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Artificial Neural Network Modeling of Hot-air Drying Kinetics of Mango Kernel

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Large quantities of mango seeds are generated as waste during extraction of mango pulp. The mango kernels are nutritionally rich and can be used as food in the form of flour and starch. Present study was undertaken to investigate the effect of blanching and convective drying air temperature of 50, 60 and 70°C on drying characteristics of mango kernel in splitted and shredded form. The drying characteristics of prepared samples were studied in terms of moisture ratio, drying time, and effective moisture diffusivity. The colour parameters (‘L’, ‘a', ‘b’) of dried samples, were also estimated separately. Drying kinetics (moisture ratio *vs* drying time) of mango kernels modelled using three transfer functions (Tansig, Logsig and Purelin) of Artificial Neural Network (ANN). A reduction in the total drying time was observed with decrease in size of kernel but with rise in drying air temperature. The splitted and shredded kernels took about 450 to 840 min and 210 to 600 min respectively to be dried to final moisture content of 9 ± 1% (d.b.). Blanching did not show any significant influence on drying time. The drying process of mango kernels for all the conditions was observed to follow the falling rate. Modeling of drying kinetics of mango kernels was carried out using experimental results through artificial neural network. Results showed that the developed ANN model using logsig transfer function could predict the moisture ratio with high coefficient of determination (R^2 = 0.99) and low root mean square error (0.01) within the range of tested operating conditions. The established ANN model can be used for online prediction of moisture content of splitted and shredded mango kernels during hot air drying process which has relevance to the food and pharmaceutical industry to produce dried mango kernels at desired moisture content.

Keywords: Blanching, Colour parameters, Effective moisture diffusivity, Logsig transfer function, Splitted & Shreded

Introduction

Mango (*Mangifera indica* L.) is the largest produced tropical fruit grown in over 100 countries and accounts for 52% of the world’s major fruit production.[1] Mango production in India is about 21.82 million tonnes, which is around 39.40% of global production.[2,3] Mango fruit conquers highest position in India and covers an area and yield of approximately 2.25 million ha and 9663 kg/ha, respectively.[3] The fruit is consumed either directly or in the form of beverage and other confectionery etc.[4] During the industrial processing of mangoes, the by-products containing peels of 12–15% and seeds of 15–20% of the fruits are usually discarded as waste. Earlier studies reported that the kernel found inside the seed weighs from 45%–75% of the seed.[5] Mango kernel contains carbohydrates, fats, proteins and minerals[6,7] and rich in phytonutrients.[8–10] After extraction of nutritious edible oil from mango kernel, it can be further consumed as a substitute to wheat flour.[11]

Due to the structural limitations the mango seeds are highly perishable and may lead to development of toxins if not processed or disposed properly. Therefore, appropriate post-harvest processing is essential to protect the quality of kernels for effective use, thereby safeguarding the environmental pollution. Drying as a preservation method can increase the shelf life of a commodity by reducing the water activity level to prevent development of microorganisms, enzymatic and other deteriorative reactions.[12] It is a unit operation which includes both heat and mass transfer, regulated by drying material as well as drying medium. The prediction of drying kinetics of the commodity is vital for designing the equipment, maintaining the quality of the finished product and monitoring of energy consumption. The form and size of drying material and the controlling parameter of the drying medium such as temperature and velocity are crucial in manipulating the drying

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behaviour as well as the quality of the dried material. Several research workers proposed mathematical models for the estimation of moisture ratio with drying time for mango fruits. However, none of the researchers have tried artificial neural network for predicting the moisture ratio with drying time for mango kernels. Therefore, present study was undertaken to investigate the effect of blanching treatment and convective drying air temperature on drying characteristics of mango kernel in splitted and shredded form. Also, drying kinetics (moisture ratio *vs* drying time) of mango kernels was modelled using three transfer functions (Tansig, Logsig and Purelin) of artificial neural network (ANN).

Fig. 1 — Sample preparation for studying drying characteristics of mango kernel

Materials and Methods

Sample Preparation

Mango (*Mangifera indica* L.) *Totapuri*, a variety commonly grown (available during May-June) and consumed in South India including Odisha, was selected for the study. Fresh ripe mango seeds were collected from a local fruit juice processing unit located at Bhubaneswar, India. These were washed and brushed thoroughly with clean water to remove the fragments of pulp and the impurities on both sides of the seed. Later, the surface water was wiped with a clean cloth. The mango seeds were decorticated (to separate the kernel from stony endocarp) using the hand operated mango seed decorticator, developed at the College of Agricultural Engineering and Technology, OUAT, Bhubaneswar.

Experimental Procedure for Kernel

To study the drying characteristics of mango kernel, the samples were prepared by splitting the kernel into two cotyledons of about 8 ± 1 cm in length, a width of 3.5 ± 0.5 cm with a thickness of 0.5 ± 0.1 cm. The other sample was prepared by shredding into small slices (1 × 1 × 0.5 cm^3). One part of sample was blanched in hot water at 90°C for 2 min to get the shred blanched (SRB), shred unblanched (SRUB), split blanched (SPB) and split unblanched (SPUB) kernel as shown in Fig. 1 to examine the influence of blanching on the drying characteristics as compared to unblanched samples.

Thin-layer drying of mango kernels (shred and split form) samples were performed in a hot air convective dryer (Classic scientific, model C3-84) under different drying air temperatures (50, 60 and 70°C). The components of the hot air dryer were a centrifugal blower, an electrical resistance air heating section, sensor based measuring and the data recording system. The hot air oven method was followed to determine the initial moisture content of samples at 105°C for 24 h. Samples used in drying study were weighed prior to drying. Before keeping the sample in a tray in the dryer, the dryer was started for half an hour to maintain the steady-state condition of the drying air to the predefined drying air temperature. Air velocity of 1.2 m/s was considered during all drying trials. For the drying experiments, the samples were weighed at 30 min interval initially and then followed by 60 min intervals. When the weight of the samples was stabilized to two decimal digits, the experiment was stopped.

Determination of Drying Indices

Moisture Ratio

The moisture ratio of the samples was calculated using following formula.[13]

$$MR = \frac{M_T - M_E}{M_O - M_E} \qquad \ldots (1)$$

where, MR is moisture ratio (dimensionless), M_O, M_T and M_E are initial moisture content, moisture content at any given time, and equilibrium moisture content (kg water/kg dry matter), respectively.

As the value of M_E is comparatively small to M_T and M_O, therefore, the M_E value can be omitted. Then, the Eq. (1) can be simplified as[14]

$$MR = \frac{M_T}{M_O} \qquad \ldots (2)$$

Drying Rate

The time and weights were recorded for each drying interval. The removal of water with time as mentioned against each drying temperature was observed regularly. The drying rate for each time interval for each drying temperature was determined for the particular interval and was expressed in (g/min-gdm) using the following equations.[15]

$$DR = \frac{M_T - M_{T+\Delta t}}{\Delta t} \quad \ldots (3)$$

where, Δt and M_T+Δt are the time interval to find the weight of the sample (min) and moisture content at time T+Δt (kg water/kg dry matter).

Effective Moisture Diffusivity

Fick's diffusion equation for particles with slab geometry is given by[16]

$$MR = \frac{M_T - M_E}{M_O - M_E} = \frac{8}{\pi^2}\sum\frac{1}{(2n+1)^2}\exp\left(\frac{-Deff(2n+1)^2\pi^2\,T}{4S^2}\right) \quad \ldots (4)$$

The Eq. (4) can be expressed as (neglecting the higher order terms)

$$MR = \frac{8}{\pi^2}\exp\left(\frac{-\pi^2 D_{eff}T}{4S^2}\right) \quad \ldots (5)$$

where, D_{eff} is effective moisture diffusivity (m^2/min), T is the drying time (min) and S is the half slab thickness (meter).

Thus, Eq. (5) could further be linearized to:

$$\ln(MR) = \ln\left(\frac{M_T - M_E}{M_O - M_E}\right) = \ln\left(\frac{8}{\pi^2}\right) - \left(\frac{D_{eff}\pi^2 T}{4\,S^2}\right) \quad \ldots (6)$$

Therefore, the slope (β_0) was determined by plotting drying time versus ln (MR).

$$\beta_0 = \frac{\pi^2 D_{eff}}{4S^2} \quad \ldots (7)$$

Drying Kinetics of Mango Kernel using Artificial Neural Network

The artificial neural network tool of MATLAB software (The Math-Works, Inc., R2015a) was used to develop a model for the simulation of experimental drying parameters of mango kernels. Various types of networks are used by ANN like feed-forward and feedback network. Multilayer feed-forward neural network is an important tool involved in predicting and solving the complex problems of food processing operations by interpreting the input and output parameters.[17] The artificial neural network models are trained by an algorithm using back propagation method. It practices the organized training technique to initialize the biases and weights of the network randomly at beginning of the training stage.[18] To increase the ANNs accuracy, the back propagation process adopted the gradient descent search method to adjust the connection of weights. The working of back-propagation technique in an artificial neural network modelling comprises of four major steps: (i) gathering of dataset and describing of input and output data, (ii) deciding the network architecture (iii) network training and (iv) modelling. The internal activation level of each neuron is expressed by its transfer function. The precision in output from a neuron is dependent on the proper selection of transfer function. To explain linear and nonlinear regression problems in engineering applications and for obtaining the best network topology of it, three transfer functions namely (Logsig, Tansig and Purelin) were used.[15]

$$H_j = \frac{1}{1+\exp(-G_j)} \text{ (Logsig)} \quad \ldots (8)$$

$$H_j = \left[\frac{2}{(1+\exp(-2G_j))-1}\right] \text{ (Tansig)} \quad \ldots (9)$$

$$H_j = (G_j) \text{ (Purelin)} \quad \ldots (10)$$

G_j is the j-th input neuron and calculated as below:

$$G_j = \sum_{i=1}^{Q} C_{ij}\,H_i + a_j \quad \ldots (11)$$

where Q, C_{ij}, H_i, and a_j are the total of output layer neurons, weight connections between i-th and j-th layers, output neuron in j-th layer, and a_j is the bias of neurons in j-th layer.

The topmost error minimization algorithm such as Levenberg-Marquardt (LM) was selected for analysis of neural network performance. In the case of kernels, three input variables, (mango kernel sample type, drying temperature and drying time) were in the input layer and moisture ratio was used as the output variable in the experiments for estimating drying performance. Thus, the input layer contained 3 neurons, 10 in hidden layer and the output layer held 1 neuron. These selected after standardizing the ANN model through several rounds. The 143 data set obtained from drying tests were distributed into three subgroups:100 data for training (≈70%), 21 data for validation (≈15%) and 21 for testing (≈15%). The schematic illustration of the neural network with 3-10-1 architecture for mango kernel is presented in Fig. 2. Mango kernel sample codes as used in ANN are: 1 = SRB, 2 = SRUB, 3 = SPB, and 4 = SPUB. To establish a best-suited model, training of artificial neural networks was done three times to get the finest values for each drying variable. The best training performance of the neural network was based on the model determinants (R^2) and (RMSE).

$$R^2 = 1 - \frac{\sum_{v=1}^{D}\left(U_{pre,v} - U_{exp,v}\right)^2}{\sum_{v=1}^{D}\left(U_{pre,m} - U_{pre,v}\right)^2} \quad \ldots (12)$$

$$RMSE = \sqrt{\frac{\sum_{v=1}^{D}\left(U_{pre,v} - U_{exp,v}\right)^2}{D}} \quad \ldots (13)$$

where, $U_{pre,v}$ is the v-th predicted output by the neural network model,

$U_{exp,v}$ is the v-th experimental (target) output,

$U_{pre,m}$ is the mean value of predicted output and

D is the number of observational data.

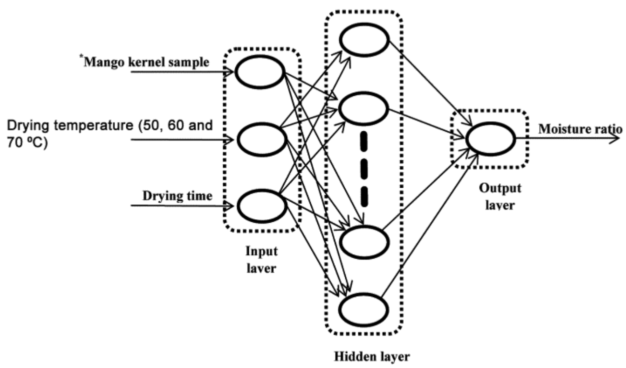

Fig. 2 — Schematic illustration of neural network with 3-10-1 topology for mango kernel drying kinetics

Results and Discussion

Drying Characteristics of Mango Kernel

The drying characteristics of the mango kernel samples in form of shred blanched (SRB), shred unblanched (SRUB), split blanched (SPB) and split unblanched (SPUB) kernel at drying air temperatures of 50, 60 and 70°C were studied. It was observed from Table 1 that these samples were dried from an IMC of 170.23 to 389.89% (d.b.) to a FMC of 8.14 to 12.54% (d.b.) with a drying time requirement of 210 to 840 min. The split kernels, in general required more drying time (450 to 840 min) as compared to shred kernels (210 to 600 min) for any given temperature and blanching treatment. The drying air temperature of 50°C needed more drying time for SPB (840 min) as compared to SRB (600 min) to attain the EMC as shown in Fig. 3 and Table 1.

Similar, trends were observed for the other two drying air temperatures (60 and 70°C), in which drying time decreased with decrease in size of sample (Fig. 3). It was attributed to the increased surface area of the samples in shred kernels, which resulted in more exposure to drying air heat. However, the drying of kernels of both the sizes was prominently influenced by drying air temperature. Their drying time requirement decreased with increasing drying air temperature irrespective of blanching treatment. The

Table 1 — Drying characteristics of mango kernel under different conditions

Samples	Drying air temperature (°C)	IMC (%, d.b.)	FMC (%, d.b.)	FDR (g/min-gdm)	FMR	TDT (min)	EMD (m^2/min)
Shred blanched kernel	SRB 50	301.70	8.45	0.015	0.028	600	1.5198×10^{-8}
	SRB 60	301.80	8.20	0.029	0.027	300	3.3689×10^{-8}
	SRB 70	297.50	9.94	0.063	0.033	270	3.4195×10^{-8}
Shred unblanched kernel	SRUB 50	170.27	9.80	0.007	0.058	600	1.5198×10^{-8}
	SRUB 60	178.23	10.01	0.027	0.056	300	2.4063×10^{-8}
	SRUB 70	170.23	8.14	0.013	0.048	210	3.723×10^{-8}
Split blanched kernel	SPB 50	389.89	9.72	0.032	0.025	840	1.1145×10^{-8}
	SPB 60	316.77	9.36	0.041	0.030	600	1.5198×10^{-8}
	SPB 70	380.25	10.39	0.040	0.027	510	1.7731×10^{-8}
Split unblanched kernel	SPUB 50	231.54	8.16	0.035	0.035	780	1.0638×10^{-8}
	SPUB 60	319.75	12.54	0.024	0.039	600	1.4438×10^{-8}
	SPUB 70	231.52	8.21	0.014	0.035	450	1.8741×10^{-8}

IMC: Initial moisture content, FMC: Final moisture content, FDR: Final drying rate, FMR: Final moisture ratio, TDT: Total drying time, EMD: Effective moisture diffusivity

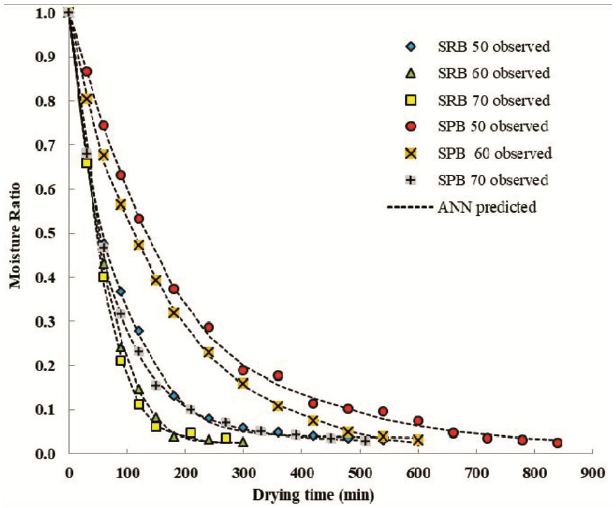

Fig. 3 — Effect of drying temperature and form of blanched kernel on moisture ratio with drying time

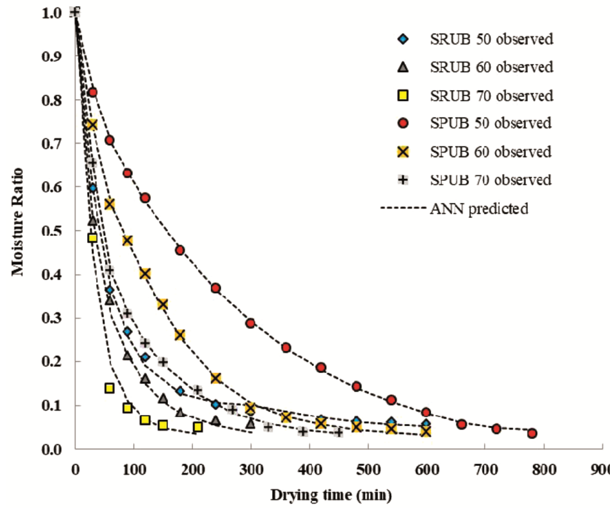

Fig. 4 — Effect of drying temperature and form of unblanched kernel on moisture ratio with drying time

drying time for split and shred blanched kernels were about 1.64 and 2.22 times more at 50°C than that at 70°C, respectively. This effect specified that mass transfer was quicker during higher drying air temperature as an outcome of additional energy transfer to samples, generating rise in temperature of the sample. The variation in experimental and predicted moisture ratio (MR) using optimum ANN model with drying time for the blanched split and shred kernels are presented in Figs 3 and 4. In general, MR values of split kernels showed a slow and gradual decreasing trend with higher drying times as compared to shred kernels, in which a rapid decreasing trend was noticed requiring lesser drying time to obtain same MR values. It was evident that the MR decreased continuously with increase in drying time and temperatures in all the samples (Figs 3 and 4). Several researcher has also reported similar findings of decreasing moisture ratio with drying time at higher drying air temperatures for drying of kiwi slices[19], (potato, garlic, cantaloupe)[15], turnip slices[20], cherry tomato[21] and carrot cubes.[22] In Fig. 4 the effect of drying air temperature on MR with drying time of unblanched kernels is shown. It was observed that the value of MR reduced with time and drying air temperatures in a similar manner as observed for the blanched samples. However, no substantial change in total drying time was observed due to blanching treatment.

Drying rate characteristics curves of blanched and unblanched kernels were drawn at the three different drying air temperatures. As shown in Figs 5 and 6, the drying rate of kernels (blanched and unblanched)

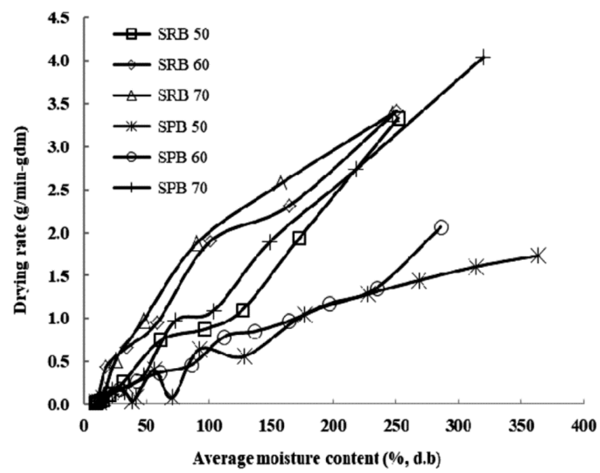

Fig. 5 — Effect of drying air temperature and form of blanched kernel on drying rate with average moisture content

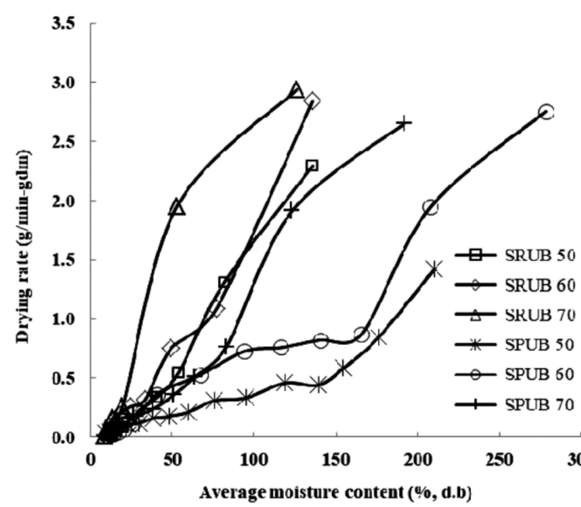

Fig. 6 — Effect of drying air temperature and form of blanched kernel on drying rate with average moisture content

increased as the hot air convective temperature was increased. The graphs also revealed that there was absence of constant rate drying period and the drying operations for both the types of samples (blanched and unblanched) occurred in the falling rate period throughout, which proposed that the kernel surface was not saturated with water and the drying rate was maintained by internal diffusion mechanism as per mass transfer phenomenon. It concluded that the drying rate was high during initial stage of drying and subsequently the rate reduced and got stabilized during later stage of drying.

This was due to the fact that during the initial part of drying the moisture was evaporated from the surface through surface diffusion until the surface water was completely evaporated and in later stage of drying the moisture was gradually diffused from the interior of kernel to the surface. The rate of drying decreased more rapidly during initial stage of drying and continued until the equilibrium moisture reached. The maximum drying rates were higher for blanched samples (about 4 g/min-gdm) than unblanched samples (about 3 g/min-gdm). Similarly, the graphs (Figs 5 & 6) clearly illustrated that at same drying air temperature the split kernels had lower drying rates than those of shred samples within the same range of average moisture content. In Table 1 the effective moisture diffusivity values for all the samples are listed. The values increased with increase in drying temperature for all the category of samples based on size and blanching treatment. However, the moisture diffusivity values for split kernels were lesser (1.8741×10^{-8} to 1.0638×10^{-8} m^2/min) than shred kernels (3.723×10^{-8} to 1.5198×10^{-8} m^2/min). Similar results were observed by other researcher for different vegetables for kiwi slices[19] (4.55 to 21.27×10^{-11} m^2/s), sweet cheery[23] (1.54 to 5.68×10^{-10} m^2/s); carrot[24] (0.77 to 9.33×10^{-9} m^2/s); apricot[25] (6.76 to 12.76×10^{-10} m^2/s).

Effect of Blanching and Drying Air Temperature on Colour Parameter

The objective measurement of colour values of the dried samples has been depicted in Table 2. The total colour change values of all the samples have been calculated based on the 'L,' 'a' and 'b' values of fresh kernel which were 86.52 ± 1.17, 2.76 ± 0.30 and 11.62 ± 0.97, respectively. It was observed that the 'L' values of all the samples were less, whereas both 'a' and 'b' values were more, exhibiting the change of white colour of fresh samples towards light brownish in dried samples. Careful, examination of data showed that the total colour change (ΔE) was less in split kernels (15.15 ± 2.50 to 24.54 ± 2.35) as compared to shred kernels (30.92 ± 3.32 to 44.67 ± 1.73). It was further observed that the colour deterioration was more in blanched shred kernels. This could be attributed to the fact of exposure of larger surface area of shred samples to heated drying air. Since the kernels contained lipids, hot water blanching could have been a stimulating factor for release of fat component from cut-open surfaces of shred samples and there by changing the colour of kernels to relatively darker. Probably, for the same reason definite trend of change in colour was attained with variation in the drying air temperature.

However, the blanched split sample dried at 60°C could retain maximum colour as it displayed the minimum total colour change (15.15 ± 2.50). The colour of the samples of all the categories subjected to

Table 2 — Change in colour of dried mango kernels at different drying air temperature

Samples	Drying air temperature (ºC)	L	a	b	ΔE
Fresh kernel	—	86.52 ± 1.17	2.76 ± 0.30	11.62 ± 0.97	—
Shred blanched kernel	SRB 50	44.3 ± 3.01^{e}	6.20 ± 0.87^{bcd}	10.48 ± 2.33^{e}	42.43 ± 3.05^{a}
	SRB 60	42.24 ± 1.89^{e}	7.92 ± 0.71^{bcd}	13.04 ± 1.46^{cde}	44.63 ± 1.83^{a}
	SRB 70	42.30 ± 1.84^{e}	8.92 ± 0.63^{bc}	12.36 ± 0.86^{de}	44.67 ± 1.73^{a}
Shred unblanched kernel	SRUB 50	45.00 ± 1.93^{e}	5.54 ± 0.75^{d}	13.64 ± 1.88^{bcde}	41.70 ± 1.97^{a}
	SRUB 60	52.42 ± 1.45^{d}	5.96 ± 1.49^{cd}	13.72 ± 2.43^{bcde}	34.41 ± 1.56^{b}
	SRUB 70	55.72 ± 3.35^{d}	5.24 ± 0.62^{d}	10.88 ± 0.77^{e}	30.92 ± 3.32^{b}
Split blanched kernel	SPB 50	63.66 ± 2.75^{c}	9.22 ± 3.05^{b}	16.96 ± 0.63^{ab}	24.54 ± 2.35^{c}
	SPB 60	**72.36 ± 2.91^{a}**	**7.76 ± 0.90^{bcd}**	**10.86 ± 1.21^{e}**	**15.15 ± 2.50^{e}**
	SPB 70	65.22 ± 2.85^{c}	13.06 ± 1.32^{a}	16.14 ± 2.40^{abc}	24.26 ± 2.31^{c}
Split unblanched kernel	SPUB 50	65.50 ± 1.41^{bc}	7.88 ± 0.26^{bcd}	17.78 ± 0.74^{a}	22.51 ± 1.40^{cd}
	SPUB 60	70.48 ± 1.91^{ab}	7.14 ± 2.53^{bcd}	15.96 ± 0.61^{abcd}	17.36 ± 169^{e}
	SPUB 70	68.62 ± 1.79^{abc}	6.90 ± 0.72^{bcd}	14.08 ± 2.72^{bcde}	18.73 ± 1.45^{de}

Same superscripts along a column indicates no significant difference at $p<0.05$

drying at 50°C was found to be degraded maximum probably because of longer drying period. Split kernels dried at 70°C also lost the colour components as compared to those of 60°C. This could be due to the theory proposed by a researcher[26] indicating unusual change in fatty acid profile in kernel oil beyond 60°C. However, no significant ($p < 0.05$) influence of blanching treatment was observed on split kernels. The intactness of surfaces could have been a possible reason for this finding.

Artificial Neural Network Modelling of Drying Kinetics

An ANN model to predict the moisture ratio with drying time of mango kernels of all the categories for hot air drying at different temperature was developed. The back propagation and Levenberg-Marquardt were used as the method of computation and training algorithm to minimise the error of the drying data.

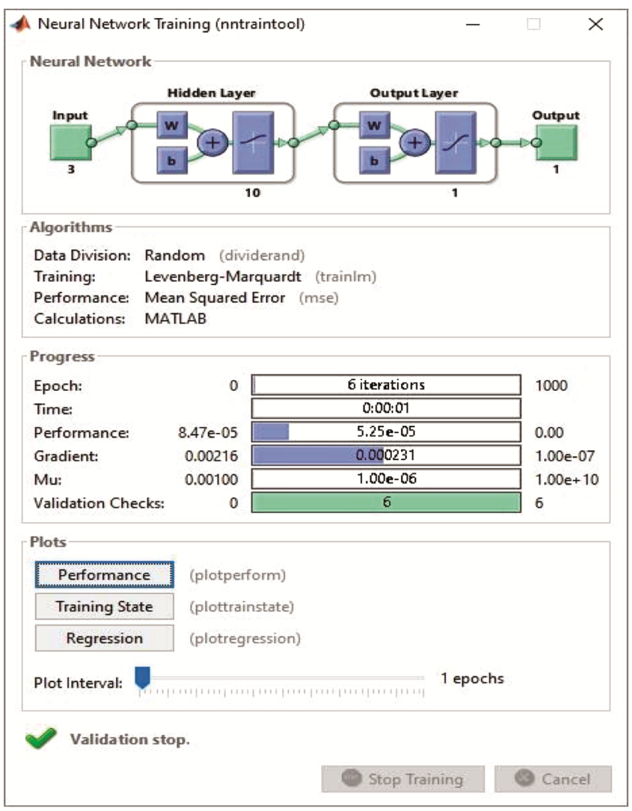

Fig. 7 — Results of ANN modelling of drying kinetics of mango kernel using Logsig transfer function

Based on trial runs 1000 epochs were used with 6 iterations for network training with an aim of minimum error (Fig. 7). The transfer functions used in the study were tangent sigmoid (tansig), log sigmoid (logsig) and linear purelin. The best fitting with training data set were obtained with only one hidden layer and 10 neurons were sufficient to minimise the error. R^2 obtained ranged from 0.865–0.9988, with RMSE values of 0.0104 to 0.1104 for different transfer functions. However, among all the three transfer functions, logsig was found to be fitted best with highest R^2 value of 0.9988 and an error of 0.0104 (Table 3 and Fig. 8). A plot between predicted MR values and observed MR values along with a fitted regression line at 45° is shown in Fig. 9. The close proximity of data points with the 45° line further validated the accuracy of logsig transfer function as a predictor of this drying kinetics. The efficacy of ANN modelling is further appreciated as handling of three input parameters with twelve experimental combinations simultaneously and predicting precisely through a single transfer function.

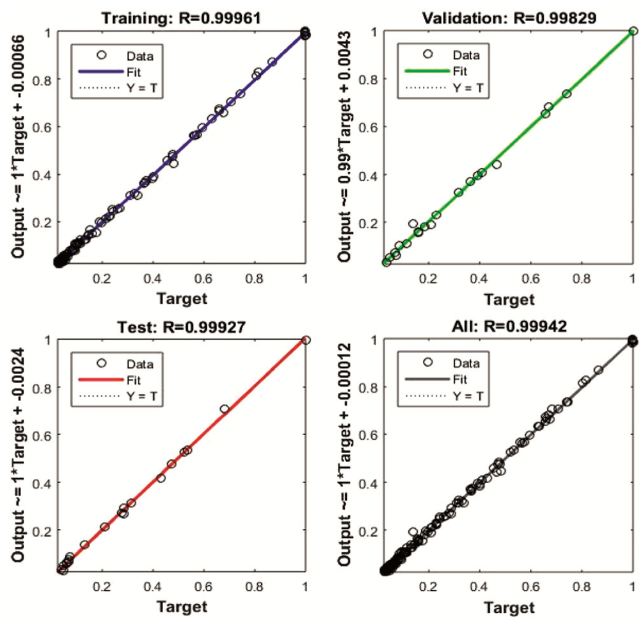

Fig. 8 — Comparison between experimental and predicted moisture ratio values of mango kernels (Training, validation and test)

Table 3 — Regression parameters of ANN modelling of moisture ratio vs drying time of mango kernel (LM = Levenberg-Marquardt)

Responses	Training Algorithm	Transfer function	ANN Topology	R^2	RMSE	Epoch
Moisture Ratio	LM	Tansig	3-10-1	0.9987	0.0109	6
	LM	**Logsig**	**3-10-1**	**0.9988**	**0.0104**	**6**
	LM	Purlin	3-10-1	0.8660	0.1104	6

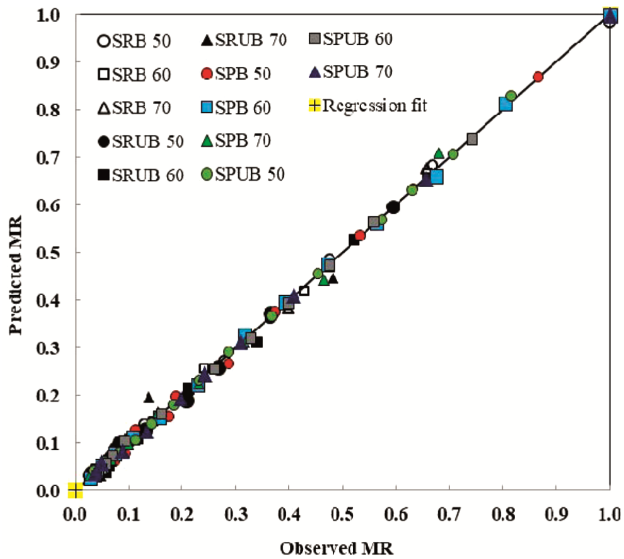

Fig. 9 — Plot of predicted moisture ratio vs observed moisture ratio of mango kernel; SRB: Shred blanched kernel, SPB: Split blanched kernel, SRUB: Shred unblanched kernel, SPUB: Split unblanched kernel, MR: Moisture ratio

Conclusions

The split and shred blanched kernels required 450 to 840 min and 210 to 600 min, respectively to be dried from initial moisture content to final moisture content of 9 ± 1% (d.b.). Drying temperature strongly influenced drying rate and drying time of kernels, however, there was no significant impact of blanching on total drying time. The effective moisture diffusivity values for split kernels were lesser (1.8741×10^{-8} to 1.0638×10^{-8} m^2/min) than shred kernels (3.723×10^{-8} to 1.5198×10^{-8} m^2/min). The effective moisture diffusivity increased with rise in drying temperature for all the category of samples based on size and blanching treatment. Change in colour (ΔE) was observed to be more in shred sample than the split sample in general. Among split samples, the minimum change in colour was exhibited by blanched kernel dried at 60°C (SPB 60). The developed ANN model for drying of kernels using Logsig transfer function could predict the drying kinetics with highest coefficient of determination ($R^2 = 0.9988$) and lowest root mean square error (0.0104) within the range of study. It is recommended to dry the mango kernels in split form at 60°C after blanching at 90°C till the final moisture content of 9 ± 1% (d.b.) within a total drying time of about 600 min. Future scope of research lies in evaluating the physico-chemical properties of the dried mango kernels which will strengthen the current research.

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