Comparative ANN-TLBO and RSM optimisation approach for bioactive potential of microwave convective dried mango (Mangifera indica)

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Terminologies

ANN : Artificial neural network

TLBO : Teaching Learning Based Optimization

RSM : Response surface methodology

TPC : Total Polyphenol Content

MWC : Microwave convective drying

GAE : Gallic Acid Equivalent

Introduction

- Mango (*Mangifera indica*) is a rich source of antioxidants like phenolic acids and flavonoids.

- Polyphenol oxidase (PPO) and peroxidase (POD) enzyme oxidises mono and/or diphenols, thus the antioxidant potential diminished. Drying operation deactivates PPO and POD.

- This study shows the comparison among RSM and ANN-TLBO for predicting the virtually compatible process conditions for getting better optimised result (TPC value).

Objectives

Cost-effective and sustainable preservation of this sub-tropical climacteric fruit (in terms of TPC) by determining optimal process conditions.

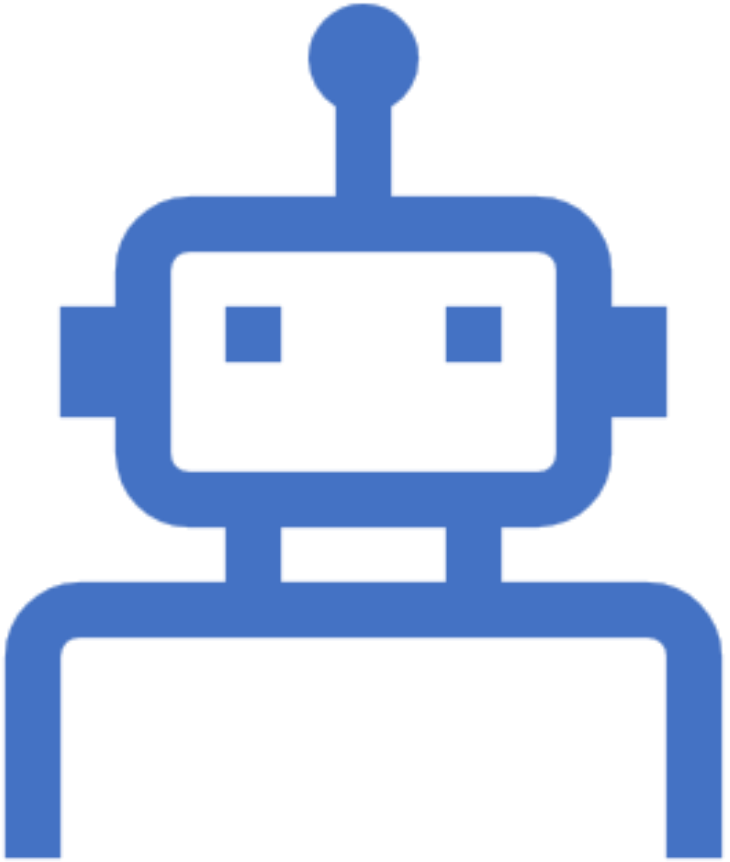
Understanding the relationship between the TPC value and other parameters (microwave power, temperature, puree load and total soluble solid).

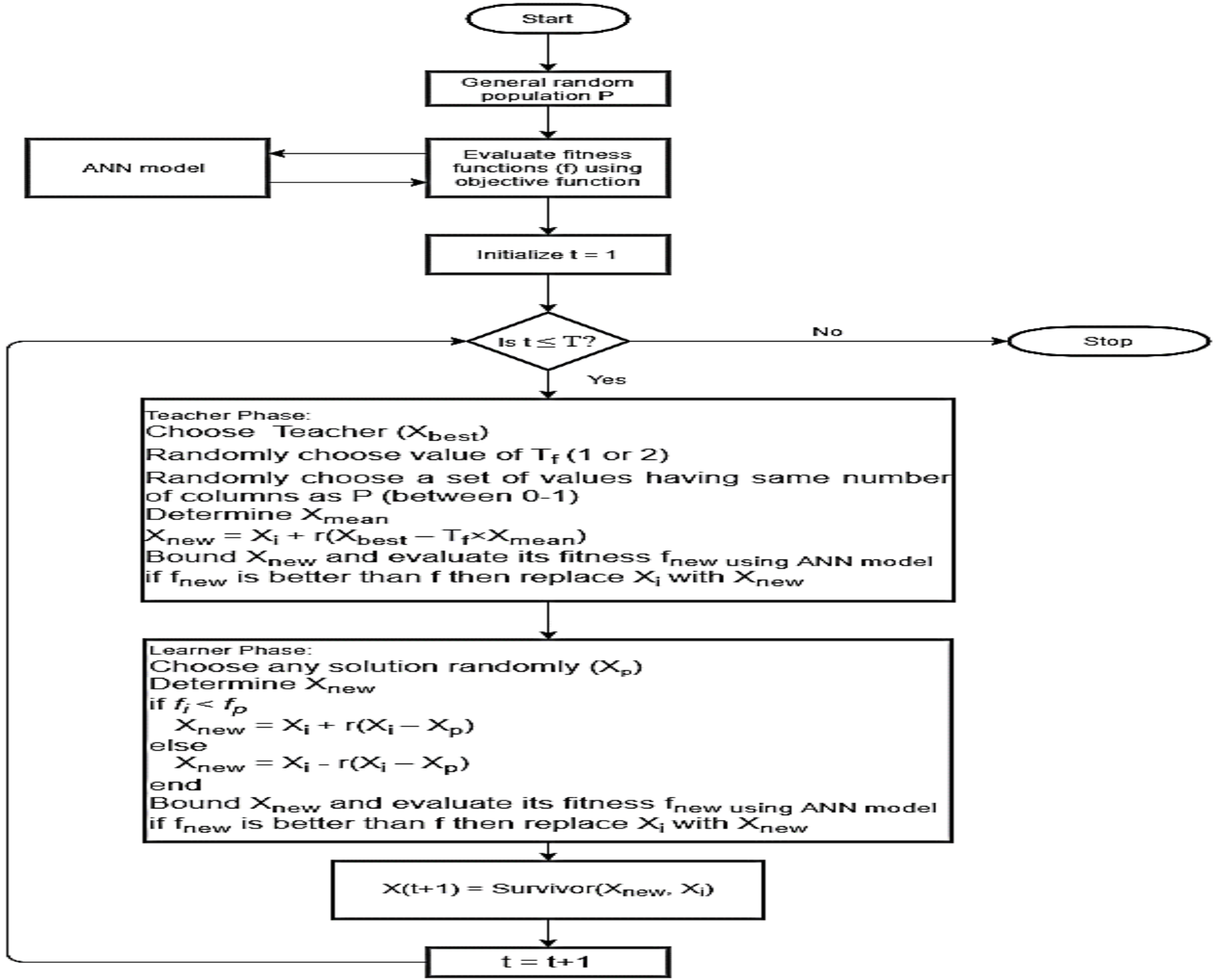
Comaprison of RSM and ANN-TLBO algorithms to determine the optimum result.

Methods

- Samples were prepared as per our previous work Sarkar et al., 2020 [2] but using microwave convective (MWC) dryer instead of hot-air drying.
- Central composite design was adopted for MWC with power level in the range of 100–300 W, temperature from 40 to 80 °C, total soluble solid from 20 to 30 °B and pulp amount 0.4 to 0.6 g/cm3 .
- Sample extract preparation and estimation of total phenolic content (TPC) was done following our previous work Hazra et al., 2019.
- Response surface methodology (RSM) and ANN-TLBO was conducted using Design Expert 7.0.0 and MATLAB 2018a.

Artificial neural network-teaching Learning Based Optimization (ANN-TLBO)




Start
General random population P
ANN model
Evaluate fitness functions (f) using objective function
Initialize t = 1
Is t ≤ T?
No
Stop
Yes
Teacher Phase:
Choose Teacher (X_{best})
Randomly choose value of T_f (1 or 2)
Randomly choose a set of values having same number of columns as P (between 0-1)
Determine X_{mean}
$X_{new} = X_i + r(X_{best} - T_f \times X_{mean})$
Bound X_{new} and evaluate its fitness f_{new} using ANN model
if f_{new} is better than f then replace X_i with X_{new}
Learner Phase:
Choose any solution randomly (X_p)
Determine X_{new}
if $f_i < f_p$
$X_{new} = X_i + r(X_i - X_p)$
else
$X_{new} = X_i - r(X_i - X_p)$
end
Bound X_{new} and evaluate its fitness f_{new} using ANN model
if f_{new} is better than f then replace X_i with X_{new}
$X(t+1) = Survivor(X_{new}, X_i)$
t = t+1

Results

Table 1. Central composite design was adopted for microwave convective drying of mango

Parameters	-1 Level	+1 Level	-alpha	+alpha
Temperature (°C)	40	80	20	100
Puree load (g/cm^3)	0.4	0.6	0.3	0.7
Brix (°B)	20	30	15	35
Power level (W)	100	300	0	400

Fig 1. ANN model

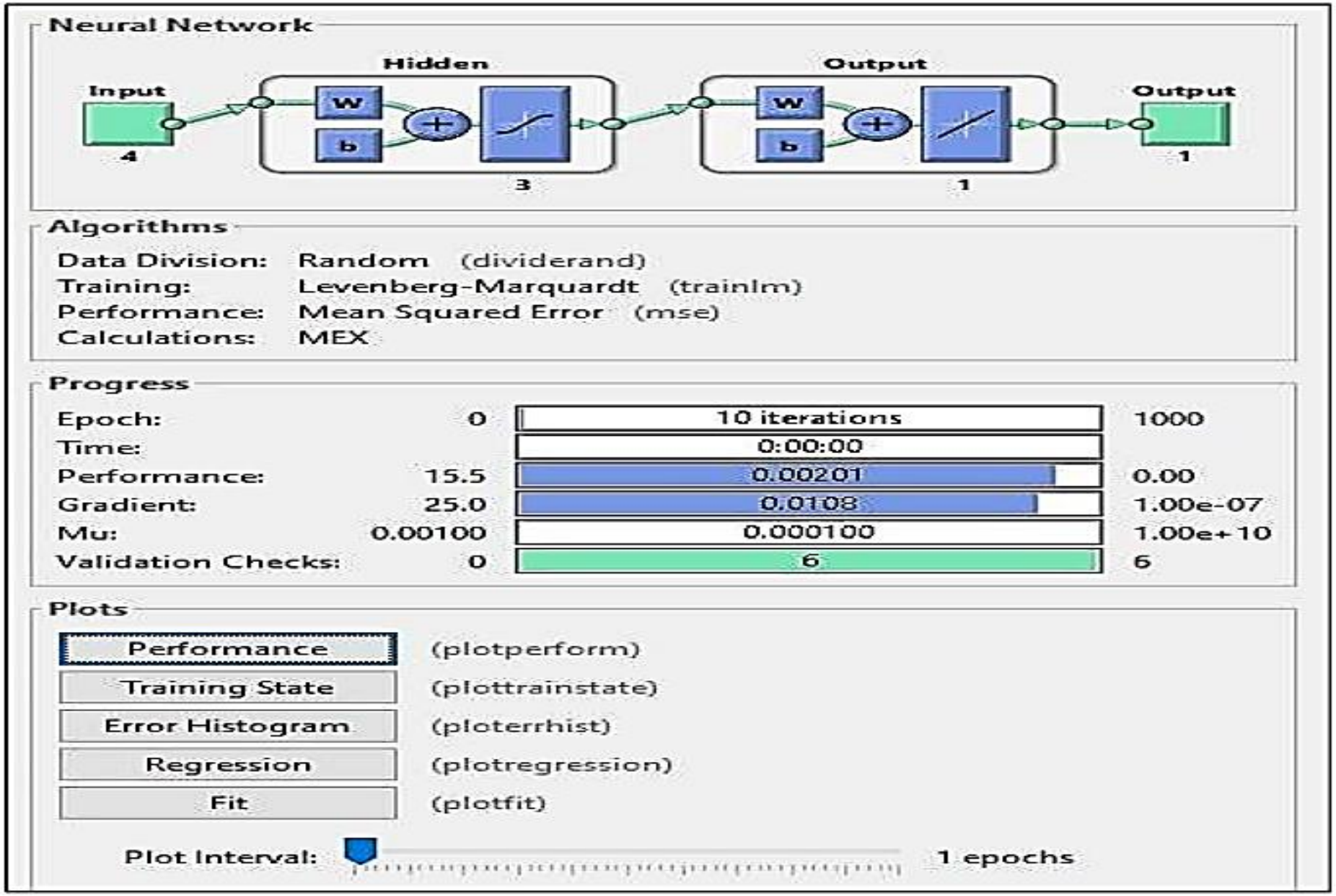


Table 2. Comparison of optimisation efficiencies of rehydration ratio between RSM and ANN-TLBO

Sl. No.	Algorithm	Temperature (°C)	TSS content (°B)	Power level (watt)	Puree load (g/cm2)	TPC value (mg GAE/100 g)
1	ANN-TLBO	57.15	29.25	175.08	0.6	14.29
2	RSM	57.84	29.05	170.27	0.6	13.36

Conclusion

The inhibition or deactivation of polyphenol oxidase was there resulting in higher TPC content along with availability of free polyphenols during the microwave convective drying. Using RSM optimization the highest TPC value was observed 13.36 mg GAE/100 g for the combination of 57.84 °C (MWC dryer temperature), 29.05 °B (total soluble solid content), 170.27 watt (microwave power level) and 0.60 g/cm2 (pulp amount). The maximum TPC value of 14.29 mg GAE/100 g was found using ANN-TLBO for the combination of drying parameters as follows: 175.08 watt, 57.15 °C, 0.60 g/cm2 and 29.25 °B. More robust model with higher coefficient of correlation was achieved by ANNTLBO technique than that of RSM.

References

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"If you torture the data long enough, it will confess"

- Ronald Coase