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 Unika Soegijapranata1

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**Unika SOEGIJAPRANATA**  
Talenta pro patria et humanitate

Introduction

Carotenoids  
Polyphenols  
Fatty acids  
others

Health promoting compounds

VS

Labels for Soxhlet: Condenser, Soxhlet Extractor, Algae Reservoir, Siphoned Hexane/Oil, Distillation flask, Hexane/Oil Reservoir, Heat Source.

Labels for CO2 system: CO2 Tank, CO2 Pump, Heater, Extraction Vessel, Constant temperature water bath, Back Pressure Regulator, Cold Trap, Wet Gas Meter.



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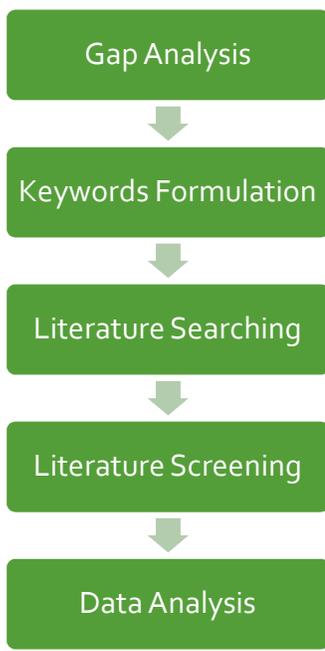
# Aim

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

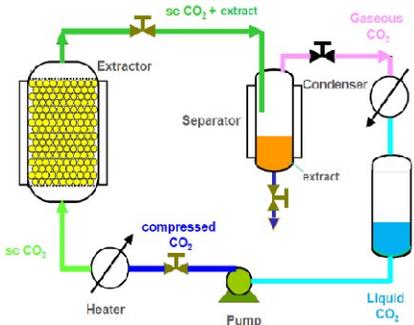


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graph TD; A[Gap Analysis] --> B[Keywords Formulation]; B --> C[Literature Searching]; C --> D[Literature Screening]; D --> E[Data Analysis];
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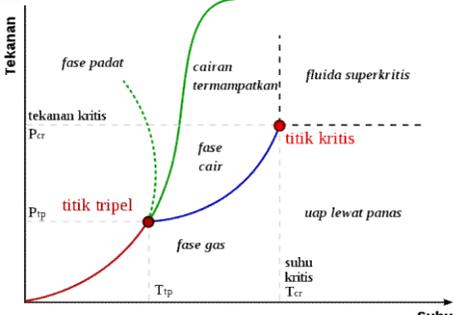
**Results & Discussion:**

Supercritical Fluid Extraction (SFE)



Advantages :

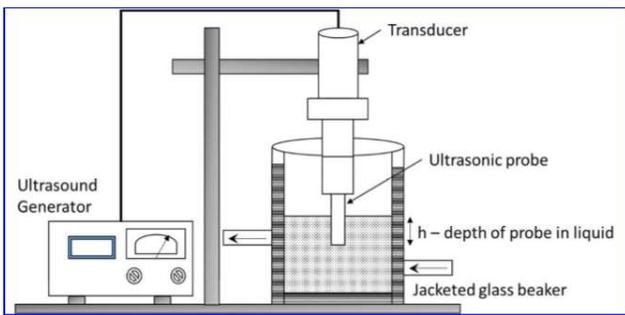
- Good selectivity of compounds
- Fast extraction
- Environment-friendly (low solvent)



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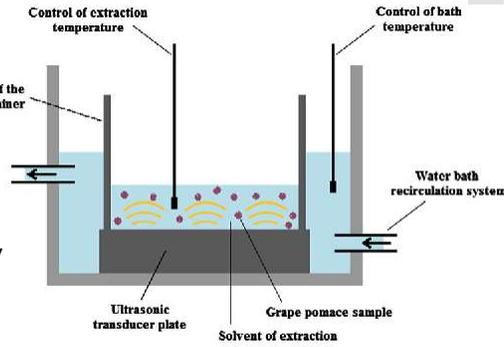
**Results & Discussion:**

Ultrasound Assisted Extraction (UAE)



Advantages :

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



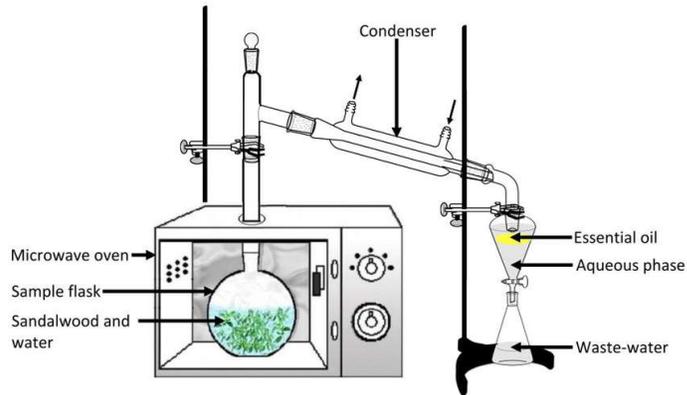


## Results & Discussion:

### Microwave Assisted Extraction (MAE)

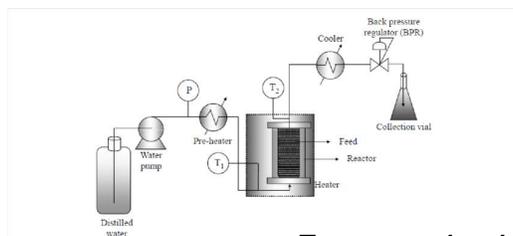
#### Advantages :

- Fast extraction
- Environment-friendly
- Low cost



## Results & Discussion:

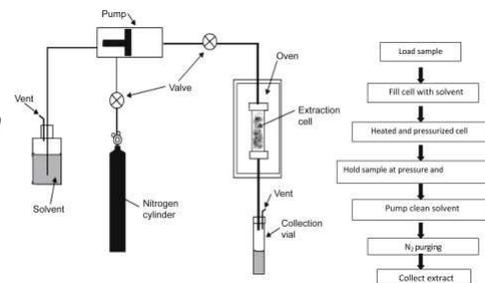
### Other Extraction Methods



### 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
<b>Green Seaweed</b>								
<i>Cladophora glomerata</i>	10;20; <u>30</u>	40;50; <u>60</u>	120	EtOH [0; <u>7.5</u> ;15]	Carotnds Plypnols	1.69-21.50mg FE/g 2.26-6.10mg GAE/g		[1]
<i>Ulva flexuosa</i>	30	40	120	EtOH [11.4]	Carotnds Plypnols	5.68±0.15mg FE/g 12.18±2.48mg GAE/g		[1]
<i>Chara fragilis</i>	30	40	120	EtOH [11.4]	Carotnds Plypnols	24.90±1.61mg FE/g 30.20±4.96 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
<b>Brown Seaweed</b>								
<i>Fucus serratus</i>	15;22.5; <u>30</u>	30;40; <u>50</u> <u>60</u> ;105		-	Fcoxathn Xthopyll	0.51-2.18mg TFC/g 0.027-0.112mg TXC/g		[2]
<i>Laminaria digitate</i>	15;22.5; <u>30</u>	30;40; <u>50</u> <u>60</u> ;105		EtOH	Fcoxathn Xthopyll	0.354-1.123mg TFC/g 0.009-0.032mg TXC/g		[2]
<i>Undaria pinnatifida</i>	40	25; <u>40</u> ;50 ;60	180	-	Fcoxathn	±30-38.5mg/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.
<i>Undaria pinnatifida</i>	8-20; 25; <u>30</u>	30;40; <u>50</u> ;60	50	Ethanol [3]	Fcoxathn Plypnols	48*10 <sup>-5</sup> -753*10 <sup>-5</sup> µg/g ±10–700µg/g	[4]
<i>Saccharina japonica</i>	20- <u>30</u>	45; <u>50</u> ;55	240	Sunflower, soybean, canola oils, EtOH:H <sub>2</sub> O	Carotnds Fcoxathn Phlrotanin	1.3-2.405mg/g 0.38-1.432mg/g 0.29-0.928mg/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.
<i>Saccharina japonica</i>	25	45	120	EtOH	Fcoxathn Plyphnol	0.41±0.05mg/g 0.60±0.05mg/g	[6]
<i>Sargassum horneri</i>	25	45	120	EtOH	Fcoxathn Plyphnol	0.77±0.07mg/g 0.64±0.01 mg/g	[6]
<b>Red Seaweed</b>							
<i>Gracilaria mammillaris</i>	10;20; <u>30</u>	40; <u>50</u> ; 60	240	EtOH [2;5;8]	Plyphnol Carotnids	0.368-3.791 mg GAE/g 0.597-5.038 mg/g	[7]

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

Effect of UAE								
Species	Freq (kHz); Pwr (W)	Solvent (mL)	Temp (°C)	Time (min)	Concentration			Ref
<b>Brown Seaweed</b>								
<i>Hormosira banksii</i>	50;150-250	50(70% EtOH)	30;40;50	20;40;60	Polyphenol	14.46-23.12	mg/g	[8]
<i>Ascophyllum nodosum</i>	20;750	Aqds & HCl 0.03M	-	25	Polyphenol	63.54-139.73	mg GAE/g	[9]
					Fucose	11.62-86.63	mg/g	
					UronicAc	46.46-117.44	mg/g	
Ref [8]: Dang et al.. 2017; [9]: Kadam et al.. 2014)								

Effect of UAE								
Species	Freq (kHz); Pwr (W)	Solvent (mL)	Temp (°C)	Time (min)	Concentration			Ref.
<i>Ascophyllum nodosum</i>	20;750	Aqds & HCl 0.1M	-	15	Polyphenol	0.128-0.156	mg GE/g	[9]
<i>Laminaria hyperborea</i>	20;750	Aqs & HCl 0.1M	-	15	Laminarin	5.290-5.822	%	[9]
<i>Ecklonia cava</i>	40;200	aqds; MeOH	30	360;720	Polyphenol	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.
<b>Green Seaweed</b>								
<i>Caulerpa racemosa</i>	100;200; 300	40;50;60 % EtOH	30;40;50	30;40;50	Plypn ol	45.08-67.89	mg GAE/ 100 g	[11]
<i>Enteromorpha prolifera</i>	450;500; 550;600	25;30;35; 40% EtOH	-	20;25;30; 35	Plypn ol	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.
<b>Brown Seaweed</b>								
<i>Carpophyllum flexuosum</i>	-	Aqds, acetrn. EtOH, propl, Et- asett	135;160 ;185	1;3;5;10 ;15;20	Plorgluci nol	11.4	%GE	[13]
<i>Carpophyllum flexuosum</i>	-	Aquds	160	3	Phlrotrnin	62.1±04.8	mg GAE/g	[14]
Ref [13]: Magnusson et al., 2017; [14]: Zhang et al., 2018								



## 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



## 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



## Acknowledgment

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Thank You

