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INTRODUCTION

Chokeberries are a rich source of phenolic compounds (anthocyanins, flavonols, flavanols, proanthocyanidins and phenolic acids) that are related to antioxidant, anti-inflammatory and antimicrobial activity. The interaction between proteins and phenolic compounds affects the stability of phenolics and among the proteins, casein and whey have excellent functional and nutritional properties. The aim of this study was to investigate the binding of chokeberry phenolics to casein and whey proteins (with and without lecithin).

MATERIALS AND METHODS



RESULTS

Table 1 Total phenolic and proanthocyanidin content of casein, whey/chokeberry juice microparticles

Sample	Total phenolic content (mg GAE/g)	Proanthocyanidin content (mg PB2/g)
CJ/C	15.65 ± 0.69 ^d	6.51 ± 0.15 ^e
CJ/W_L	51.41 ± 0.68 ^b	42.85 ± 0.16 ^b
CJ/W	59.46 ± 0.61 ^a	54.79 ± 0.12 ^a
CJ/C/W_L	24.39 ± 0.23 ^c	15.03 ± 0.17 ^d
CJ/C/W	25.39 ± 0.48 ^c	16.89 ± 0.30 ^c

Table 2 Antioxidant activity of casein, whey/chokeberry juice microparticles

Sample	DPPH (μmol TE/100 g)	ABTS (μmol TE/100 g)	FRAP (μmol TE/100 g)	CUPRAC (mmol TE/100 g)
CJ/C	91.77 ± 0.76 ^e	79.43 ± 0.78 ^e	0.94 ± 0.05 ^e	0.62 ± 0.02 ^e
CJ/W_L	204.66 ± 0.57 ^b	315.22 ± 0.38 ^b	3.34 ± 0.02 ^b	2.35 ± 0.02 ^b
CJ/W	255.92 ± 0.76 ^a	354.91 ± 0.86 ^a	4.21 ± 0.03 ^a	3.11 ± 0.02 ^a
CJ/C/W_L	116.91 ± 0.79 ^d	118.50 ± 0.21 ^d	1.44 ± 0.04 ^d	1.07 ± 0.00 ^d
CJ/C/W	132.15 ± 0.08 ^c	129.02 ± 0.52 ^c	1.61 ± 0.05 ^c	1.14 ± 0.02 ^c

CJ – chokeberry juice; W_L – whey protein with lecithin; W – whey protein without lecithin; C – casein. The results are all expressed as means ± standard deviation (SD). Within the column, different letters mean significant differences (p ≤ 0.05)

CJ – chokeberry juice; W_L – whey protein with lecithin; W – whey protein without lecithin; C – casein. The results are all expressed as means ± standard deviation (SD). Within the column, different letters mean significant differences (p ≤ 0.05)

Table 3 Individual phenolic compounds (mg/100 g) of casein, whey/chokeberry microparticles

Sample	C 3-G	C 3-A	Que	NCA	DChA	ChA
CJ/C	226.80 ± 1.27 ^d	59.34 ± 0.73 ^c	116.17 ± 0.29 ^b	136.72 ± 1.83 ^c	112.89 ± 0.12 ^d	239.08 ± 2.70 ^b
CJ/W_L	234.76 ± 2.68 ^c	63.74 ± 0.71 ^{bc}	118.09 ± 3.96 ^b	122.33 ± 0.58 ^d	121.02 ± 0.27 ^c	235.07 ± 3.35 ^b
CJ/W	273.76 ± 0.71 ^a	75.53 ± 1.11 ^a	91.07 ± 3.23 ^c	174.94 ± 1.26 ^a	125.75 ± 0.13 ^b	318.54 ± 0.71 ^a
CJ/C/W_L	252.62 ± 5.67 ^b	66.87 ± 2.09 ^b	156.25 ± 0.69 ^a	114.73 ± 3.31 ^e	124.58 ± 2.01 ^b	237.88 ± 0.53 ^b
CJ/C/W	256.48 ± 1.74 ^b	67.46 ± 2.97 ^b	158.89 ± 1.14 ^a	159.20 ± 3.05 ^b	166.01 ± 0.24 ^a	317.03 ± 1.24 ^a

CJ – chokeberry juice; W_L – whey protein with lecithin; W – whey protein without lecithin; C – casein; C 3-G – cyanidin 3-galactoside; C 3-A – cyanidin 3-arabinoside; Que – quercetin; NCA – neochlorogenic acid; DChA – chlorogenic acid derivate; ChA – chlorogenic acid. The results are all expressed as means ± standard deviation (SD). Within the column, different letters mean significant differences (p ≤ 0.05).

Table 4 Color parameters of casein, whey/chokeberry microparticles

Sample	L*	a*	b*
C	90.79 ± 0.07 ^b	-1.50 ± 0.02 ^g	16.34 ± 0.14 ^a
W	94.01 ± 0.01 ^a	0.10 ± 0.02 ^f	7.37 ± 0.04 ^c
W_L	90.50 ± 0.11 ^b	-1.57 ± 0.03 ^g	12.74 ± 0.06 ^b
CJ/C	50.41 ± 0.40 ^d	9.53 ± 0.11 ^e	-1.03 ± 0.01 ^g
CJ/W	52.66 ± 0.33 ^c	17.87 ± 0.06 ^a	-0.31 ± 0.04 ^e
CJ/W_L	42.60 ± 0.11 ^g	12.34 ± 0.05 ^c	-0.09 ± 0.01 ^d
CJ/C/W	45.58 ± 0.06 ^f	15.56 ± 0.07 ^b	-1.26 ± 0.03 ^h
CJ/C/W_L	46.48 ± 0.10 ^e	10.86 ± 0.03 ^d	-0.77 ± 0.02 ^f

C – casein; W – whey protein without lecithin; W_L – whey protein with lecithin; CJ – chokeberry juice. The results are all expressed as means ± standard deviation (SD). Within the column, different letters mean significant differences (p ≤ 0.05).

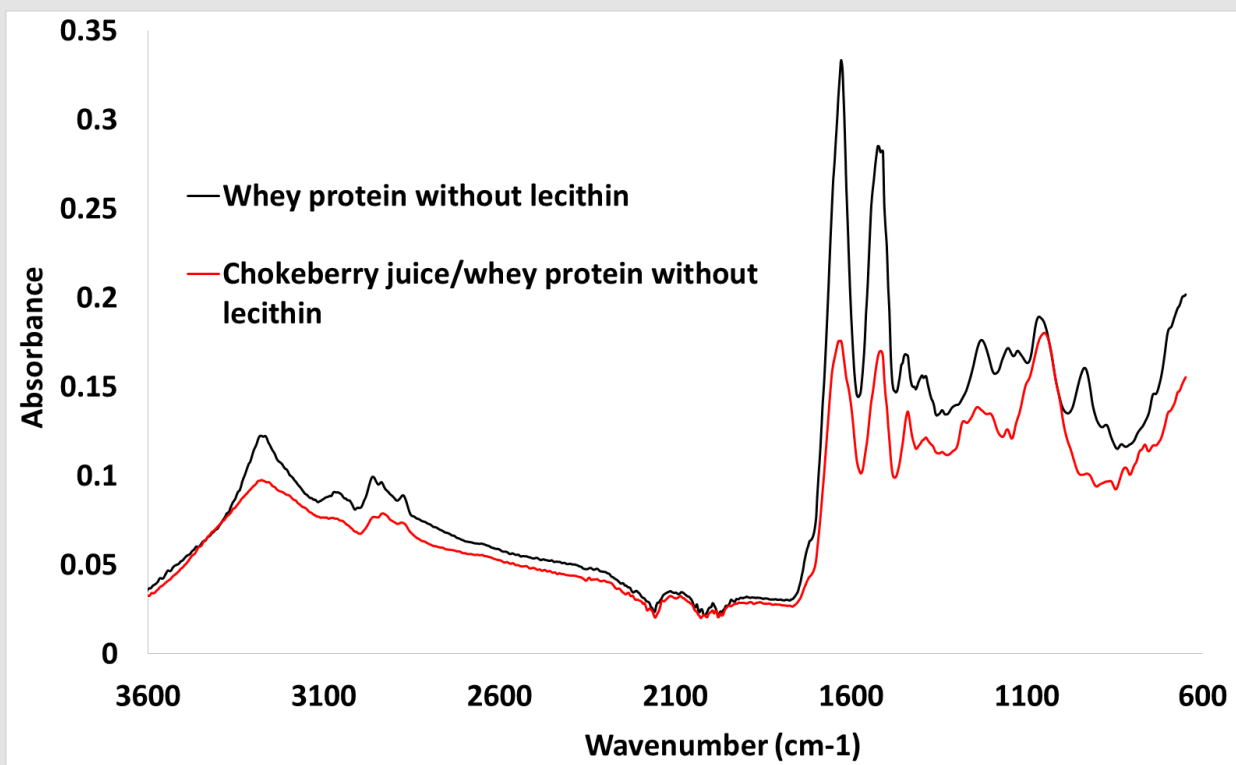


Figure 1 IR spectra of whey protein without lecithin and whey protein without lecithin/chokeberry juice microparticles

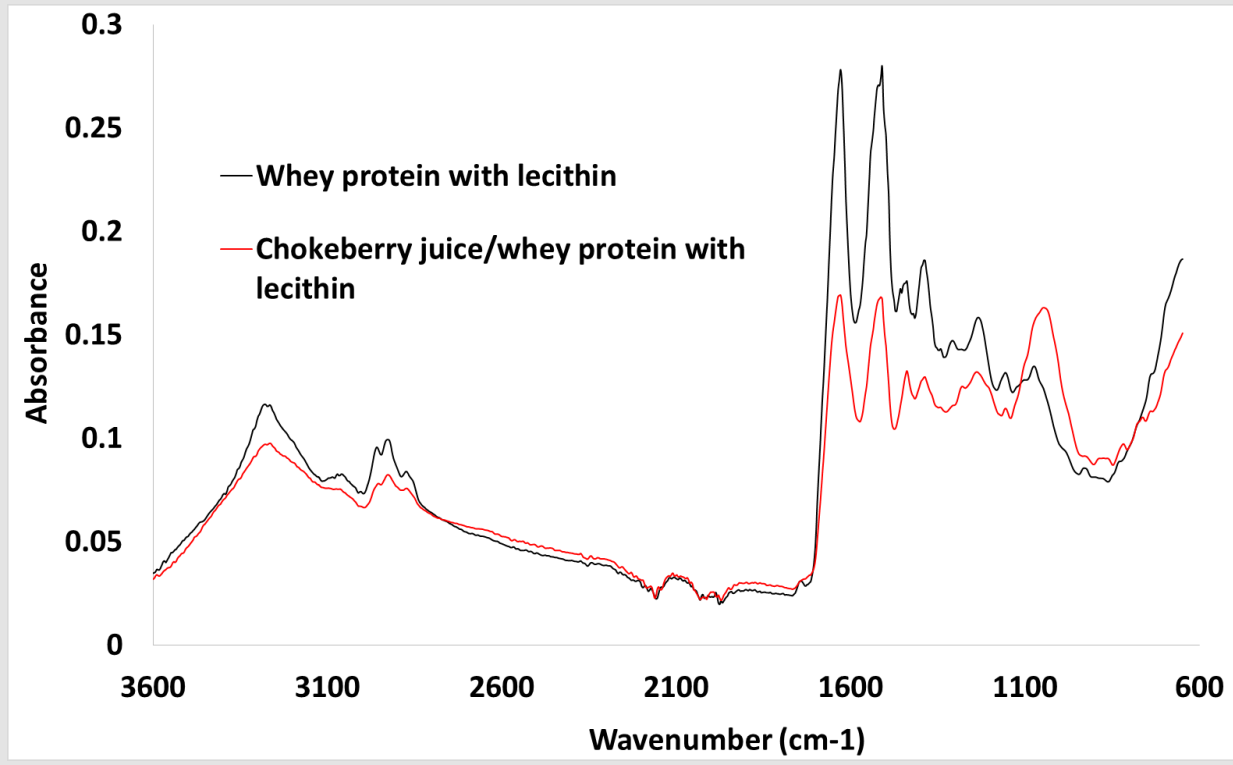


Figure 1 IR spectra of whey protein with lecithin and whey protein with lecithin/chokeberry juice microparticles

DISCUSSION AND CONCLUSIONS

- Highest total phenolic and proanthocyanidin content, as well as antioxidant activity had a whey protein without lecithin/chokeberry microparticles;
- Whey protein without lecithin/chokeberry microparticles had the highest anthocyanin content, according to HPLC analysis, and the highest a* parameter (redness);
- IR spectra of the microparticles showed small changes and confirmed the binding of the chokeberry phenolics on whey proteins;
- Whey protein chokeberry phenolics microparticles can be used in the food industry as bioactive food additives.