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ADSORPTION ISOTHERMS FOR STUDYING INTERACTIONS BETWEEN FLAVONOLS AND ANTHOCYANINS FROM ARONIA AND β-GLUCAN

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INTRODUCTION

Aronia is a fruit very rich in polyphenols, particularly anthocyanins and flavonols. Accordingly, it is often used in a diet as a rich source of polyphenols. Interactions with food macromolecules such as dietary fibers might influence possible beneficial effects of aronia berry polyphenols. The aim of this work was to study the interaction of flavonols and anthocyanins from aronia berries with dietary fiber β-glucan through the adsorption process.

MATERIALS AND METHODS

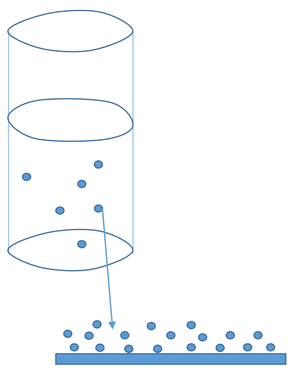
Flavonols and anthocyanins were extracted with ultrasonic assisted extraction, and characterized by using reversed-phase high-performance liquid chromatography. Adsorption onto β-glucan was conducted for 5 h with different initial concentrations of flavonols and anthocyanins. The amount of adsorbed (q_e) and un-adsorbed (c_e) polyphenols were modelled with non-linear regression using adsorption isotherm equations (Langmuir, Freundlich, Dubinin-Radushkevich, Hill and Temkin).

RESULTS AND DISCUSSION

Anthocyanins (cyanidin-3-galactoside, cyanidin-3-glucoside, cyanidin-3-arabinoside and cyanidin-3-xyloside) and flavonols (quercetin-3-rutinoside, quercetin-3-galactoside and quercetin-3-glucoside) were quantified. All flavonols and anthocyanins adsorbed onto β-glucan (Table 1).

Table 1. Adsorption capacity (mg/g of β-glucan) of flavonols and anthocyanins from chokeberry

	Adsorption capacity
Flavonols	mg/g
quercetin-3-rutinoside	187.2± 9.1
quercetin-3-galactoside	99.8± 14.3
quercetin-3-glucoside	87.3± 8.2
Anthocyanins	
cyanidin-3-galactoside	194.2± 0.0
cyanidin-3-glucoside	35.4± 6.4
cyanidin-3-arabinoside	397.3± 64.3
cyanidin-3-xyloside	82.1± 10.2



Adsorption was concentration dependent (Figure 1)

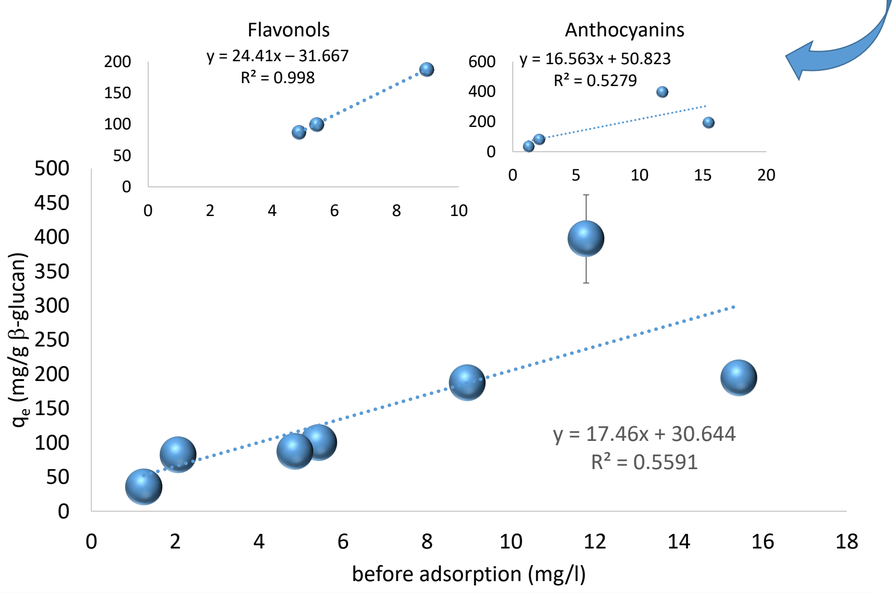


Figure 1. The relationship between adsorbed amount of flavonols and anthocyanins and their concentration before adsorption

Adsorption was modelled with adsorption isotherms which gave additional information about adsorption process (Figure 2).

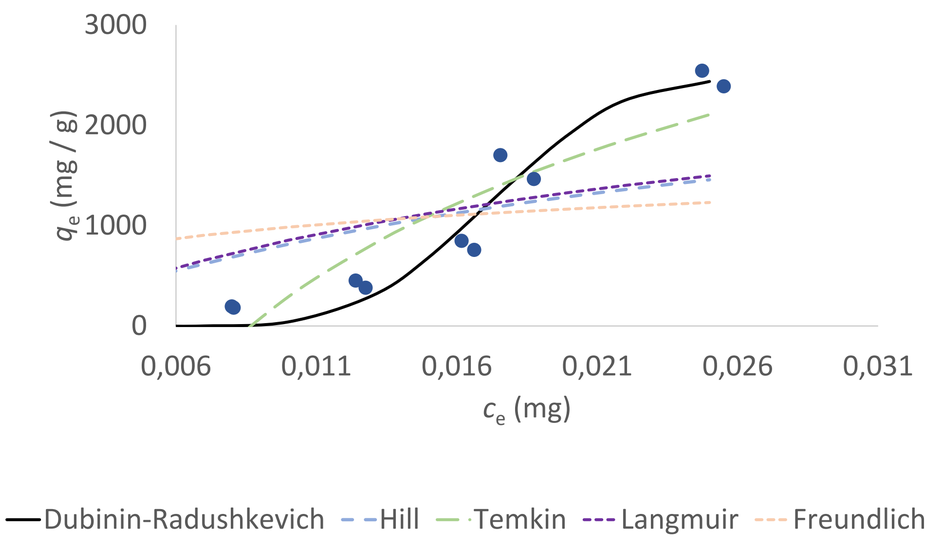


Figure 2. An example of adsorption isotherm obtained by non-linear modelling (quercetin-3-rutinoside)

Dubinin-Radushkevich and Hill isotherm suited best adsorption data due to lower standard error (se). Acording to *E* from Dubinin-Radushkevich isotherm which is lower than 8 000 J/mol, H bonds and Van der Waals forces could be suggested as bonds between flavonols, anthocyanins and β-glucan (Table 2).
Parameters of adsorption isotherm are theoretical parameters and need to be checked with additional analysis.

Table 2. Parameters of Langmuir, Freundlich, Dubinin-Radushkevich, Hill and Temkin adsorption isotherms obtained by non-linear regression

	Langmuir			Freundlich			Dubinin-Radushkevich				Hill				Temkin		
	q_m	K_L	se	K	$1/n$	se	q_s	E	c_s	se	q_m	n_H	K_D	se	b_T	A	se
	mg/g	1/mg		(mg/g) (1/mg) $^{1/n}$			mg/g	J/mol	mg		mg/g		mg^{nH}		J/mol	1/g	
Flavonols																	
quercetin-3-rutinoside	3000	40	680	3000	0.24	836	2437	794	0.025	249	3000	1.02	0.025	725	1.3	115	396
quercetin-3-galactoside	1200	92	330	1200	0.18	389	1075	647	0.012	166	1200	0.99	0.012	354	2.4	198	184
quercetin-3-glucoside	850	118	250	850	0.16	290	799	603	0.01	125	850	0.98	0.01	252	3	225	139
Anthocyanins																	
cyanidin-3-galactoside	4500	19	1240	$1.8\ 10^6$	2.1	678	3998	1006	0.06	591	5597	3.9	$4.8\ 10^{-6}$	613	0.89	57	845
cyanidin-3-glucoside	5000	260	99	$1.7\ 10^6$	1.6	45	411	1219	0.005	38	500	0.96	0.005	108	10	871	63
cyanidin-3-arabinoside	6000	29	1281	772178	1.6	553	5104	1107	0.045	4503	6374	3.7	$2.5\ 10^{-6}$	494	0.8	94	828
cyanidin-3-xyloside	1000	192	230	5246393	1.75	82	890	968	0.007	88	1667	2.8	$8.9\ 10^{-7}$	80	4.6	559	150

CONCLUSION

Adsorption isotherms might be a useful tool for studying interactions between polyphenols and β-glucan. It can give an insight into the adsorption (interaction) process. But those results need to be confirmed with additional analysis.

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