Green Extraction for Bioactive Compounds in Seaweeds

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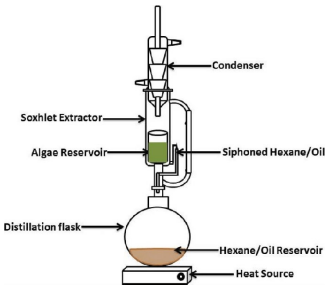
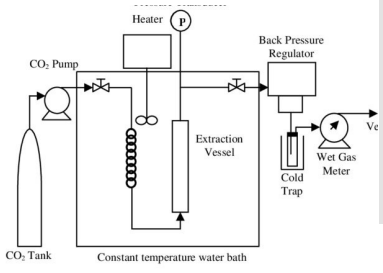
Introduction

- Carotenoids
- Polyphenols
- Fatty acids
- others

Health promoting compounds



VS



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Aim

to review various non-conventional methods of extraction and to analyze how the extraction parameters affect the concentration of health promoting polyphenols and carotenoids from seaweeds

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Method

- Gap Analysis
- Keywords Formulation
- Literature Searching
- Literature Screening
- Data Analysis

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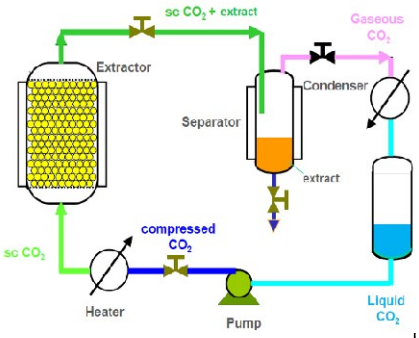
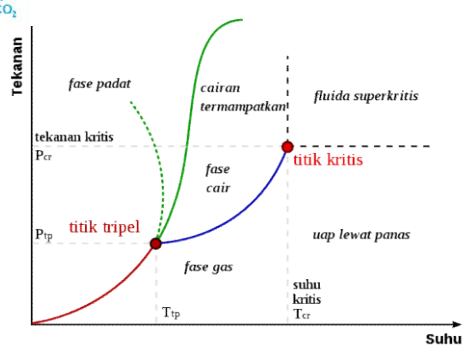
Results & Discussion:

Supercritical Fluid Extraction (SFE)



Advantages :
- Good selectivity of compounds
- Fast extraction
- Environment-friendly (low solvent)



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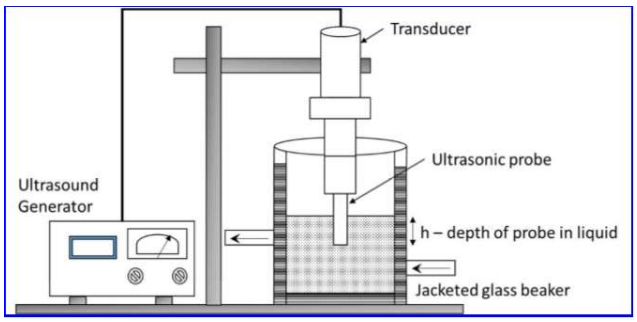
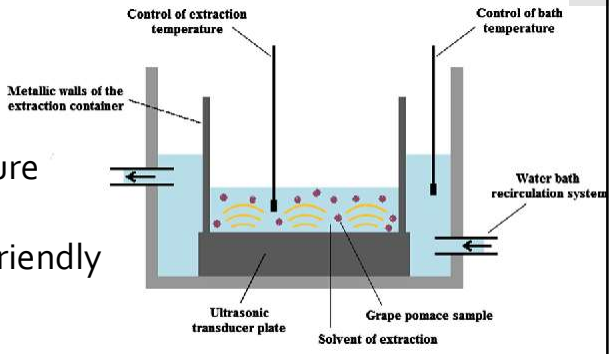
Results & Discussion:

Ultrasound Assisted Extraction(UAE)



Advantages :
- Low temperature
- Fast extraction
- Environment-friendly
- Low cost



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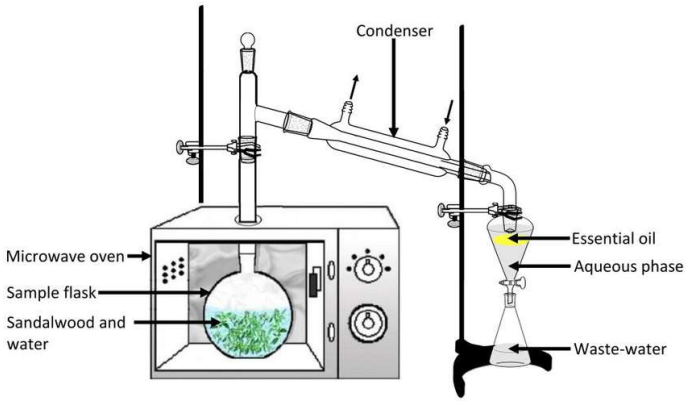
Results & Discussion:

Microwave Assisted Extraction (MAE)

Advantages :
- Fast extraction
- Environment-friendly
- Low cost



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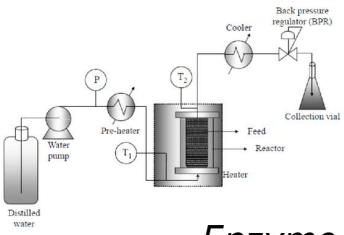
Results & Discussion:

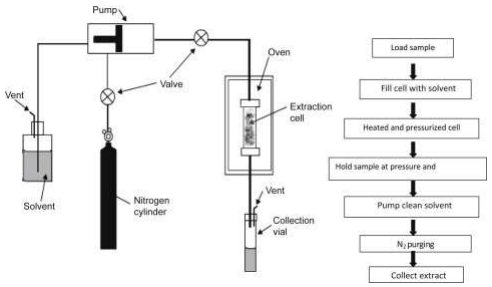
Other Extraction Methods



Subcritical Water Extraction

Enzyme Assisted Extraction

Pressurized Liquid Extraction



Effect of SFE

Species	Press. [MPa]	Tem [°C]	Time [min]	*Co-Solvt* [%w/w]	Concentration			Ref
Green Seaweed								
Cladophora glomerate	10;20;<u>30</u>	40;50;<u>60</u>	120	EtOH [0;<u>7.5</u>;15]	Carotnds Plypnols	1.69-21.50 2.26-6.10	mg FE/g mg GAE/g	[1]
Ulva flexuosa	30	40	120	EtOH [11.4]	Carotnds Plypnols	5.68±0.15 12.18±2.48	mg FE/g mg GAE/g	[1]
Chara fragilis	30	40	120	EtOH [11.4]	Carotnds Plypnols	24.90±1.61 30.20±4.96	mg FE/g mg GAE/g	[1]

Ref [1]: Fabrowska et al., 2016

Effect of SFE

Species	Press. [MPa]	Tem [°C]	Time [min]	*Co-Solvt* [%w/w]	Concentration			Ref
Brown Seaweed								
Fucus serratus	15;22.5;<u>30</u>	30;40;<u>50</u>	<u>60</u>;105	-	Fcoxathn Xthopyll	0.51-2.18 0.027-0.112	mg TFC/g mg TXC/g	[2]
Laminaria digitate	15;22.5;<u>30</u>	30;40;<u>50</u>	<u>60</u>;105	EtOH	Fcoxathn Xthopyll	0.354-1.123 0.009-0.032	mg TFC/g mg TXC/g	[2]
Undaria pinnatifida	40	25;<u>40</u>;50;60	180	-	Fcoxathn	±30-38.5	mg/g	[3]

Ref [2]: Heffernan et al., 2016; [3]: Quitain et al., 2013

Effect of SFE

Species	Press. [MPa]	Tem [°C]	Time [min]	*Co-Solvt* [%w/w]	Concentration			Ref.
Undaria pinnatifida	8-20; 25;30	30;40;50 ;60	50	Ethanol [3]	Fcoxathn Plypnols	$48*10^{-5}$-$753*10^{-5}$ ±10–700	µg/g µg/g	[4]
Saccharina japonica	20-30	45;50;55	240	Sunflower, soybean, canola oils, EtOH:H_2O	Carotnds Fcoxathn Phlrotanin	1.3-2.405 0.38-1.432 0.29-0.928	mg/g mg/g mg/g	[5]

Ref [4]: Roh et al.,2008; [5]: Saravana et al., 2017)

Effect of SFE

Species	Press. [MPa]	Tem [°C]	Time [min]	*Co-Solvt* [%w/w]	Concentration			Ref.
Saccharina japonica	25	45	120	EtOH	Fcoxathn Plyphnol	0.41±0.05 0.60±0.05	mg/g mg/g	[6]
Sargassum horneri	25	45	120	EtOH	Fcoxathn Plyphnol	0.77±0.07 0.64±0.01	mg/g mg/g	[6]
Red Seaweed								
Gracilaria mammillaris	10;20; 30	40;50; 60	240	EtOH [2;5;8]	Plyphnol Carotnids	0.368-3.791 0.597-5.038	mg GAE/g mg/g	[7]

Ref [6]: Sivagnanam et al., 2015; [7]: Ospina et al., 2017)

Effect of UAE

Species	Freq (kHz); Pwr (W)	Slvent (mL)	Temp (°C)	Time (min)	Concentration			Ref.
Brown Seaweed								
Hormosira banksii	50;150-250	50(70% EtOH)	30;40;50	20;40;60	Plyphnol	14.46-23.12	mg/g	[8]
Ascophyllum nodosum	20; 750	Aqds& HCl 0.03M	-	25	Plyphnol Fucose UronicAc	63.54-139.73 11.62-86.63 46.46-117.44	mg GAE/g mg/g mg/g	[9]

Ref [8]: Dang et al.. 2017; [9]: Kadam et al.. 2014)

Effect of UAE

Species	Freq (kHz); Pwr (W)	Slvent (mL)	Temp (°C)	Time (min)	Concentration			Ref.
Ascophyllum nodosum	20; 750	Aqds&HCl 0.1M	-	15	Plyphnol Lminarin	0.128-0.156 5.290-5.822	mg GE/g %	[9]
Laminaria hyperborea	20; 750	Aqs&HCl 0.1M	-	15	Plyphnol Lminarin	0.343-0.365; 5.975-6.240	mg GE/g %	[9]
Ecklonia cava	40; 200	aqds; MeOH	30	360; 720	Plyphnol	0.342-0.615	mg/g	[10]

Ref [10]: Lee et al..2013

Effect of MAE

Species	Power [W]	Solvent	Temp. [°C]	Time [min]	Concentration			Ref.
Green Seaweed								
Caulerpa racemosa	100;200;300	40;50;60 % EtOH	30;40;50	30;40;50	Plypnol	45.08-67.89	mg GAE/ 100 g	[11]
Enteromorpha prolifera	450;500;550;600	25;30;35;40% EtOH	-	20;25;30;35	Plypnol	0.643-0.923	mg GAE/g	[12]

Ref [11]: Li et al..,2012; [12]: Hong-yu et al., 2010

Effect of MAE

Species	Pwr [W]	Solvent	Temp. [°C]	Time [min]	Concentration			Ref.
Brown Seaweed								
Carpophyllum flexuosum	-	Aqds, acetn. EtOH, propl, Et- asett	135;160;185	1;3;5;10;15;20	Plorglucinol	11.4	%GE	[13]
Carpophyllum flexuosum	-	Aquds	160	3	Phlrotnin	62.1±04.8	mg GAE/g	[14]

Ref [13]: Magnusson et al., 2017; [14]: Zhang et al., 2018

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Conclusions and Future studies

- Non-conventional methods commonly performed for bioactive extraction in seaweeds: SFE, UAE, MAE, followed by EAE, SWE, & PLE
- For each extraction method, concentration of polyphenolic and carotenoid compounds is highly depend on the nature of the seaweeds and the extraction parameters, including time-temperature, pressure, power, frequency, and solvent
- The diversity of the bioactive concentrations indicates possible interactions between extraction parameters influencing the yield

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Conclusions and Further Studies

Further studies:

- Optimizing UAE parameters to obtain the optimum concentration of bioactive compounds
- Effect of seaweed processing on bioactive compounds' concentration (combined with green extraction method).
- To be performed for seaweeds in Indonesia.

On-going results:

- UAE on *Turbinaria decurrens* at 80 kHz
- Effect of time-temperature (30, 60, 90 min | 30, 50, 70 °C)
- At 60 min, 50 vs 70 °C: no significant different of polyphenol concentration & free radical scavenging activity

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Thank You