SIIC001

STATISTICAL OPTIMIZATION AND ARTIFICIAL NUERAL NETWORK MODELLING OF *ANNONA MURICATA* (SOURSOUP) LEAVES IN SUPERCRITICAL CARBON DIOXIDE EXTRACTION

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Abstract:

Supercritical fluid extraction (SFE) using carbon dioxide as a solvent is one of the non-conventional method recently used in extraction. Carbon dioxide is used as a solvent in this extraction because it is a non-toxic solvent. From the previous study, *Annona Muricata* Leaves have effectiveness as an anti-inflammatory, anticancer and also antioxidant. Response Surface Methodology (RSM) and Artificial Neural Network (ANN) were used in this research to investigate and compare the performance of RSM and ANN in optimization total yield, antioxidant activity and total phenolic content from extract of *Annona Muricata* Leaves using SFE technique. All the responses (optimization total yield, antioxidant activity and total phenolic content) were modeled and optimized as functions of four independent parameters with were temperature, pressure, size of particle and percentage of co-solvent using RSM and ANN. the coefficient of determination (R^2) and root mean square error (RMSE) were employed to compare the performance of both modelling tools. From the results, ANN show higher predictive potential compare to RSM with higher correlation coefficient 0.9594, 0.9876, 0.917 for total yield, antioxidant activity and total phenolic content respectively. ANN also shows the lower RMSE compare to RSM with 0.461 for total yield, 0.998 for antioxidant activity and 23.697 for total phenolic content. Thus, as conclusion ANN model could be a better alternative in data fitting for SFE for extraction of total yield, antioxidant activity and total phenolic content from *Annona Muricata* Leaves.

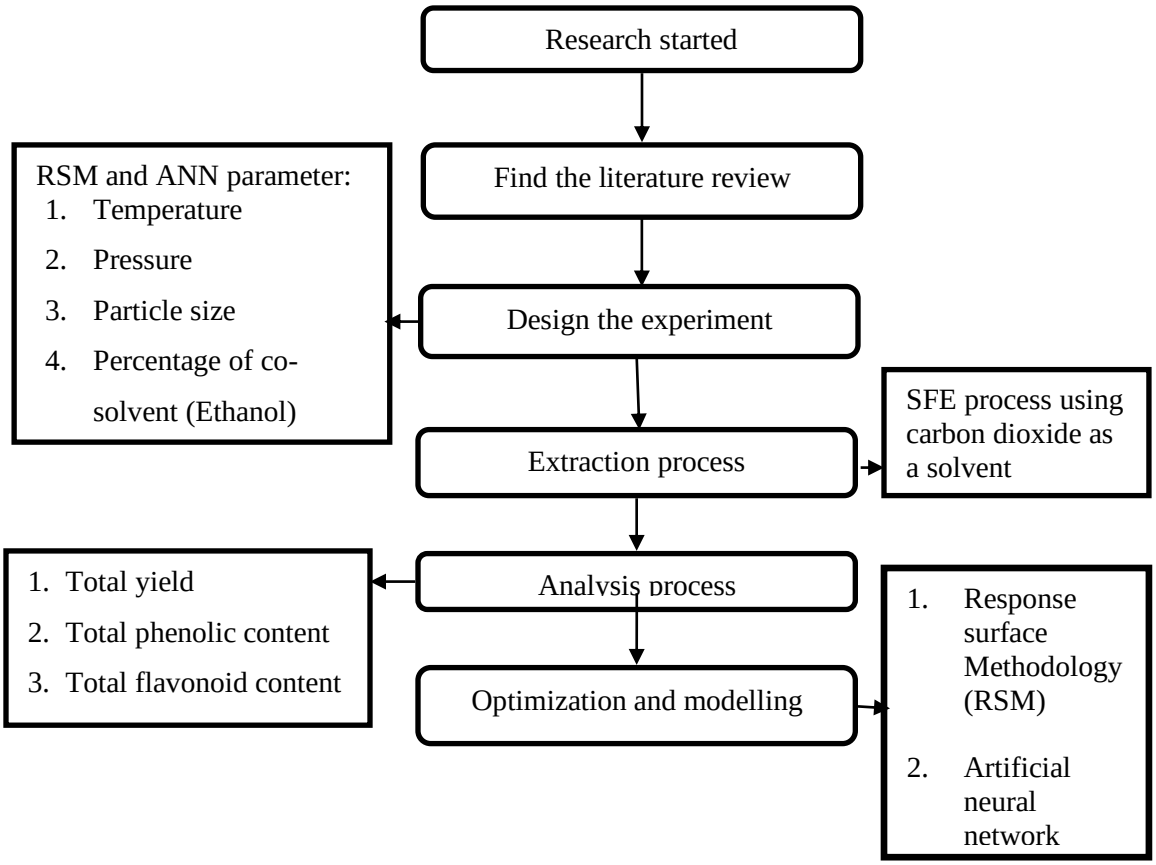
***Keywords*:**

Supercritical fluid extraction (SFE), *Annona Muricata* Leaves, Optimization, Response Surface Methodology (RSM), Artificial Neural Network (ANN) metals

Objectives:

- To optimize the optimal process condition for the extraction of *Annona Muricata* Leaves via supercritical fluid extraction (SFE) using response surface methodology (RSM).
- To model, artificial neural network (ANN) for *Annona Muricata* Leaves and compare with RSM.

Methodology:



Results:

ANN model

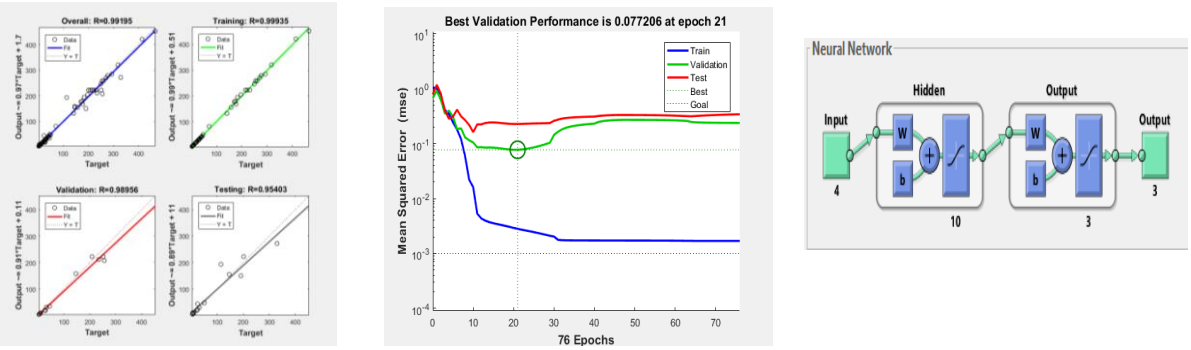


Figure 3-2: (a) Post regression analysis with Lavenberg-Marquardt (LM) algorithm (b) The Best Validation Performance for network 4-10-3 (c) Optimized ANN network [4-10-3] model

RSM model

Response 1: Total yield

Table 4-0-5: ANOVA for regression model total yield

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	141.94	14	10.14	11.78	< 0.0001	significant
A-Pressure	0.4338	1	0.4338	0.5040	0.4886	
B-Temperature	6.69	1	6.69	7.77	0.0138	
C-Particle size	41.17	1	41.17	47.84	< 0.0001	
D-%co-solvent	66.78	1	66.78	77.59	< 0.0001	
AB	0.0033	1	0.0033	0.0039	0.9511	
AC	1.02	1	1.02	1.18	0.2938	
AD	4.61	1	4.61	5.36	0.0352	
BC	0.9181	1	0.9181	1.07	0.3180	
BD	1.01	1	1.01	1.18	0.2947	
CD	7.90	1	7.90	9.17	0.0085	
A^2	3.04	1	3.04	3.53	0.0797	
B^2	4.90	1	4.90	5.70	0.0306	
C^2	34.25	1	34.25	39.80	< 0.0001	
D^2	6.92	1	6.92	8.04	0.0125	
Residual	12.91	15	0.8606			
Lack of Fit	10.07	10	1.01	1.77	0.2738	not significant
Pure Error	2.84	5	0.5679			
Cor Total	154.85	29				

Response 2: Antioxidant activity

Table 4-6: ANOVA for regression model Antioxidant Activity

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	2161.39	14	154.38	22.08	< 0.0001	significant
A-Pressure	125.24	1	125.24	17.91	0.0007	
B-Temperature	309.03	1	309.03	44.20	< 0.0001	
C-Particle size	853.99	1	853.99	122.13	< 0.0001	
D-%co-solvent	81.81	1	81.81	11.70	0.0038	
AB	21.52	1	21.52	3.08	0.0998	
AC	67.29	1	67.29	9.62	0.0073	
AD	307.97	1	307.97	44.04	< 0.0001	
BC	4.93	1	4.93	0.7057	0.4141	
BD	0.7420	1	0.7420	0.1061	0.7491	
CD	115.40	1	115.40	16.50	0.0010	
A^2	163.93	1	163.93	23.44	0.0002	
B^2	94.89	1	94.89	13.57	0.0022	
C^2	482.22	1	482.22	68.96	< 0.0001	
D^2	190.38	1	190.38	27.23	0.0001	
Residual	104.88	15	6.99			
Lack of Fit	98.60	10	9.86	7.85	0.0173	significant
Pure Error	6.28	5	1.26			
Cor Total	2266.27	29				

Response 3: Total phenolic content

Table 4-7: ANOVA for regression model total phenolic content

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1.921E+05	14	13718.95	27.44	< 0.0001	significant
A-Pressure	4610.07	1	4610.07	9.22	0.0083	
B-Temperature	26125.87	1	26125.87	52.26	< 0.0001	
C-Particle size	40172.44	1	40172.44	80.35	< 0.0001	
D-%co-solvent	68396.93	1	68396.93	136.80	< 0.0001	
AB	12256.37	1	12256.37	24.51	0.0002	
AC	4737.38	1	4737.38	9.48	0.0077	
AD	9633.75	1	9633.75	19.27	0.0005	
BC	9542.77	1	9542.77	19.09	0.0006	
BD	101.48	1	101.48	0.2030	0.6588	
CD	2844.63	1	2844.63	5.69	0.0307	
A^2	4249.57	1	4249.57	8.50	0.0107	
B^2	1004.70	1	1004.70	2.01	0.1768	
C^2	12088.97	1	12088.97	24.18	0.0002	
D^2	9849.79	1	9849.79	19.70	0.0005	
Residual	7499.49	15	499.97			
Lack of Fit	5844.30	10	584.43	1.77	0.2755	not significant
Pure Error	1655.19	5	331.04			
Cor Total	1.996E+05	29				

Figure 3-1: ANOVA for regression model (a) total yield (b)antioxidant activity (c)total phenolic compound

Table 3-2: Comparison between RSM and ANN model in terms of R^2 and RMSE

Parameter	**RSM**			**ANN**		
	Total Yield	**Antioxidant Activity**	**Total Phenolic Content**	**Total Yield**	**Antioxidant Activity**	**Total Phenolic Content**
R^2	0.9382	0.9536	0.900	0.9594	0.9876	0.917
RMSE	0.571	1.871	28.072	0.461	0.998	23.697

Conclusion:

For the conclusion in this study, the suggested optimum condition of maximum extraction of total yield (11.0557%), antioxidant activity (49.2147%) and total phenolic content (329.476 mg Gallic acid/L) were at temperature = 59.9964℃, pressure= 282.001 bar, particle size=499.9815μm, and percentage of co solvent= 29.9%. The optimum condition was verified by conducted verification analysis and all the percentage of error was less than 5%. Thus it shows that the optimum condition suggested by RSM model was reliable. The SFE parameters of extraction of total yield, antioxidant activity and total phenolic content had been optimized by comparing results from RSM and ANN modelling. The coefficient of determination (R^2) and root mean square error (RMSE) were employed to compare the performance of both simulation tools. Based on the results, ANN model shows the higher predicative potential compared to RSM model which the value of (R^2=0.9594, 0.9876 and 0.917) respectively and the value of (RMSE= 0.461, 0.998 and 23.697) respectively. Thus, ANN model could be a better alternative in data fitting for SFE for extraction of total yield, antioxidant activity and total phenolic content from *Annona Muricata Leaves*.