SIIC053

ARTIFICIAL NEURAL NETWORK: PHYSICO-CHEMICAL AND MACRONUTRIENTS PARAMETERS IN AN AQUAPONIC SYSTEM

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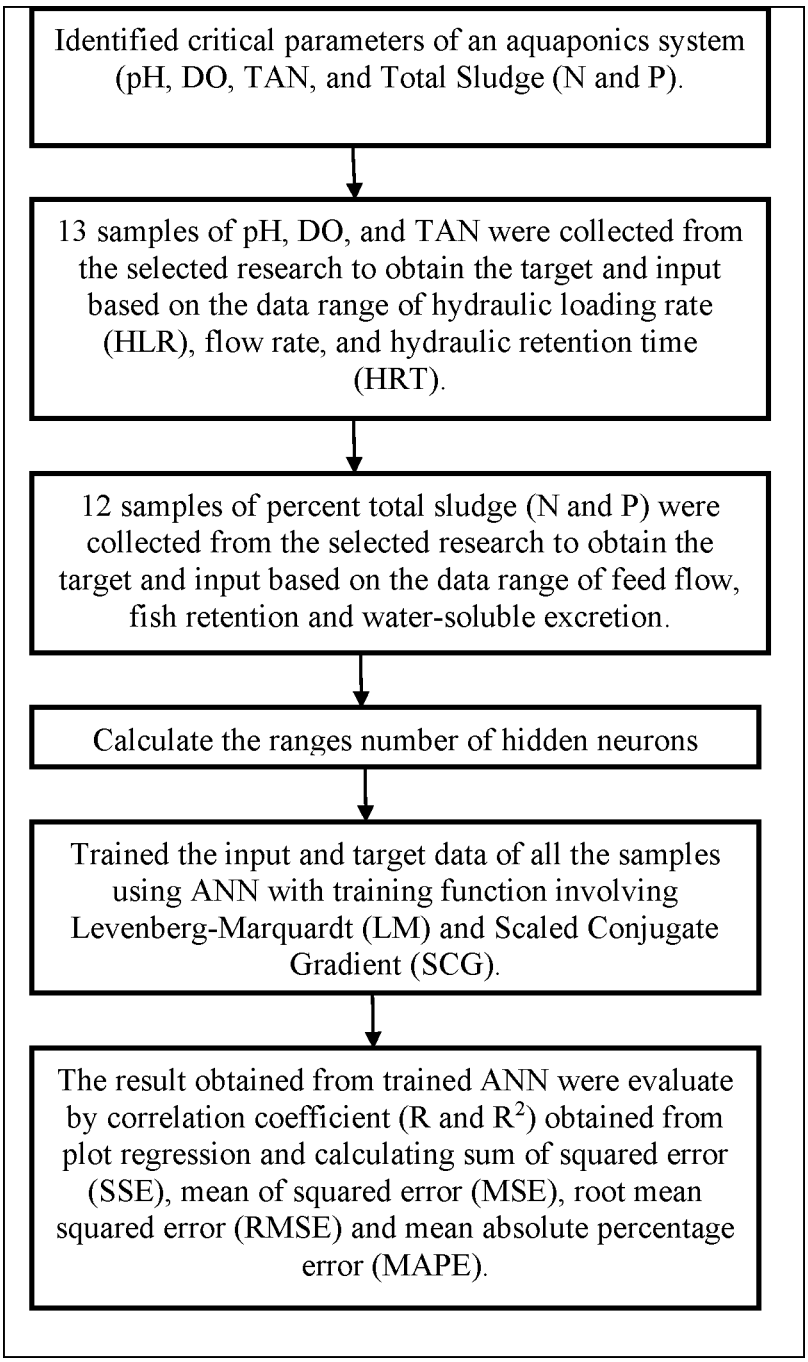
Abstract:
Aquaponic system which integrates conventional aquaculture and hydroponic in one closed-loop system plays a significant role as an alternative way to produce very least waste effluent to the environment by recycling back the nutrients (fish waste) for plant growth. Prediction of water quality parameter in wastewater using conventional mathematical modeling is very complex to simulate and model out the system. Therefore, this paper proposed ANN model to evaluate graph comparison between the performances of the actual data from aquaponics activity and forecast data from simulated artificial neural network (ANN). Then, the best algorithms will be selected in a variety of neuron numbers of the ANN's model. The parameter such as pH, DO, TAN, and percent total sludge of Phosphorus (P) and Nitrogen (N) were investigated by taking the input and target data value from the selected research paper covering the fields of aquaponic. In this study, Levenberg-Marquardt (LM) and Scaled Conjugate Gradient (SCG) training function were used to measure those parameters to obtain the predict values. For parameter pH, DO, TAN, ranges hidden neurons of 4, 6, 8, 10, 12, 13 neurons were studied. Meanwhile, ranges hidden neurons of 3, 4, 6, 9, 12 neurons were studied for total sludge (P and N). Different range neurons value was used for pH, DO, TAN, and Total Sludge (P and N) due to different input data found in the literature. The outputs from the model of training function LM show the most optimum neuron number for each parameter of pH, DO, TAN at neuron 6. As for total sludge (N and P), the most optimum neuron number at neuron 3. For the training function SCG, the most optimum neuron number at neuron 4 for each parameter pH, DO, TAN and at neuron 9 and neuron 4 were the most optimum neuron number for parameter Total Sludge (N and P). The result for the most optimum neuron number can be explained by the value of Sum Squared Error (SSE) and Mean Absolute Percentage Error (MAPE%) with the lowest value. The investigated forecast parameters of the trained neural network according to correlation coefficient (R) and Mean Square Error (MSE) showed LM performed better rather than SCG.

***Keywords*:**
Aquaponics; Artificial neural network; Physico-chemical parameters; Nitrogen; Phosphorus

Objectives:

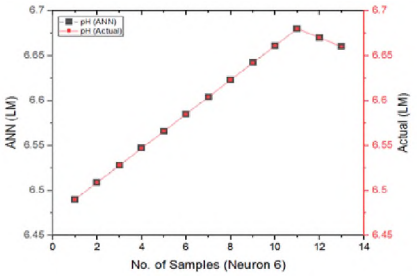
- To evaluate graph comparison between the performances of the actual data from aquaponics activity and forecast data from simulated artificial neural network (ANN).
- To select the best algorithms in a variety of neuron numbers of the ANN's model.

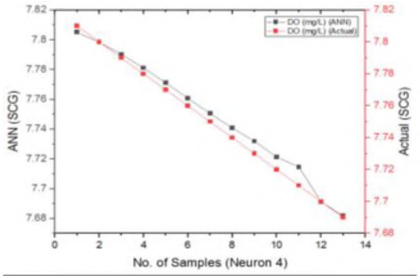
Methodology:

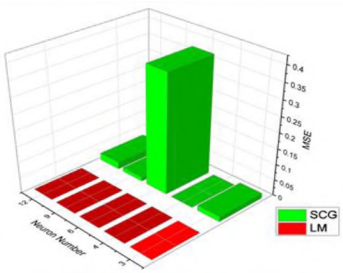


Results:

(LM) pH – Neuron 6 ***(SCG) DO – Neuron 4*** ***(LM & SCG) vs Neuron Number - Total Sludge (P)***







Performance results of the ANN model with LM and SCG training function of Nitrogen

Training Function	Neuron	Epoch	SSE	MSE	RMSE	R	R2	MAPE %
LM	3	1000	1.98E-05	4.92E-09	7.01E-05	1	1	0.003494
	4	23	0.017494	5.27E-06	2.30E-03	0.99996	0.99992	0.18256
	6	6	2.136575	1.08E-29	3.29E-15	0.99025	0.980595	1.747711
	9	10	16.28837	1.09E-21	3.30E-11	0.93713	0.878213	4.001259
	12	4	4.518046	1.04E-19	3.22E-10	0.98925	0.978616	1.322292
SCG	3	14	0.365589	1.84E-03	4.29E-02	0.99838	0.996763	0.72509
	4	15	0.330777	4.90E-03	7.00E-02	0.99869	0.997382	0.668899
	6	8	35.24835	3.99E-01	6.32E-01	0.94335	0.889909	7.897725
	9	32	0.157783	1.15E-03	3.39E-02	0.99935	0.9987	0.467015
	12	10	15.62896	2.04E-01	4.52E-01	0.95145	0.905257	5.014022

Conclusion:

In this paper, prediction of water quality and macronutrients in an aquaponic system is extremely important for the system balance and optimum condition as well as good growth and healthy food products (fish and plants). The main aim of this study is to evaluate graph comparison between the predicted data and actual data of a critical parameters in an aquaponic system in the ANN model and select the best learning algorithms in a variety of neuron numbers of the ANN's model. pH, DO, TAN and Total Sludge (%N and %P) is selected due to critical parameter that should be taken account in the aquaponic system. LM and SCG algorithms of this network were compared to each other and the best neurons and layers were indicated based on lower SSE and MAPE% values. By these measures, the outputs plotted on the graph from the model of training function LM shows that the most optimum neuron number for each parameter of pH, DO, TAN is at neuron 6. As for total sludge (Nitrogen and Phosphorus), the most optimum neuron number at neuron 3. For the training function SCG, the most optimum neuron number is neuron 4 for each parameter of pH, DO, TAN. Neuron 9 and neuron 4 were the most optimum neuron number for parameter Total Sludge (N and P). Based on the calculated formula equation used in ANN evaluation that has been tabulate and plotted in bar graphs shows LM algorithm is the best learning algorithms in a variety of neuron numbers of the ANN's model compared to SCG algorithm. Overall, this shows the advantages of ANN method that it does not need any mathematical

relationship between input and output data and it is a promising tool for simulation, modelling and prediction of water quality and micronutrient performance in an aquaponic system. The feed-forward back-propagation neural network was used to predict the output of modelling which can be used for sensitivity analysis and to study the dynamic behavior of the water quality and macronutrients. The neural network was shown a good prediction.