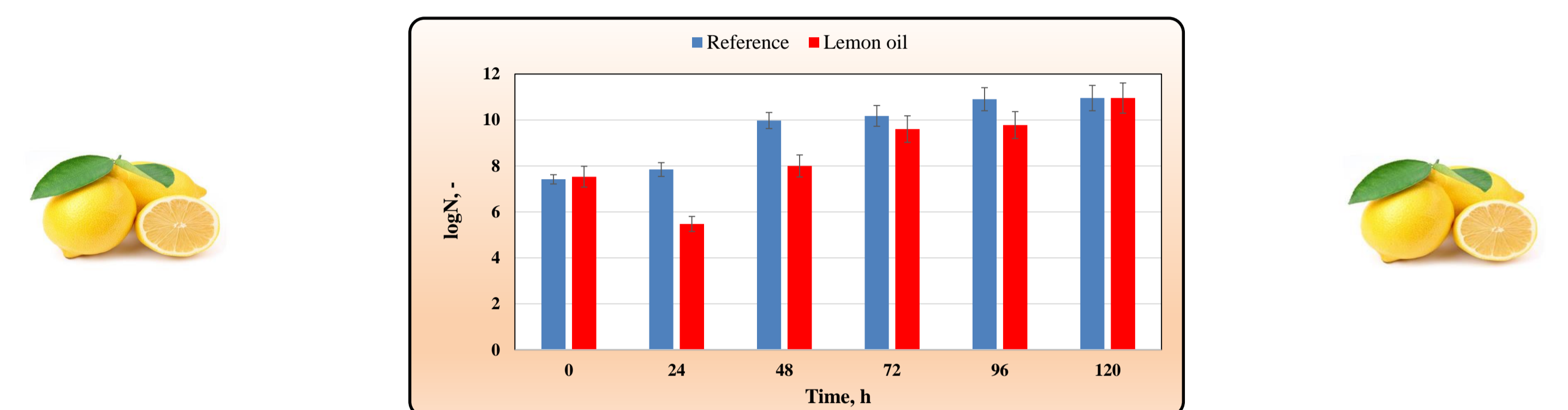
## RESULTS AND DISCUSSION



**Fig. 1a** Changes in wort extract during fermentation



**Fig. 1b** Changes in alcohol concentration during fermentation



**Fig. 1c** Changes in viable cells concentration during fermentation. Log N on Y axis is  $\log_{10}N$ , where N is the number of viable *S. boulardii* cells, cfu/cm<sup>3</sup>

**Table 1**  
Changes in phenolic compounds concentration and antioxidant activity

	Reference		Lemon oil	
	0 h	120 h	0 h	120 h
<b>Phenolic compounds by FC, mg/dm<sup>3</sup></b>	700±31	672±34	760±38	701±35
<b>Phenolic compounds by modified Glories method, mg/dm<sup>3</sup></b>	894±45	772±39	917±46	1152±58
<b>Phenolic acids, mg/dm<sup>3</sup></b>	162±8	175±9	173±9	236±10
<b>Flavonoid phenolic compounds, mg/dm<sup>3</sup></b>	55±3	100±5	74±4	154±6
<b>Antioxidant activity by DPPH, µmol TE/dm<sup>3</sup></b>	1523±85	1092±55	1626±85	1127±56
<b>Antioxidant activity by FRAP, µmol TE/dm<sup>3</sup></b>	1692±76	1169±58	1704±81	1452±73

**Table 2.**

Results of descriptive sensorial analysis of beverage produced

Sample	Description
<b>Reference</b>	aroma: wort / sweet corn / toasted bread crust taste: wort / caramel / honey
<b>Lemon oil</b>	aroma: aroma of lemon peel taste: lemon taste