Optimization of ultrasound-assisted extraction of phenolic compounds from Jussara (Euterpe Edulis M.) using response surface methodology

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INTRODUCTION

- ❖ Bioactive compounds have been a subject of interest for the last years because of growing regulations to food coloring and the restriction of synthetic food colorants.
- ❖ New techniques have been developed by which natural food colorants can be extracted from plants/ fruits and used as colorant in the industry.
- ❖ Some examples are carotenoids from carrot and anthocyanins from grapes. This last compound, anthocyanins, are vastly found in the fruits from the different forests of Brazil. Mainly in the Amazon Forest and Atlantic Forest. Some examples of fruits are jabuticaba, acai and jussara.
- ❖ This research is based on the Jussara fruit which is found in the Atlantic Forest at the east coast of Brazil.

OBJECTIVES

- ❖ Optimizing Ultrasound-assisted extraction of phenolic compounds from jussara using response surface methodology.
- ❖ Comparison between optimized ultrasound-assisted extraction and conventional extraction.

MATERIALS AND METHODS

JUSSARA
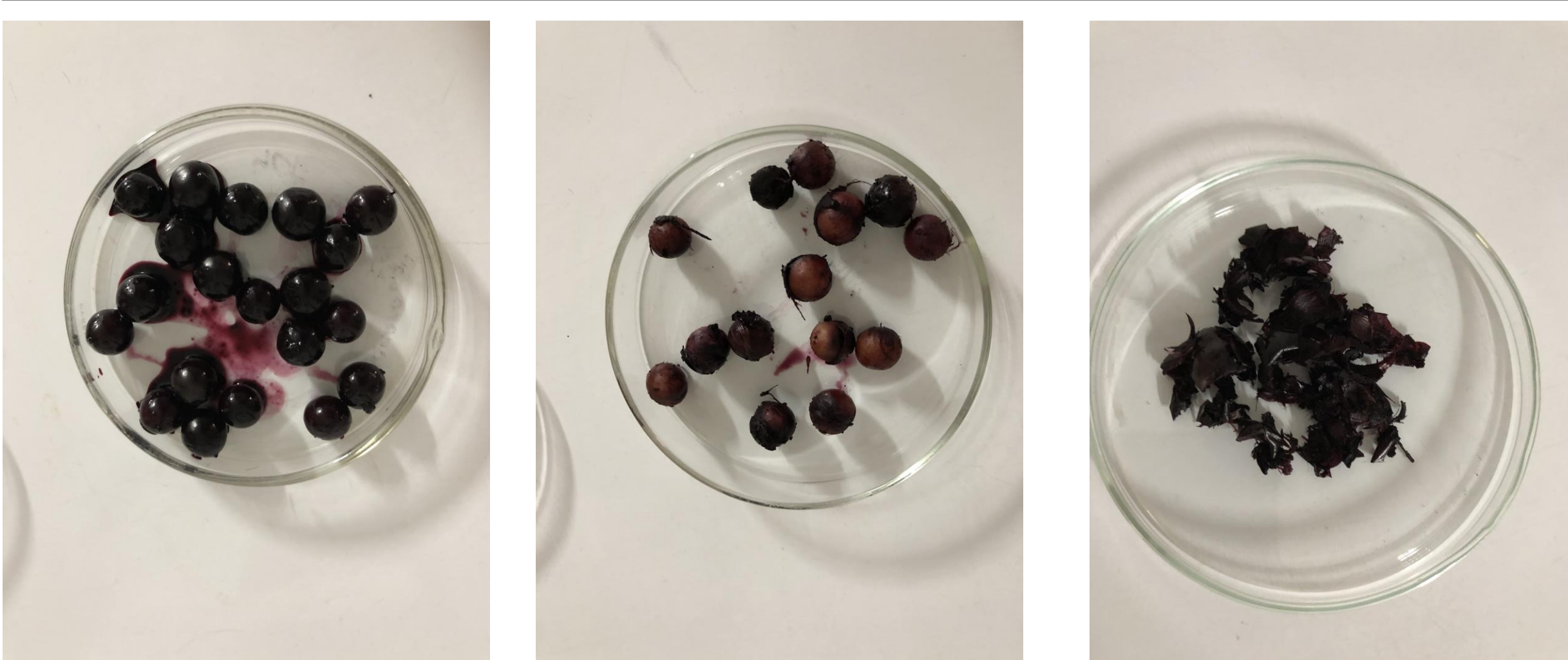
CONVENTIONAL EXTRACTION

- ❖ Performed with acidified ethanol (70 vol%) for 24 hours at 5 °C with a 1:10 (m/V) fruit/solvent ratio.

ULTRASOUND-ASSISTED EXTRACTION

- ❖ Performed with acidified ethanol (70 vol%) in an ultrasonic bath (Elma TI-H 10) and the parameters time (5 – 75 min), temperature (30 – 70 °C) and fruit/solvent ratio (1:20 – 1:40 (m/V)) were evaluated. Sonication power and frequency were constant at 50% and 25 kHz respectively.

OPTIMIZING ULTRASOUND-ASSISTED EXTRACTION

- ❖ Box-Behnken design
- ❖ Statistica software

Experimental variables	Code	Coded levels		
		-1	0	+1
Time (min)	X_1	5	40	75
Temperature (°C)	X_2	30	50	70
Fruit/Solvent ratio (m/V)	X_3	1:20	1:30	1:40

TOTAL ANTHOCYANINS DETERMINATION

- ❖ The total anthocyanins content (mg/100 g fruit) of the extracts was determined with Fuleki & Francis (1968)
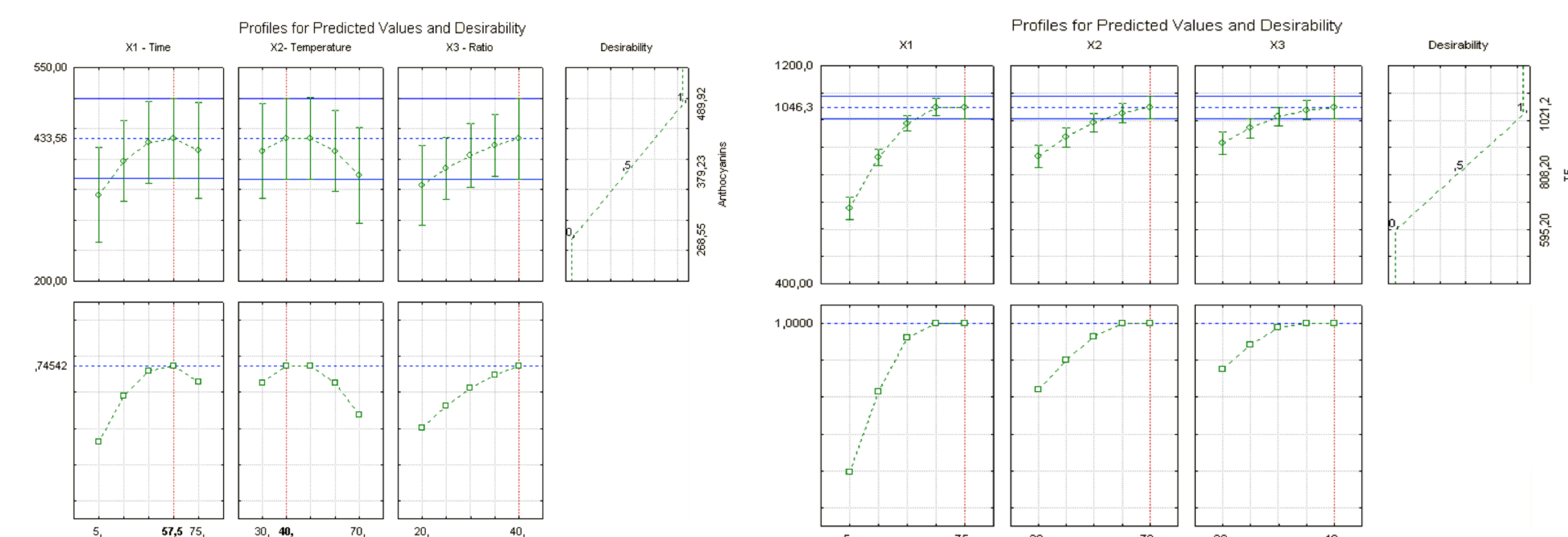
TOTAL PHENOLICS DETERMINATION

- ❖ The total phenolic content (mg GAE/100 g fruit) of the extracts was determined with Singleton & Joseph (1965)

ACKNOWLEDGMENTS

RESULTS AND DISCUSSION

OPTIMIZATION TOTAL ANTHOCYANINS & TOTAL PHENOLICS EXTRACTION

- ❖ p < 0,10
- ❖ R^2 = 0,92
- ❖ Extraction time: 57,5 min
- ❖ Extraction temperature: 40 °C
- ❖ Fruit/solvent ratio: 1:40 (m/V)
- ❖ Expected total anthocyanins extract: 489,92

$$Y_{TA} = 335,2383 + 73,4115 \cdot t + 76,0780 \cdot R + 49,5814 \cdot t^2 + 40,0192 \cdot T^2 - 82,3951 \cdot t^2 \cdot T - 74,9637 \cdot T \cdot R$$

- ❖ P < 0,05
- ❖ R^2 = 0,98
- ❖ Extraction time: 75 min
- ❖ Extraction temperature: 70 °C
- ❖ Fruit/solvent ratio: 1:40 (m/V)
- ❖ Expected total anthocyanins extract: 1021,2

$$Y_{TP} = 816,2879 + 277,9705 \cdot t + 131,8517 \cdot T + 85,9839 \cdot S/L + 125,9705 \cdot t^2 + 32,7339 \cdot T^2 + 31,2909 \cdot S/L^2 + 45,7933 \cdot t \cdot T + 44,6207 \cdot t \cdot S/L$$

VALIDATION OPTIMIZED EXTRACTION MODELS

Run	Time (min)	Temp (°C)	Ratio (m/V)	Aver. TP (mg/100g)	Aver. TA (mg/100g)
1	57,5	40	1:40	1165,43 ± 110,39	324,60 ± 22,71
2	57,5	40	1:40		
3	57,5	40	1:40		
4	75	70	1:40	1011,84 ± 42,22	267,89 ± 60,23
5	75	70	1:40		
6	75	70	1:40		

- ❖ Total anthocyanins
  - ❖ Expected: 489,92 mg/100 g fruit
  - ❖ Expected/experimental: 66,26%
- ❖ Total Phenolics
  - ❖ Expected: 1021,2 mg GAE/100 g fruit
  - ❖ Expected/experimental: 99%

COMPARISON OPTIMIZED VS CONVENTIONAL EXTRACTION
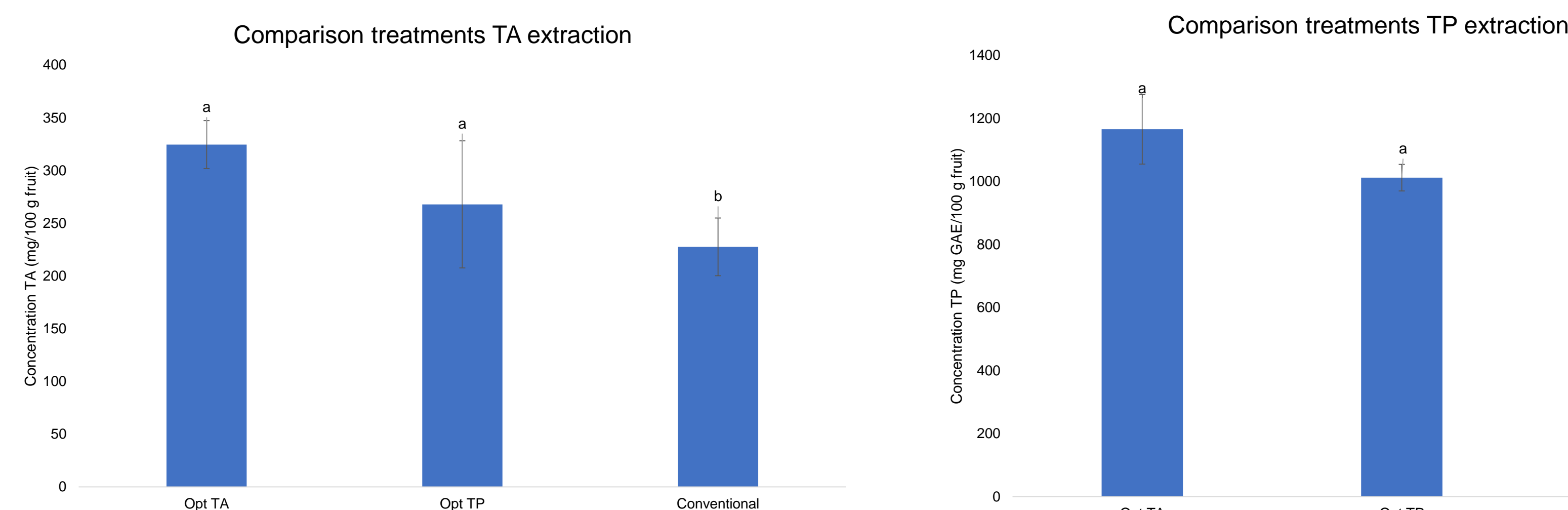
- ❖ Total anthocyanins content of the optimized ultrasound-assisted treatments for total anthocyanins (Opt.TA), total phenolics (Opt.TP) and the conventional extraction. Error bars indicates ± standard deviation. Means followed by the same letter are not significantly different (P > 0,05) by the Tukey HSD test.

- ❖ Comparison between the optimized total anthocyanins extraction treatment and conventional treatment shows an improvement of 43% (227,62 to 324,6 mg/100 g fruit)

- ❖ Comparison between the optimized total phenolics extraction treatment and conventional treatment shows an improvement of 39% (728,62 to 1165,43 mg GAE/100 g fruit)

CONCLUSIONS

- ❖ Optimized extraction models
  - ❖ No validation for total anthocyanins model (R^2 = 0,92; 66,26% (expected/experimental))
  - ❖ Validation for total phenolics model R^2 = 0,98; 99% (expected/ experimental)
- ❖ Optimum extraction conditions
  - ❖ Total anthocyanins
    - ❖ 57,5 min, 40 °C, 1:40 ratio (m/V)
  - ❖ Total phenolics
    - ❖ 75 min, 70 °C, 1:40 ratio (m/V)
- ❖ Comparison between optimized and conventional extraction
  - ❖ Significant improvement (p < 0,05) extraction yield between optimized and conventional extractions
  - ❖ Significant improvement in extraction time (24h to 57,5 and 75 minutes)

References

- ❖ T. Fuleki and F. J. Francis, "Quantitative Methods for Anthocyanins.," *Journal of Food Science*, no. 33, pp. 72-77, 1968.
- ❖ V. L. Singleton and J. A. Rossi, "COLORIMETRY OF TOTAL PHENOLICS WITH PHOSPHOMOLYBDIC-PHOSPHOTUNGSTIC ACID REAGENTS," Am J Enol Vitic., no. 16, pp. 144-158, 1965.