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PREDICTION OF HESPERIDIN CONTENT IN ORANGE PEEL EXTRACT USING ARTIFICIAL NEURAL NETWORK MODEL

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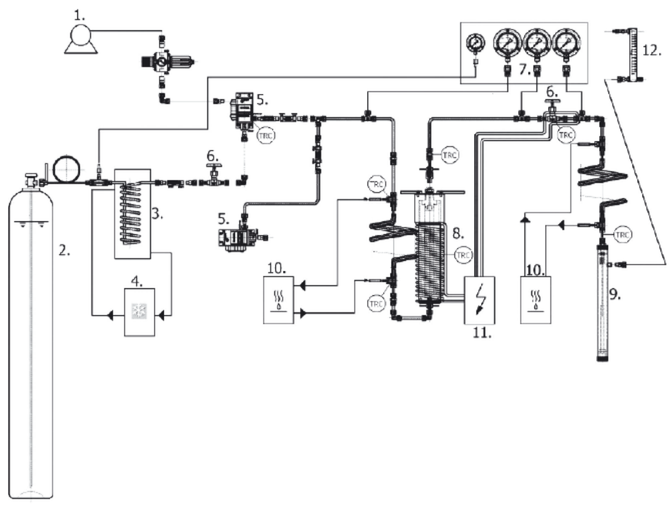
INTRODUCTION

During industrial citrus processing, large quantities of waste material is produced mainly as citrus peels [1]. These food industry by-products represent a potential source of valuable components being important raw materials in the food, chemical and pharmaceutical industries. Hence, the utilization of these citrus residues rich in bioactive and functional components has become a study of interest. In recent years, artificial neural networks (ANNs) are receiving more attention from researchers as an effective predictive tool. It has also been reported that ANN models can be used to predict extraction yields [2]. Therefore in this study, the prediction of hesperidin content as the main bioflavonoid in orange peel extracts was studied by ANN.

Experimental procedure

Orange peel
(variety *Washington Navel*)

Extraction



Supercritical CO_2 extraction

Experimental conditions

Pressure
8.27 to 33.37 MPa

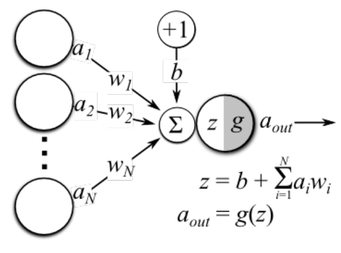
Temperature
35.86 to 64.14 °C

Residue

Experimental conditions

Extraction temperature	Ethanol/water ratio
30, 50, 70 °C	20 %, 50 % v/v
Extraction time	**Solvent-solid ratio**
15, 30, 45 min	10, 30 and 50 mL/g

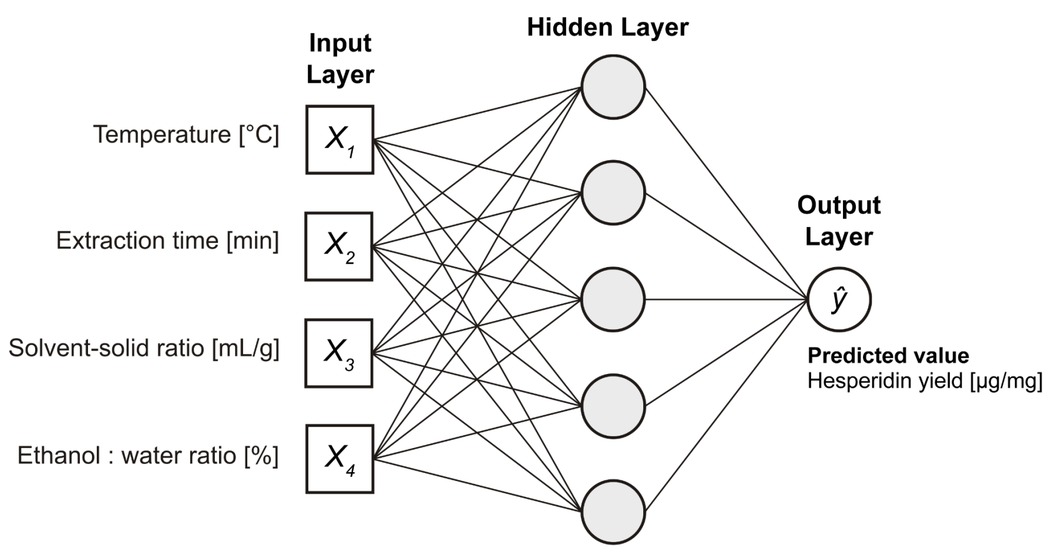
Ultrasound-assisted extraction

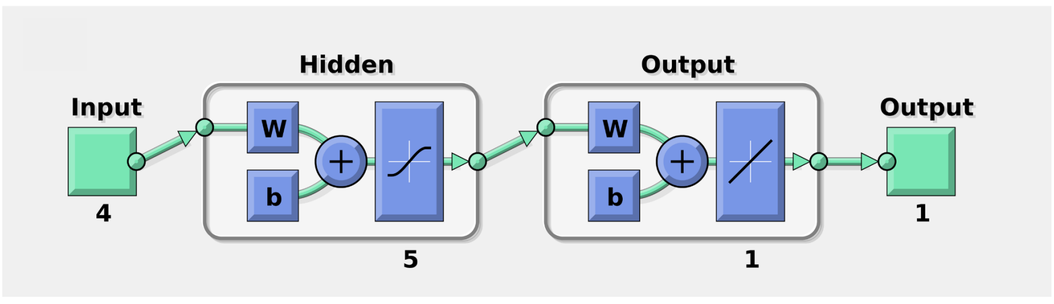


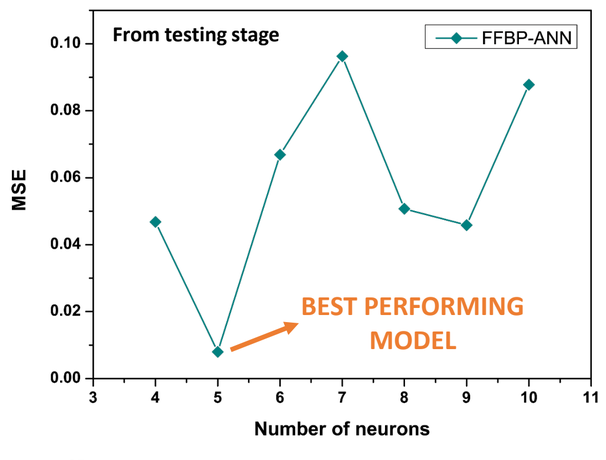
Optimization (ANN or RSM)

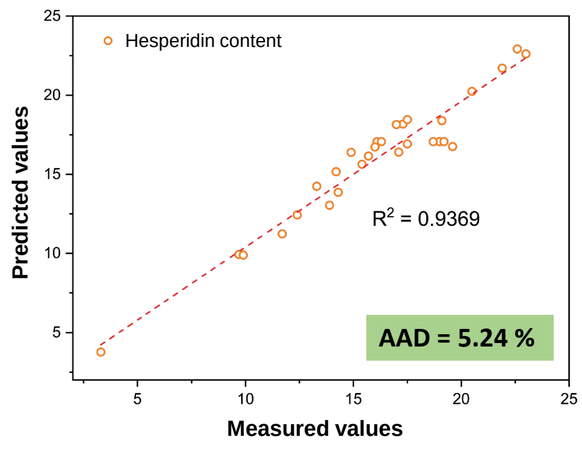
The experimental hesperidin yield was determined by reversed-phase high performance liquid chromatography (HPLC) and its content was in the range from 3.3 to 23.0 µg/mg.

Feed-forward multilayer backpropagation neural network (FFBP-ANN)

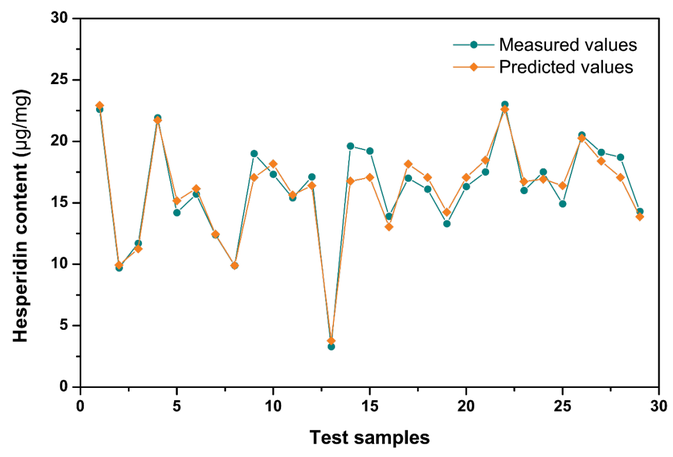








FFBP-ANN (4-5-1) architecture



Experimental database that consisted of 29 data points was used for network training and testing.

The optimal number of five neurons in the hidden layer was determined by obtaining minimum error and suitable correlation analysis parameters.

Table 1. Performance parameters for FFBP-ANN model

Parameters	Training	Validation	Test
R	0.9769	0.9782	0.9837
MSE	0.0108	0.0146	0.0080
Input	4 inputs (extraction temperature, time, ethanol/water ratio, solid-solvent ratio)		
Net	3 layers (input, hidden, output), *TANSIG* and *PURELIN* functions, Levenberg–Marquardt learning algorithm, data normalization (-1,+1)		

CONCLUSIONS

Comparing developed models based on the AAD (Average Absolute Deviation), MSE (Mean Squared Error), and *R* coefficients (coefficient of correlation), the best performing ANN model was determined in order to predict hesperidin content extracted from orange peel.

1. **The obtained AAD of 5.24 %, *R* value of 0.9769 and 0.9837 and minimum MSE of 0.0108 and 0.0080 during training and testing stage indicated that developed 4-5-1 FFBP-ANN model is the best performing model in predicting the hesperidin yield for studied dataset.**
2. **The ANN predictive model was found to be a suitable performing model for extraction hesperidin yield prediction from orange peel extract, as indicated by the statistical analysis.**

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ByProExtract

HrZZ Croatian Science Foundation

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