Valorisation of seabuckthorn pomace to obtain bioactive soluble dietary fibre using response surface methodology

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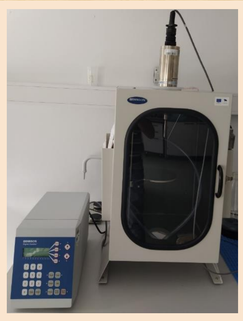
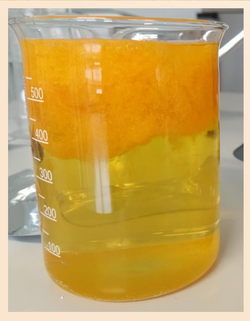
Introduction

Seabuckthorn pomace is a considered as a valuable industrial by-product acquired after juice extraction that contains various bioactive compounds including dietary fibres. Due to the lack of appropriate processing and handling facilities, most of this pomace is just used as livestock feed or simply discarded.

Materials and Methods




- Lyophilized and grinded samples (kept at -20 °C) were used for soluble dietary fiber (SDF) extraction, and determination of yield and hydration properties.
- Ultrasonic-assisted extraction was applied to for extraction of SDF.
- A three-level, three-factor RSM combined with Box-Behnken design (BBD) was used to examine the best order of variables to get the maximum yield of SDF (Table 1).

Table 1. Independent variables values of with their corresponding levels

Independent variables	Symbol		Levels		
	Un-coded	Coded	-1	0	1
Ultrasonic Temp. (°C)	X1	X1	60	70	80
Ultrasonic power (W)	X2	X2	100	130	160
Ultrasonic time (min)	X3	X3	30	45	60

Results

- Table 2 lists the complete design of experiments, with independent variables at three variant levels with actual and predicted yield.
- The yield of SDF obtained was 16.08 ± 0.18%, which was close to the predicted value (15.66%).
- Sonication temperature showed significant effects at $p \leq 0.01$, while sonication power and extraction time showed significant effects at $p \leq 0.05$ on the yield of SDF.
- The 3D response surface plots were produced by the model (Figure 2) to show the visual effects of experimental variable levels on the response, relationship or interaction between two independent variables as well as to evaluate the optimal level of variables for optimized yield of SDF from sea buckthorn pomace.
- Higher values of hydration properties such as the WHC, SWC and OHC were found in SDF were 7.25 ± 0.10 g g^{-1}, 7.24 ± 0.05 mL g^{-1} and 1.49 ± 0.02 g g^{-1}, respectively, followed by IDF (6.30 ± 0.02, 5.75 ± 0.07 and 1.25 ± 0.03) and STP (4.17 ± 0.04, 3.48 ± 0.06 and 0.89 ± 0.03), respectively (Table 3).

Table 2. Box–Behnken Design (BBD) design with observed responses and predicted values for the yield of soluble dietary fiber form sea buckthorn pomace

	Coded variable levels			Yield of soluble dietary fiber (%)	
Run	X1	X2	X3	Actual Yield	Predicted Yield
1	-1 (60)	0 (130)	1 (60)	15.62	15.51
2	0 (70)	-1 (100)	-1 (30)	12.96	12.76
3	0 (70)	1 (160)	-1 (30)	15.52	15.71
4	-1 (60)	0 (130)	-1 (30)	16.76	16.66
5	0 (70)	0 (130)	0 (45)	16.40	16.94
6	-1 (60)	-1 (100)	0 (45)	16.52	16.81
7	0 (70)	0 (130)	0 (45)	16.96	16.94
8	1 (80)	0 (130)	-1 (30)	12.54	12.65
9	0 (70)	0 (130)	0 (45)	17.82	16.94
10	0 (70)	0 (130)	0 (45)	16.34	16.94
11	0 (70)	1 (160)	1 (60)	13.38	13.58
12	0 (70)	-1 (100)	1 (60)	13.26	13.07
13	1 (80)	-1 (100)	0 (45)	11.96	12.05
14	0 (70)	0 (130)	0 (45)	17.18	16.94
15	-1 (60)	1 (160)	0 (45)	17.64	17.55
16	1 (80)	0 (130)	1 (60)	11.88	11.98
17	1 (80)	1 (160)	0 (45)	15.05	14.76

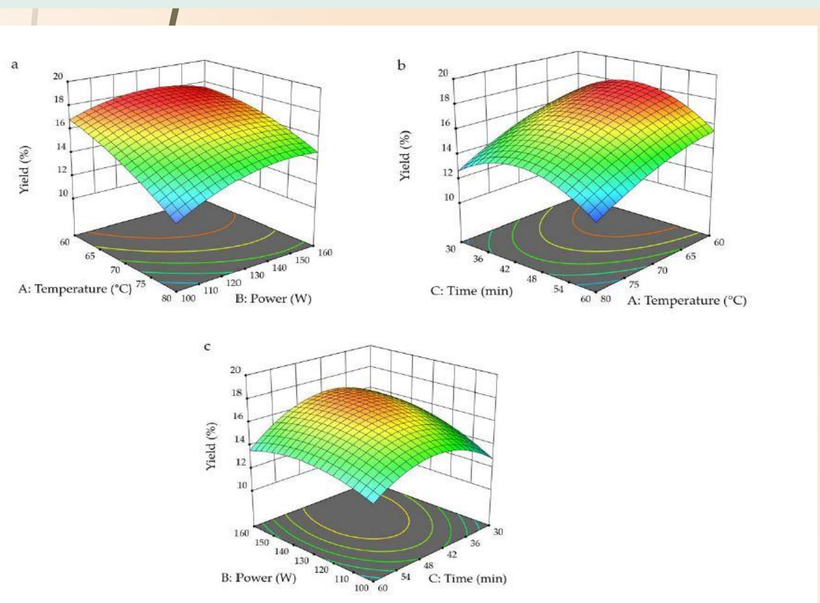


Figure 2. Three-dimensional response surface plots (a) showing the effects of ultrasonic temperature and power, (b) showing the effects of ultrasonic temperature and time and (c) showing the effect of ultrasonic power and time on soluble dietary fibre yield. Blue colour indicates the lowest, while red colour shows the highest yields (%) of soluble dietary fibre.

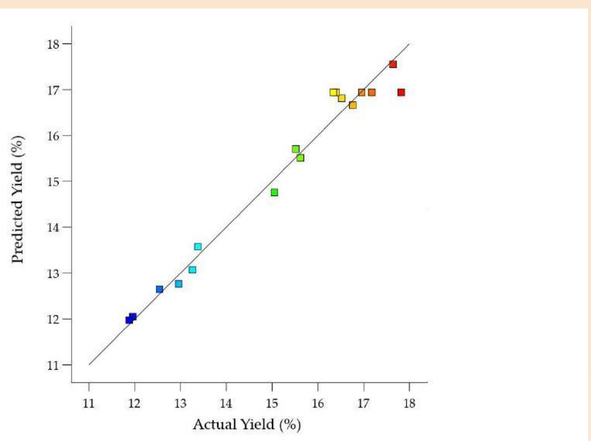


Figure 1. Correlation of actual and predicted yield of soluble dietary fibre (%). Blue colour indicates the lowest, while red colour shows the highest actual and predicted yields (%) of soluble dietary fibre.

A satisfactory fit of plot for experimental and actual value of SDF yield was shown in Figure 1.

Table 3. Hydration properties dietary fractions of seabuckthorn pomace

Sample	Hydration properties		
	WHC (g g^{-1})	SWC (mL g^{-1})	OHC (g g^{-1})
STP	4.17 ± 0.04^{c}	3.48 ± 0.06^{c}	0.89 ± 0.03^{c}
IDF	6.30 ± 0.02^{b}	5.75 ± 0.07^{b}	1.25 ± 0.03^{b}
SDF	7.25 ± 0.10^{a}	7.24 ± 0.05^{a}	1.49 ± 0.02^{a}

WHC - water-holding capacity; SWC - swelling capacity; OHC - oil-holding capacity; STP - seabuckthorn pomace powder; IDF - insoluble dietary fibre; SDF - soluble dietary fibre
The values are presented as mean ± SD (n = 3).
The values followed by different superscript letters (a–c) within the same column are significantly different ($p \leq 0.05$) from each other.

Conclusions

- At modified optimized variables, the optimal yield of SDF was much close to the predicted yield.
- Improved hydration properties were also observed in the samples.
- It is expected that the results generated from this study will be of practical help to provide evidence for effective valorisation of seabuckthorn pomace to obtain dietary fibre, which can find potential applications in producing novel, value-added products.

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