CARBOXYMETHYLCELLULOSE HYDROGELS AS DELIVERY SYSTEMS OF TART CHERRY PHENOLICS AND VOLATILES

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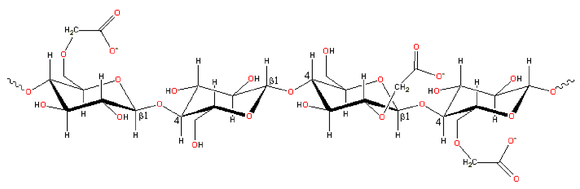
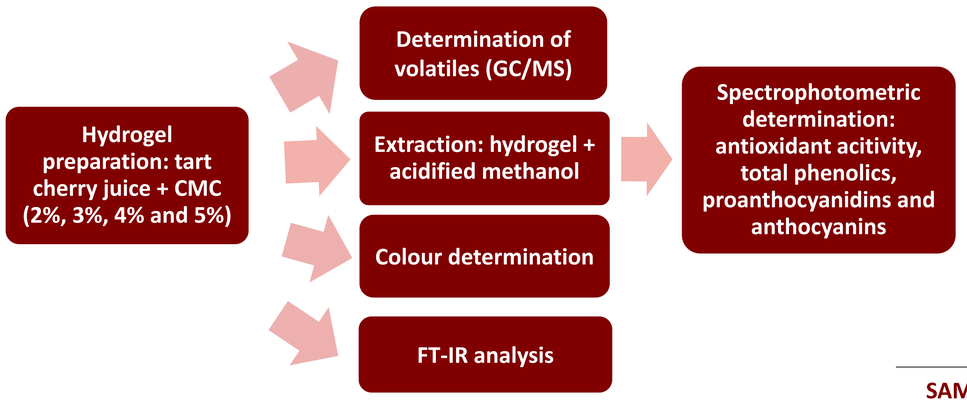


INTRODUCTION

As a result of their chemical degradation, biochemical instability and/or low water solubility, delivery of bioactive compounds to target sites through food is often disturbed. Protection of active compounds is of increasing interest for the food industry thus formulation of adequate delivery systems is of great importance. Consequently, we investigated possibility of carboxymethylcellulose (CMC) hydrogels as delivery systems of tart cherry phenolics and volatiles as active compounds which are beneficial not only for human health but also for food quality and stability.

MATERIALS AND METHODS



RESULTS

Table 1 Volatile compounds (µg/kg) of CMC hydrogels

VOLATILE COMPOUND	2% CMC	3% CMC	4% CMC	5% CMC
Benzaldehyde	1213.20^{d}	599.90^{b}	633.61^{c}	484.09^{a}
Benzyl alcohol	104.62^{c}	85.44^{b}	75.50^{a}	88.74^{b}
Linalool	55.48^{c}	32.24^{b}	27.88^{a}	25.36^{a}
Eugenol	64.73^{c}	44.27^{b}	42.88^{b}	35.99^{a}
β - ionone	5.11^{b}	4.63^{b}	0^{a}	0^{a}

2 – 5% CMC - amount of carboxymethylcellulose used for hydrogel preparation. Within the row, means followed by superscript different letters are significantly different at p ≤ 0.05 (ANOVA, Fisher's LSD).

Table 2 Antioxidant activity of tart cherry juice and its CMC hydrogels

SAMPLES	CUPRAC (µmol/100 ml)	DPPH (µmol/100ml)	ABTS (µmol/100ml)
2% CMC	60.93 ± 1.81^{a}	4.80 ± 0.19^{a,b}	1.32 ± 0.41^{a}
3% CMC	66.83 ± 1.76^{b}	4.63 ± 0.03^{a}	2.30 ± 0.10^{b}
4% CMC	75.82 ± 0.23^{c}	6.06 ± 0.24^{c}	3.53 ± 0.63^{c}
5% CMC	64.00 ± 0.74^{a,b}	5.45 ± 0.03 ^{b,c}	2.59 ± 0.34^{b}
TART CHERRY JUICE	82.54 ± 2.59^{d}	11.67 ± 0.49^{d}	8.90 ± 0.17^{d}

2 – 5% CMC - amount of carboxymethylcellulose used for hydrogel preparation. Within the column, means followed by superscript different letters are significantly different at p ≤ 0.05 (ANOVA, Fisher's LSD).

Table 3 Total phenolics, proanthocyanidins and anthocyanins of tart cherry juice and its CMC hydrogels

SAMPLES	TOTAL PHENOLICS (g/L)	PROANTHOCYANIDINS (g/kg)	ANTHOCYANINS (mg/kg)
2% CMC	0.87 ± 0.05^{a}	0.50 ± 0.01^{b}	170.38 ± 3.32^{a}
3% CMC	0.92 ± 0.24^{a}	0.57 ± 0.01^{b}	204.04 ± 0.21^{a,c}
4% CMC	1.11 ± 0.14^{a,b}	0.65 ± 0.06^{c}	222.99 ± 2.28^{b,c}
5% CMC	0.91 ± 0.04^{a}	0.53 ± 0.01^{b}	199.53 ± 1.66^{a,b}
TART CHERRY JUICE	1.17 ± 0.07^{b}	0.45 ± 0.00^{a}	1035.31 ± 84.34^{d}

2 – 5% CMC - amount of carboxymethylcellulose used for hydrogel preparation. Within the column, means followed by superscript different letters are significantly different at p ≤ 0.05 (ANOVA, Fisher's LSD).

Table 4 Colour parameters of tart cherry juice and its CMC hydrogels

SAMPLES	L*	a*	b*	ΔE	°h	C*
2% CMC	20.10 ± 0.01^{c}	3.22 ± 0.02^{b}	1.48 ± 0.03^{d}	1.11	24.69 ± 0,56^{a}	3.55 ± 0.01^{d}
3% CMC	20.01 ± 0.03^{b}	2.19 ± 0.22^{a}	1.02 ± 0.03^{b}	0.42	25.23 ± 1.81^{a}	2.42 ± 0.21^{a,b}
4% CMC	20.15 ± 0.06^{c}	2.28 ± 0.02^{a}	1.04 ± 0.01^{b}	0.54	24.57 ± 0.38^{a}	2.50 ± 0.01^{a,c}
5% CMC	20.60 ± 0.03^{d}	2.11 ± 0.04^{a}	0.91 ± 0.03^{a}	1.01	23.35 ± 0.91^{a}	2.30 ± 0.02^{a}
TART CHERRY JUICE	19.67 ± 0.01^{a}	2.23 ± 0.05^{a}	1.27 ± 0.04^{c}		29.80 ± 1.18^{b}	2.56 ± 0.02^{b,c}

L*-lightness of sample (L* = 0 dark, L* = 100 light); a* > 0 red, a* < 0 green; b* > 0 yellow, b* < 0 blue; °h-hue; C*-saturation; ΔE-colour change of the hydrogels compared to tart cherry juice. Within the column, means followed by superscript different letters are significantly different at p ≤ 0.05 (ANOVA, Fisher's LSD).

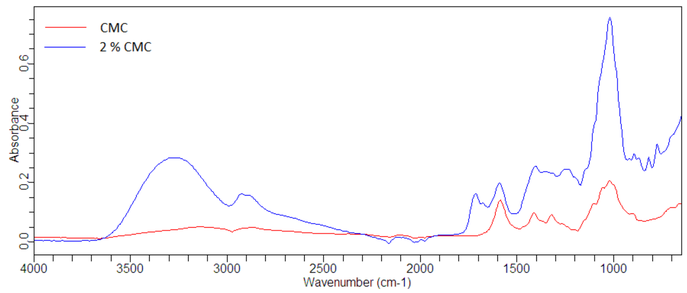


Figure 1 IR spectra of CMC and 2% CMC hydrogel

DISCUSSION

- Increase of CMC up to 4% caused slight increase of phenolics and proanthocyanidins, while increase of anthocyanins content was more pronounced (170 mg/kg, 204 mg/kg and 223 mg/kg for 2%, 3% and 4% of CMC). With further increase of CMC to 5% for preparation of hydrogels decrease of phenolics, proanthocyanidins and anthocyanins occurred. Antioxidant activity evaluated by DPPH, ABTS and CUPRAC methods followed the trend that was observed for phenolic compounds.
- The most important volatiles for tart cherry flavour (benzaldehyde, benzyl alcohol, eugenol, linalool, β – ionone) were selected for evaluation of impact of CMC amount for hydrogel preparation. For all volatiles it was determined that with the increase of CMC amount decrease of volatiles amounts occurred.
- The influence of CMC content on the hydrogel colour was also observed. Measured colour parameters showed that the highest colour change in hydrogels when comapred to tart cherry juice was in the sample containing 2% of CMC.

CONCLUSION

Results of our study showed importance of proper formulation in order to achieve retention of active compounds in our case tart cherry phenolics and volatiles.

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