International Journal of Food and Fermentation Technology
Citation: *Int. J. Food Ferment. Technol.*, **16**(01): 177-190, June 2026
DOI: 10.30954/2277-9396.01.2026.12

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

RESEARCH PAPER

Evaluation of Drying Characteristics of Guava (*Psidium guajava* L.) Fruit Slices and Study its Physico-chemical Properties

Hemlata Suresh Chaudhari and Shrikant Baslingappa Swami*

Department of Post-Harvest Engineering, Post-Graduate Institute of Post-Harvest Management, Killa-Roha. Dist: Raigad (Maharashtra State) (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli-Campus Roha), India

*Corresponding author: swami_shrikant1975@yahoo.co.in

Paper No.: 355 **Received:** 13-04-2026 **Revised:** 12-05-2026 **Accepted:** 24-05-2026

ABSTRACT

The aim of the present study was to determine the drying characteristics and its physico-chemical and functional properties of Guava slice were dried at different temperatures in tray dryer at 45°C, 55°C, 65°C. Drying kinetics of guava slices has been experimentally investigated in a tray dryer. Drying experiments were performed at constant air velocity of 2.0 m/s and initial thickness of 5 mm for guava slice the drying time decreased with increase in drying air temperature. This study was conducted to determine nutritional composition and functional properties of guava powder. Guava powder proximate composition (moisture, ash, crude protein, and crude fat) were determined. Average moisture content of 5.94 to 6.53% was observed, while average percent ash, protein and fat, fiber contents were 5.19 to 4.08 %, 5.34 to 4.75%, and 4.537 to 3.80% and 40.70 to 37.08 % respectively. Various functional properties of Guava powder were bulk density (g/cc), water absorption capacity (g/ml) at 45°C, 55°C, and 65°C respectively.

Keyword: Guava powder, Drying characteristics, Physico-chemical properties

Guava (*Psidium guajava* L.) is a member of the *Myrtaceae* family. The genus *Psidium* includes about 150 species, but *Psidium guajava* is the most important fruit of this genus Pommer and Murakami, (2009). Guava prices become very low during main season and sometimes farmers have to pay to throw away their produces because of higher perishable nature of the produce. Fresh guava has 92 to 94% water and it can be stored for 2 to 4 weeks at 0°C Mudgal and Pandey, (2007).

Guava is extensively cultivated in India over 246.2 thousand hectare land with a production of 3993.5 thousand million tonnes (India Stat, 2016). Though it is successfully grown all over the country, the most important guava growing states are: Maharashtra, Bihar, Madhya Pradesh, Uttar Pradesh, Chattisgarh, Punjab and Haryana. The Allahabad district of Uttar Pradesh has the reputation of growing best quality guava in the country as well as in the world. In Punjab, guava is cultivated on a large scale in all the districts and is a very productive and highly profitable fruit crop. It ranks second in cultivation after citrus and occupies an area of 8205 ha with a production of 1.80 million tonnes Anonymous, (2014)**.** According to the national nutrient database of the United States Department of Agriculture (USDA), the major

How to cite this article: Chaudhari, H.S. and Swami, S.B. (2026). Evaluation of Drying Characteristics of Guava (*Psidium guajava* L.) Fruit Slices and Study its Physico-chemical Properties. *Int. J. Food Ferment. Technol.*, **16**(01): 177-190.

Source of Support: None; **Conflict of Interest:** None

nutritional components of fresh guava fruit per100 g are sugars 8.92 g; vitamin C 228.3 mg; vitamin A 624 IU; vitamin E0.73 mg; vitamin K 2.6 μ g; lycopene 5.2 mg (in red-fleshed cultivars only); potassium 417 mg; phosphorus 40 mg; magnesium 22 mg, and calcium 18 mg USDA, (2010). It is an excellent source of antioxidants, such as ascorbic acid, carotenoids and phenols Kondo *et al.* (2005); Lim *et al.* (2007).

The presence of a high concentration of dietary fibre (48–49 % on dry matter basis) in the peel and pulp of guava fruit makes it natural food product that meets requirements for consideration as an antioxidant dietary fibre Jiménez- Escrig *et al.* (2001). Guava can be consumed fresh or can be processed into juice, nectar, pulp, jam, jelly, slices in syrup, fruit bar or dehydrated products, as well as being used as an additive to other fruit juices or pulps Leite *et al*. (2006).

Guava has been used in the treatment of diarrhea, dysentery, menstrual disorders, vertigo, anorexia, digestive problem, gastric insuffiency, inflamed mucous membrane, skin problem, ulcer, cold cough, jaundice, diabetes, malaria (Kumar, 2012).

Hot-air drying is the most widely used method for production of dehydrated vegetables and fruits due to low investment and operating cost Sonawane and Arya, (2015). The main function of drying is to lower the water activity of the product and consequently, to inhibit the growth of microorganisms and decrease chemical reactions in order to prolong the shelf life of the product at room temperature. It also results in less space needed for storage and lighter weight for transportation Inchuen, *et al*. (2010).

Guava powder can be used to prepare cloudy juices because there was no significant difference in the sensory rating for juices prepared from pasteurized, clear nectar, freeze-dried puree powder and freeze-dried clear juice powder. There is also potential for use of guava powder in formulated drinks, baby foods and other products Chopda and Barrett, (2001).

In the present investigation the drying characteristics of guava slice at 45°C, 55°C and 65°C has been studied. The dried product quality i.e. nutritional and functional quality has been evaluated i.e. Protein, fat, fiber, ash, carbohydrate, bulk density, water absorption capacity and colour in terms of *L, a, b,* has been studied.

MATERIALS AND METHODS

Fresh, healthy disease free Guava fruit were obtained from the Nashik District, Maharashtra, India. The research work carried out in the Department of Post-Harvest Engineering. P.G. Institute of Post-Harvest Management, Killa-Roha.

Blanching pre-treatment

Good quality fruit was sliced at 5 mm thickness pieces with help of knife. After the sliced guava pieces were blanched at 80°C for 5 minutes by tying them in muslin cloth and dipping the sample in the brine solution 2% Concentration. Kshetrimayum,. (2015); Latpapi and Barrett (2006).

Drying of guava slices

1. Convective hot air drying

Convective hot air drying of Guava was performed at Department of Post-Harvest Engineering, Post Graduate Institute of Post-Harvest Management, Killa- Roha. The drying was carried out in the convective hot air dryer (Make M/s. Aditi Associates, India; Model: ATD-124) having capacity of 5 kw. There were nine numbers of trays inside the convective hot air dryer. The size of the tray was 81cm × 41cm × 3.4 cm. The slices were spread on the tray in single layer. The mesh (square) size of the tray was 1×1 mm. The temperature of the drying was 45°C, 55°C and 65°C. The weight loss with respect to the time was recorded from trays at different location in the convective hot air dryer. The moisture content with respect to the time was calculated from drying data. The drying data includes initial moisture content; weight loss, average moisture content with respect the time, drying rates, moisture ratios, and final moisture content of guava slice was recorded. Seven replications were taken for each experiment.

2. Drying rate

The drying rate of Guava slice was calculated on dry basis using following formula Chakraverty, (2005).

$$R = \frac{W_r}{T \times W_d} \times 100 \qquad \ldots(1)$$

Where,

R = Drying rate (g/min)

W_r = Amount of moisture removed (g)

T = Time taken (min)

W_d = Total bone dry weight of sample (g)

3. Moisture ratio

The moisture ratio of Guava slice calculated on dry basis using following formula Chakraverty, (2005).

$$\text{Moisture ratio} = \frac{M - M_e}{M_o - M_e} \qquad \ldots(2)$$

Where,

MR = Moisture ratio

M_0 = Initial moisture content, %(db)

M_e = equilibrium moisture content, % (db)

M = Moisture content at any time θ, %(db)

The root mean square error was for the best fit of the model was determined for higher R^2 values and lower MSE.

$$RMSE = \left[\frac{1}{N}\sum_{i=1}^{n}\left(MR_{\exp} - MR_{pre}\right)^2\right]^{1/2} \qquad \ldots(3)$$

Where,

MR_{exp} = experimental moisture ratio

MR_{pre} = predicted moisture

N and n = number of observations, number of constant Togrul and Pehlivan, (2004).

4. Drying model

Moisture Content (%db) versus drying time (min) and drying rate (g of water removed / 100 g bone dry material / min) with respect to moisture content was determined for drying of guava slices. Moisture ratio versus drying time (min) was also determined from the experimental data.

Table 1: Mathematical model tested with the moisture ratio of Guava slices

Sl. No.	Model	Equation	Reference
1	Hendernson and Pabis	$MR = a\exp(-kt)$	Henderson and Pabis (1961)
2	Logarithmic	$MR = a\exp(-kt)+c$	Togrul and Pehlivan (2002)
3	Exponential two term	$MR = a\exp(-kt)$ + 1–a) $\exp(-kat)$	Sharaf-Eldenet *et al*. (1980)
4	Simplified Fick's Diffusion(SFFD) equation	$MR = a \exp\left(-c\left(\frac{t}{L^2}\right)\right)$	Diamante and Munro (1991)

Various mathematical models listed in Table 1 were tested on the experimental data on moisture ratio versus drying time in minute of guava slices with convective hot air drying the moisture ratio determines the unaccomplished moisture change defined as the ratio of free water still to be removed, at time t over the initial total free water Henderson and Pabis, (1961).

Correlation regration coefficient and error analysis

The goodness of fit of the tested mathematical models to the experimental data was evaluated with the correlation coefficient (r^2), chi-square (χ^2) and the equation (4). The higher the r^2 value and lower the chi-square (χ^2) equation (4) and lower value of RMSE values, the better is the goodness of fit Ozdemir *et al*, (1999); Wang *et al.* (2007). According to Wang *et al.* (2007) reduced chi-square (χ^2) and root mean square error (RMSE) can be calculated as follows:

$$\chi^2 = \frac{\sum_{i=1}^{N}\left(MR_{ecp,i} - MR_{pre,i}\right)^2}{N - Z} \qquad \ldots(4)$$

Where,

$MR_{exp,i}$ = is the i^{th} experimental moisture ratio,

$MR_{pre,i}$ = is the i^{th} predicted moisture ratio,

N = is the number of observation, and

Z = is the number of constant.

The non-linear regression analysis was performed by using the statistical software SAS 6.5.

6. Effective moisture diffusivity

The effective moisture diffusivity and activation energy is essential for designing and modeling mass transfer in food-processing operations such as drying. The effective moisture diffusivity was calculated using method of slopes Maskan *et al*. (2002). A Fick's diffusion model with slab geometry was used to describe the transport of moisture during drying of Guava slices. The following equation is expressed as Crank (1975):

$$MR = \frac{8}{\pi^2}\sum_{i=1}^{n}\frac{1}{(2n-1)^2}\exp\left(\frac{-(2n-1)^2\pi^2 D_{eff}t}{4H^2}\right) \quad \ldots(5)$$

Where, MR is moisture ratio, n = 1, 2, 3 . . . is number of terms taken into consideration, t is drying time (s), D_{eff} is effective moisture diffusivity (m^2/s) and H is foam thickness (m). By taking the first term of Eq. (5) for long drying times, it can be simplified as Eq. (6) and expressed in a logarithmic form Falade and Solademi (2010):

$$Ln(MR) = \ln\frac{8}{\pi^2} - \frac{\pi^2 D_{eff}t}{4L^2} \quad \ldots(6)$$

The diffusivities are typically determined by plotting the experimental drying data in the terms of *ln* (*MR*) vs drying time (*t*) in equation (7), because the plot gives a straight line with the slope as follows:

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

Where,

L = half thickness

7. Activation energy

The effect of temperature dependence of the effective moisture diffusivity is generally described using Arrhenius type relationship to obtained better agreement by Suarez *et al.* (1980) and Roberts *et al.* (2008).

$$D_{eff} = D_0 \exp\left(-\frac{E_a}{RT}\right) \quad \ldots(8)$$

Where,

D_o = diffusivity constant or Arrhenius pre- exponential factor (m^2/s),

E_a = activation energy (kJ/ mol),

R = universal gas constant (kJ/ mol K),

T = air temperature (°K).

The pre exponential factor of the Arrhenius equation and corresponding activation energies were determined by using the data of effective moisture diffusivities and absolute air temperature.

Sample preparation

The dried slices were grounded into powder of size 4.885×m min mixer were used.

Physico-chemical analysis of guava powder

1. Moisture content

The moisture content of the sample guava powder prepared by dried slices at 45°C, 55°C and 65°C determined by AOAC (2010). 10 g of the guava powder was taken for in to each three different moisture boxes. The initial weight of moisture box was recorded. The samples were exposed to 105°C ± 1°C for 24 hr. in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136). The final weight was recorded. The moisture content of the sample were determined by equation (9).

$$\text{Moisture content \% (db)} = \frac{W_1 - W_2}{W_2}\times 100 \quad \ldots(9)$$

Where,

W_1 = weight of sample before drying, *g*

W_2 = weight of sample after drying, *g*

2. Protein (%)

Protein content in the sample guava powder prepared by dried slices at 45°C, 55°C and 65°C was determined by a micro-Kjeldahl distillation method (AOAC, 1990). The samples were digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate (C_uSO_4). The mixture was made alkaline with 40% NaOH. Ammonium sulphate thus formed. Released ammonia which was collected in 4% boric acid solution and titrated again with standard HCL. The per cent nitrogen content of the sample was calculated by the formula given below.

$$\% (N) = 1.4 \times (\text{ml HCl} - \text{ml blank}) \times \text{Conc. of } \frac{HCL}{Weight} \text{ of sample (g)} \quad \ldots (10)$$

% Protein = % N × Factor (6.25).

3. Fat (%)

Fat contain of sample guava powder prepared by dried slices at 45°C , 55°C and 65°C was determined using soxhlet fat extraction system AOAC, (2010). In this method, initially weight of empty flask was weighed. 2g of sample guava powder was wrapped in filter paper and was kept in siphoning tube and condenser was fixed above it and siphoned for 9 to 12 times with the petroleum ether in soxhlet apparatus. After removing assembly, evaporation of petroleum ether was allowed by heating round bottom flask. Residue reminder at the bottom of the flask and was reweighed with flask. The quantity of residue was determined as fat content of guava powder. Fat content was calculated by using equation (11);

$$\% \text{ Fat} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{weight of sample (g)}} \times 100 \quad \ldots (11)$$

4. Fiber (%)

Fiber contain of sample guava powder prepared by dried slices at 45°C, 55°C and 65°C was determined using about 2 – 5 g of moisture and fat free sample was weighed into a 500 ml beaker and a 200 ml of boiling 0.25 N sulphuric acid was added to the mixture and boiled for 30 min keeping the volume constant by addition of water at frequent intervals. The mixture was filtered through a muslin cloth and then transferred to the same beaker and 200 ml of boiling 0.31 N (1.25 %) NaOH was added. After boiling for 30 min, the mixture was filtered through muslin cloth. The residue was washed with hot water till it is free from alkali, followed by washing with alcohol and ether. It was then transferred to crucible, dried overnight at 80°C to 100°C and weighed. The crucible was heated in muffle furnace at 525°C for 2 – 3 hrs, cooled and weighed again. The difference in the weights represented the weight of crude fibre, Rangana, (1986).

$$\text{Crude Fiber}\left(\frac{g}{100g}\right) = \frac{\text{Weight of Fiber weight}}{\text{Weight of sample taken}} \times 100$$
$$\text{(Moisture+Fat free sample)} \quad \ldots (12)$$

5. Ash (%)

Ash content of sample guava powder prepared by dried slices 45°C, 55°C and 65°C at was calculated using muffle furnace. 5 gram of guava powder prepared by dried slices 45°C, 55°C and 65°C was taken in crucible. Weight of crucible and flour was recorded and kept in muffle furnace at 525 °C for 4 -5 hrs till constant weight was achieved. The crucible was cooled in desiccators and final weight of ash and crucible was recorded. Ash content was calculated by using equation (13).

$$\text{Ash content (\%)} = \frac{(W_2 - W_1)}{(\text{Weight of sample})} \times 100 \quad \ldots (13)$$

Where,

W_2 = weight of crucible + ash,

W_1 = weight of empty crucible

6. Carbohydrates (%)

The carbohydrate content of guava powder prepared by dried slices 45°C, 55°C and 65°C were calculated from protein, fat, fiber, ash and moisture content Adegunwa *et al*. (2012);

Carbohydrates = 100 – (protein + fat + fiber + ash + moisture content). …(14)

7. Water absorption capacity(g/ml)

Water absorption of samples guava powder prepared by dried slices 45°C, 55°C and 65°C was determined using the method of Sosulski, (1962) with slight modifications. The 3 g sample was dispersed in 25ml of distilled water and placed in pre weighed centrifuge tubes. The dispersions was stirred occasionally. After a holding period of 30 min, the dispersions were centrifuged at 5000 rpm for 25 min. The supernatant was removed and the pellet was dried at 50°C for 25 min which was cooled and weighed. The water absorption capacity was expressed as grams of water retained in the material. The experiment was repeated for three times and average reading was reported. The water absorption capacity calculated using equation (15).

$$\text{WAC} = \frac{W_2 - W_1}{W_0} \times 100 \quad \ldots(15)$$

Where,

W_0 = The weight of sample, (g)

W_1 = The weight of centrifuge tube plus sample, (g)

W_2 = The weight of centrifuge tube plus sediments,(g)

8. Bulk density (g/cc)

Bulk density was evaluated by 10 ml measuring cylinder bound on the weight and volume of sample of guava powder were poured into a graduated cylinder, gently tapped ten times and filled to 10 ml results were expressed as g/cc Mandge *et al.* (2014).

Bulk density (g/ml) =

$$\frac{\text{Wt. of Cylinder +Sample (g)} - \text{Wt.of empty Cylinder (g)}}{\text{Volume of Sample filled (ml)}} \quad \ldots(16)$$

9. Ascorbic acid (Vit. C)

The ascorbic acid of guava powder prepared by drying pulp at 45°C, 55°C, 65°C by convective hot air drying was determined. Determination of ascorbic acid was done by 2, 6-dichlorophenol indophenol dye method of Johnson (1948) as described by Ranganna (1986).

A sample of 10 g was mixed with 3 percent metaphosphoric acid solution and volume was made to 100 ml. The extract was filtered through filter paper and 10 ml aliquot was titrated against standard dye solution at room temperature to pink end point. The ascorbic acid content of the sample was calculated taking into consideration the dye factor as given below equation (17). The experiment was repeated for seven times for replicated;

Ascorbic acid (mg/g) =

$$\frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot of extract taken for estimation} \times} \times 100 \quad \ldots(17)$$

10. Colour

Colour of guava powder at 45°C, 55°C, and 65°C was measured by using Konica Minolta colour Reader. (Make: Minolta Camera Co. Ltd. Japan Model: (R-10). The colour of the guava powder was measured in dark room. Guava powder at 45°C, 55°C, and 65°C was placed on white surface and placing colour reader on the flour sample in a Petri dish and the colour was measured in *L, a, b* were reported. Where *L* value indicates degree of lightness or darkness, '*a*' value indicates redness or greenness and '*b*' value indicates the yellowness or blueness.

RESULTS AND DISCUSSION

Convective hot air drying of guava slices

Fig. 1 shows moisture content (db) % with respect to time (min) of guava slices dried by convective hot air dryer. The guava slices were dried from average initial moisture content of 519.030% (db) to 8.654% (db) at 45°C; 554.367 % (db) to 9.101% (db) at 55°C; 638.518 to 8.010% (db) at 65°C respectively. It took around 18hrs, 16hrs, and 13hrs time to dry the product at 45°C, 55°C, and 65°C. Fig. 2 shows the drying rate (g of water removed/100g of bone dry matter/min) w.r.t to time. The initial drying rate of guava slices was 0.268 g, of water removed /100 g of bone dry matter per minute and decrease up to the 0.0236 g of water removed/ 100g of bone dry matter per minute at 45°C; 0.299 g of water removed /100 g of bone dry matter per minute and decreases up to the 0.024 g of dry matter at 55°C; 0.269 g of water removed /100 g of bone dry matter per min and decreases up to the 0.0313g of water removed / 100 g of dry matter at 65°C.

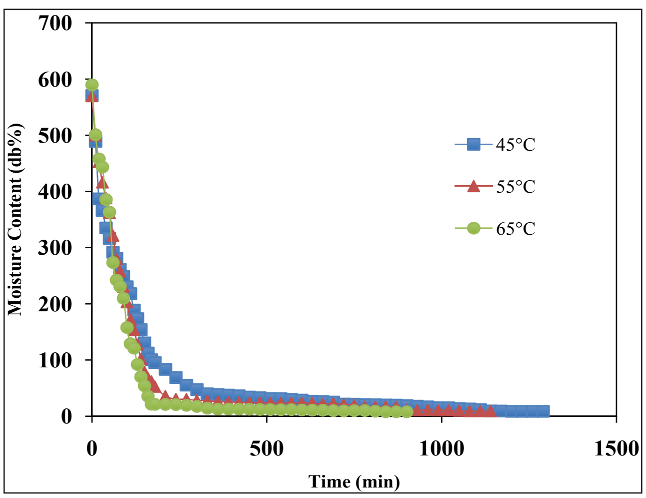

Fig. 1: Moisture content % (db) versus time (min) by convective hot air drying at different temperature for guava slices

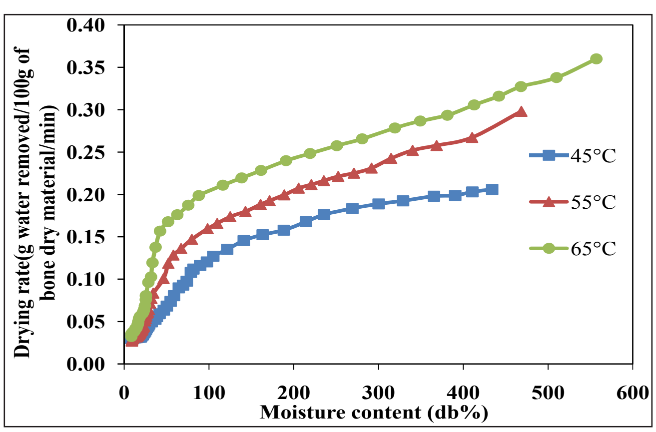

Fig. 2: Drying rate (g water removed/100 g of bone dry material/min) versus moisture content % (db) of guava slices dried by convective hot air drying method at different drying temperature

From Fig. 2 it was observed that the drying took place in falling rate period. As the temperature of drying increases from 45°C, 55°C and 65°C the drying rate also increases. Moisture removal inside the guava slices at 65°C was higher and faster than the other investigated temperature. Migration of surface moisture and evaporation rate from the surface to the air decreases with decrease of the moisture in the guava slices. The shorter time of drying was observed at higher temperature thus increased drying rate.

Fig. 3 shows variation in moisture ratio with respect to time in minute. During the drying experiment moisture ratio decreases from 1 to 1.21×10^{-1}, 1 to $9.73\times10^{-2}$and 1 to 1.88×10^{-2} at the drying temperature of 45°C, 55°C and 65°C respectively.

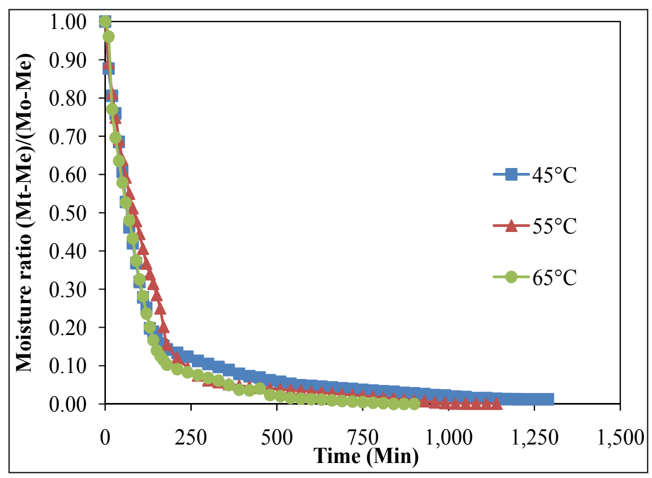

Fig. 3: Variation in moisture ratio with respect to time, min for guava slices during convective hot air drying

Evaluation of thin layer drying model of guava slices dried by convective hot air drying

The Table 2(a), 2(b) and 2(c) shows the model parameters of various model fitted to the experimental data for Henderson and Pabis model, Logarithmic, Exponential two term, Simplified Fick's Diffusion (SFFD) equation at 45°C, 55°C and 65°C by convective hot air drying of guava powder. Among the models fitted to the experimental data at 45°C, 55°C and 65°C the Logarithmic model was well fitted to the experimental data with $R^2 \geq 0.983$; MSE ≤ 0.892 and chi square (χ^2) ≥ 3.319. Non-Linear regression analysis was done according to the three thin layer models for moisture ratio data.

Table 2(a), 2(b), and 2(c) shows the statistical regression results of the different models, including the drying model coefficients and comparison criteria used to evaluate goodness of the fit including the R^2, and RMSE guava slices temperature. In all cases R^2values for the models were greater than 0.891 indicating model is well fitted. The model parameter i.e. '*a*' = 0.9160, 1.0105 and 1.0242; '*k*' = 0.0107, 0.0091 0.0121 and '*c*' = 0.0286, 0.0120, 0.0113 at 45°C, 55°C and 65°C respectively. The '*a*' value increases with in-crease in temperature from 45°C to 65°C. '*c*' value decreases with increase in temperature from 45°C to 65°C, the '*k*' values does not shows any trend w.r.t temperature.

Table 2: Model parameters, R^2, RMSE and Chi square values of Guava slices dried by Convective hot air drying at 45°C, 55°C, 65°C

Table 2 (a): Convective hot air drying at 45°C temperature

Sl. No.	Model name	Model Parameters	R^2	MSE	χ^2
1	Henderson and Pabis	*a*=0.6183277 *k*=0.0058772	0.891	0.509	27.011
2	Logarithmic	*a*=0.9160277 *k*=0.0107831 *c*=0.028626	0.989	0.192	10.015
3	Exponential two term	*a*=0.348131 *k*=0.019883	0.942	0.454	28.799
4	Simplified Fick's Diffusion(SFFD)	*a*=0.617838 *c*=0.105135 *L*=4.2316877	0.891	0.509	27.011

Table 2 (b): Convective hot air drying at 55°C temperature

Sl. No.	Model name	Model Parameters	R^2	MSE	χ^2
1	Henderson and Pabis	*a*=0.976642 *k*=0.0084542	0.982	0.138	6.666
2	Logarithmic	*a*=1.010576 *k*=0.009182 *c*=0.012033	0.983	0.087	4.124
3	Exponential two term	*a*=0.0379868 *k*=0.2175287	0.974	0.200	9.606
4	Simplified Fick's Diffusion(SFFD)	*a*=0.976644 *c*=0.097898 *L*=3.40290	0.981	0.138	6.666

Table 2 (c): Hot air drying at 65°C temperature

Sl. No.	Model name	Model Parameters	R^2	MSE	χ^2
1	Henderson and Pabis	*a*=0.990284 *k*=0.011297	0.976	0.119	4.776
2	Logarithmic	*a*=1.0242204 *k*=0.012191 *c*=0.011399	0.987	0.0851	3.319
3	Exponential two term	*a*=0.567741 *k*=0.188267	0.938	0.703	28.132
4	Simplified Fick's Diffusion(SFFD)	*a*=0.990296 *c*=0.028532 *L*=1.58889	0.976	0.119	4.776

Effective moisture diffusivity of guava slices dried by convective hot air drying

Fig. 4 shows *Ln* (*MR*) versus time (minute) for convective hot air drying of guava slices dried at 45°C, 55°C and 65°C respectively. The graph shows the straight line curve. The straight line equation $y = mx + c$, where, the m is the slope of line. Effective diffusivity (D_{eff}) at time for guava slices which was calculated by Eq (6). Table 5 shows the effective diffusivity of guava slices dried at 45°C, 55°C and 65°C. The diffusivity values were in the range of 7.606×10^{-9} to 1.698×10^{-8} m^2/s for all the temperature. As the temperature increases the diffusivity value increase from 7.606 $\times10^{-9}$, 1.419×10^{-8} and 1.698×10^{-8} at 45°C, 55°C and 65°C respectively. The effective diffusivity used to explain the mechanism of moisture movement during drying. It was observed that D_{eff} values increase greatly with increase in drying temperature and thickness. When samples are dried at higher temperature, increased heating energy would increase the activity of the water molecules leading to higher moisture diffusivity Xiao *et al*. (2010). The values obtained of effective diffusivity from this study was 7.6068×10^{-9}, 1.4199×10^{-8}, and 1.6989×10^{-8} m^2/s during the drying temperature of 45°C, 55°C and 65°C respectively. The values of obtained from this study lies within the general range of for drying Guava cubes drying was 6.09×10^9 and 10.55×10^{10} m^2/s respectively, reported by Hawlder *et al*. (2013); 4.76×10^{-9} to 8.32×10^{-9} m^2/s for drying apricot at 50°C, 60°C reported by Togrul and Pehlivan, (2004).The results were in agreement with the previous studies that the values of D_{eff} lie within the general range of 10^{-11} to 10^{-8} m^2/s for Olive leaves Erbay and Icier, (2006). Similar results are found to correspond well with those existing in the literature, such as 2.03-1.71 × 10^{-9} m^2/s for drying olive-waste cake in temperature range of 50 and 90°C Vega-Gálvez *et al.* (2010).

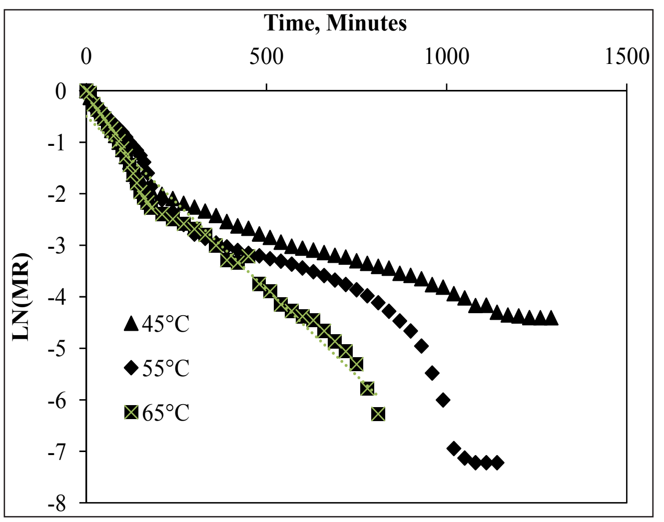

Fig. 4: *Ln*(*MR*) versus time, minute for guava slices at varied temperature

Activation energy for guava slices dried by convective hot air drying

Fig. 5 shows the *Ln* (D_{eff}) vs $1/T_{abs}$ for dried guava slices at 45°C, 55°C, and 65°C. The activation energy was calculated by plotting of *Ln* (D_{eff}) vs. reciprocal of absolute temperature showed straight line in the range of air temperature studied. The activation energy (E_a) for moisture diffusion calculated from the slope of straight lines graphs are given in Table (5) The activation energy for moisture diffusion was found to be 36.077 kJ/mol. These values are similar to reported by other authors for different products 29.75 kJ/mol in apple pomace drying Sun *et al.* (2007); 22.23 kJ/mol in tomato byproducts drying Celma *et al.* (2009) respectively.

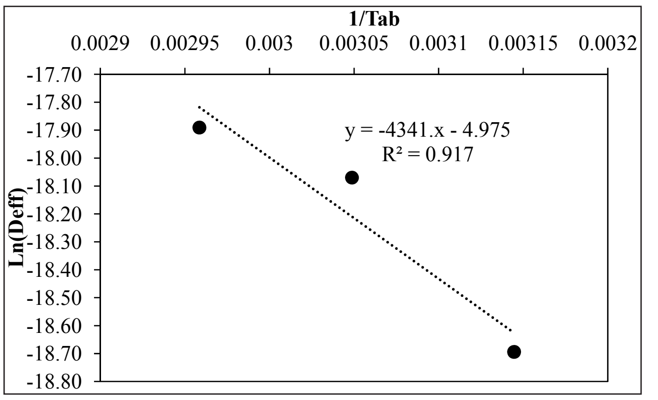

Fig. 5: *Ln* D_{eff} vs $1/T_{abs}$ of guava slices drying by convective hot air drying method

Table 5: Values of effective diffusivity and activation energy of guava slices at different temperature

Temperature	(m^2/s)	Ea (kJ/mole)
45°C	7.606×10^{-9}	
55°C	1.419×10^{-8}	36.077
65°C	1.698×10^{-8}	

The results indicated a linear relationship between (Ln D_{eff}) and ($1/T_{abs}$) as plotted in Fig. 5 for guava slices dried by convective drying at 45°C, 55°C and 65°C. The diffusivity constant or pre-exponential factor of Arrhenius equation (D_o) and activation of energy (E_a) calculated from the linear regression are 6.108 m^2/s and 36.077 kJ/mol for guava powder.

Physico-chemical and Functional Properties of guava pwder:

Table 6 shows the physico-chemical and functional properties of guava powder such as Moisture (%), Protein (%), Fat(%), Ash (%), Water absorption capacity(g/ml), Bulk density (g/cc), Colour (*L**), (*a**), (*b**). For guava slices dried at 45°C, 55°C and 65°C respectively.

1. Moisture (%)

Table 6 (a) shows moisture content of fresh and guava slice dried at 45°C, 55°C and 65°C. Moisture

Table 6: Physico-chemical and functional properties of guava powder

Sl. No.	Parameter	Fresh guava slices	Guava powder			$SE_{\pm at}$	CD at
			45ºC	55°C	65°C	$p \leq 0.05$	$p \leq 0.05$
(a)	Moisture (%)	73.98±0.123	6.532± 0.01	6.414 ±0.01	5.941 ±0.00	0.213	0.060
(b)	Protein (%)	1.42 ±1.253	5.346± 0.00	5.112± 0.09	4.752± 0.00	0.003	0.010
(c)	Fat (%)	0.69 ±0.551	4.534± 0.01	4.173±0.37	4.013 ±0.38	0.762	2.182
(d)	Fibre(%)	6.10 ±0.058	40.700± 0.16	39.346± 0.84	37.563± 0.87	1.737	4.970
(e)	Ash(%)	1.08 ±0.058	5.192 ± 0.09	5.032± 0.09	4.081± 0.01	0.002	0.007
(f)	Carbohydrate (%)	13.55 ±1.087	37.696 **±0.20**	39.923±0.37	43.65±0.38	1.711	4.895
(g)	Water absorption capacity (g/ml)	—	2.621 ±0.13	2.800 ± 0.115	2.428± 0.11	0.299	0.855
(h)	Bulk density (g/cc)		0.567 ±0.00	0.612± 0.01	0.681± 0.09	0.002	0.007
(i)	Colour *L**	89.116	78.455± 0.04	84.151 ± 0.09	80.120± 0.01	0.063	1.802
	*a**	15.859	1.500± 0.01	0.285± 0.02	1.152 ± 0.01	0.047	0.135
	*b**	32.144	39.112± 0.04	40.77 ± 0.006	39.781 ±0.01	0.019	0.055
(J)	Ascorbic acid (mg/g)	39.5	19.573±0.005	19.123±0.082	18.765 ±0.028	1.123	4.005

content for fresh guava slices was 73.98 ± 0.123 and the moisture content varied for guava powder in the range was 5.94 – 6.53% and average was 6.53±0.01, 6.41 ± 0.014, 5.94 ± 0.00 at drying temperature 45°C, 55°C, 65°C respectively. The moisture content of fresh guava slices reported in the literature was 82.6% Rathore (1976), Verma *et al*. (2013) reported that moisture content of guava powder are 6.41% and 15.01% respectively.

2. Protein (%)

Table 6 (b) shows that Protein content of fresh guava slices and guava powder. Protein content for guava slices was 1.421 ± 1.25% and protein content varied for guava powder ranged was 4.75–5.34 % at 45°C, 55°C and 65°C respectively. The protein content was 5.34 ± 0.02 %, 5.11 ± 0.09 %, 4.75 ± 0.09 % at drying temperature 45°C, 55°C and 65°C respectively. The protein content of fresh guava slices reported in the literature was 0.82–1.45% by Das *et al*. (1995); Kandu *et al*. (1995); Gosh and Chattopadhyay, (1996). The highest protein content was observed at 45°C drying temperature of guava powder. The protein content decreases with increase in drying temperature from 45°C to 65°C. The decrease in protein was significant at $p \leq 0.05$. The protein content of guava powder reported in literature was 4-3%, 5.13% reported by Patil *et al.* (2014) and Verma *et al*. (2013) respectively.

3. Fat (%)

Table 6 (c) shows that Fat content of fresh guava slices and guava powder. Fat content for fresh guava was 0.69 ± 0.99 Fat content varied for guava powder 4.013 to 4.534%. The average fat content of guava powder was 4.53 ± 0.00, 4.17 ± 0.37 and 4.01 ± 0.34 at drying temperature 45°C, 55°C and 65°C. Fat content was highest at drying temperature at 45°C of guava powder. The decrease in fat was significant at $p \leq 0.05$. The fat content of fresh guava slices reported in the literature was 0.10 to 0.70% by Das *et al*. (1995); Kandu *et al*. (1995); Gosh and Chattopadhyay (1996). Similar results of fat content of guava powder reported by Patil *et al*. (2014) 1.71 % and by Verma *et al*. (2013) reported 4.32% of fat for guava powder.

4. Fiber (%)

Table 6 (d) shows the (%) fiber content for fresh guava slices and guava powder dried at 45˚C, 55˚C and 65˚C respectively. The fiber content in fresh guava slices was 6.10%. Fiber content of guava powder was 40.70 ± 0.169%, 39.34 ± 0.845% and 37.563 ± 0.87% at 45˚C, 55˚C, 65˚C the fiber content decreases respectively

.As the temperature of drying increases from 45 ˚C to 65 ˚C. Highest fiber content observed at 45˚C of guava powder. The fiber content was significant at $p \leq 0.05$ w.r.t temperature of drying. As the temperature of drying increases from 45˚C to 65˚C fiber content decreases from 40.700 to 37.563%. The fiber content in fresh guava slices reported in the literature was 2.0-7.2% by Das *et al*. (1995); Kandu *et al*. (1995); Gosh and Chattopadhyay, (1996) respectively. The fiber content of dried guava powder reported in the literature was 42.56%, by verma *et al.* (2013).

5. Ash (%)

Table 6 (e) shows that the ash content of fresh guava slices and guava powder. Ash content for fresh guava slices 1.08±0.05%.The ash content varied for guava powder was observed in the range of 4.08 – 5.192 %. The average ash content was 5.192 ± 0.009, 5.032 ± 0.009 and 4.081 ± 0.001% at 45°C, 55°C, and 65°C. Highest ash content was observed in 45°C of guava powder. The ash content decrease with the increase in temperature from 45°C to 65°C. The decrease in ash content was significant at $p \leq 0.05$. The ash content of fresh guava reported in the literature was 0.6% by Tanwar *et al*. (2014). The ash content of guava powder was 1.5 to 3.3% Patil *et al*. (2014).

6. Carbohydrates (%)

Table 6(f) shows that the carbohydrate content of guava powder. The average carbohydrates content was 37.686 ± 0.205, 39.923 ± 0.376 and 63.986 ± 0.917 at 45°C, 55°C and 65°C respectively. Highest carbohydrate content low observed at 65oC of guava powder. The carbohydrates content increasing with increase in temperature from 45°C to 65°C. The increase in carbohydrates was significant at $p \leq 0.05$. The carbohydrate content fresh guava slices was 9.5 to 10 % Morton, (1987).

7. Water absorption capacity (g/ml)

Table 6 (g) shows that the water absorption capacity of guava powder. Water absorption capacity of guava powder ranged was 2.428 –2.621 g/ml and average water absorption capacity of guava powder was 2.62 ± 0.13, 2.80 ± 0.115, 2.42 ± 0.111g/ml at 45°C, 55°C and 65°C drying temperature. The highest water absorption capacity was observed at 55°C drying temperature and lowest water absorption capacity was observed at 65°C drying temperature. The water absorption capacity was significant at $p \leq 0.05$ Shishir *et al*. (2017) reported the water absorption capacity of guava powder was 0.33g/ml.

8. Bulk density (g/cc)

Table 6 (h) shows that the bulk density for guava powder. Bulk density varied for guava powder was in the range of 0.56 ± 0.00, 0.61 ± 0.001 and 0.68 ± 0.09 for 45˚C, 55˚C and 65˚C respectively. Highest bulk density observed at 45˚C of guava powder. Patil *et al*. (2014) reported the 0.78-0.75 g/cc value of guava powder.

9. Colour

Table 6 (i) shows the colour of fresh guava slices '*L*', '*a*' and '*b*' was .89.116, 15.859, 32.144 respectively. '*L*', '*a*' and '*b*' value for guava slices dried at 45, 55 and 65˚C. *L*, *a* and *b*. value for guava powder colour '*L*' values was 78.45 to 80.12 at 45°C, 55°C, 65°C and average was 78.45 ± 0.0043, 84.15 ± 0.009, 80.12 ± 0.001 respectively. The '*L*' values increases with drying air temperature from 45°C to 55°C followed by decreasing trend up to 65°C. The drying air temperature had significant influence of *L* value of colour of guava powder at $p \leq 0.05$. '*a*' value for guava powder 45˚C, 55˚C and 65˚C was in the range of 1.50 to 1.15 '*a*' value was highest at 45°C and lowest at 55°C '*a*' value was 1.50 ± 0.016, 0.285 ± 0.032 and 1.15 ± 0.016 at 45˚C, 55˚C and 65˚C respectively. The '*a*' value had significant influence on temperature of drying of guava slices at $p \leq 0.05$. The *b* value for guava powder at 45˚C, 55˚C and 65˚C was in the range of 39.11 to 40.77 and average was 39.11 ± 0.004, 40.77 ± 0.006 and 39.78 ± 0.010 at 45˚C, 55˚C and 65˚C respectively. The *b* value had significant influence on temperature of drying of guava slices at $p \leq 0.05$. Ali *et al.* (2016) reported the colour values *L, a* and *b* of fresh guava slices was 58.13, 2.43, 21.30 respectively. Ali *et al.* (2016) reported the colour values *L, a* and *b* of dried guava powder was 57.67 to 32.73, 9.97 to -11.03, 29.72 to 20.37 respectively.

10. Ascorbic acid (%)

Table 6 (j) shows that the ascorbic acid for fresh guava slices and guava powder.

The ascorbic acid in fresh guava slices contain 39.5 mg/g Ascorbic acid content varied for Ascorbic acid varied for guava powder was in the range of 19.573 ± 0.005, 19.123 ± 0.082 and 18.765 ± 0.028 for 45˚C, 55˚C and 65˚C respectively. Highest ascorbic acid observed at 45˚C of guava powder. Costa *et al*. (2009) reported the 19.57 % value of guava powder. The degradation of vitamin C is considerably affected from the drying conditions. Degradation of vitamin C is reduced with increasing relative humidity the variation of the retention of vitamin C for various drying air conditions. Similar behaviors were reported for granular edmame, tomato and lemon juice fruits by Erenturk *et al.* (2005), Qing-guo *et al.* (2006), Goula and Adamopoulos (2006) and Al-Zubaidy and Khalil (2007) respectively.

CONCLUSION

Air drying characteristics of guava slices and the physico-chemical and functional characteristics of dried slices have been investigated. The guava slices were dried from average initial moisture content of 346.932% (db) to 8.509% (db) at 45^0C; 371.294 % (db) to 8.179 % (db) at 55^0C; 389.642 to 8.359% (db) at 65^oC. It took around 18, 16, and 13 hrs. time to dry guava slices, dried in convective hot air dryer, at 45, 55 and 65^oC temperature respectively. The effective diffusivity values decreased with increasing drying air temperature, i.e. 2.084×10^{-9}, 1.584×10^{-9}, and 1.148×10^{-9} m^2/s at 45, 55, and 65^oC respectively. The activation energy for moisture diffusion was found to be 9.116 kJ/mol. The Logarithmic model was well fitted to the drying data at 45, 55, 65^oC respectively. The drying of guava slices occurred in the falling rate period. The guava powder obtained at 45^oC had better physico-chemical and functional properties than the samples obtained at other different temperatures selected for the study. Guava powder at 45^oC contains, moisture 6.53 %, protein 5.34 %, and fat 4.53%, fibre 40.70 % carbohydrate 37.69 %, ash 5.19 % .The powder had average of water absorption capacity at 45^oC and 2.1(g/ml)and bulk density 0.567(g/cc).

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

REFERENCES

AOAC, 1990. Official method of analysis, 15th edn. Association of Analytical Chemists, Washington.

AOAC, 2010. Official Methods of Analysis, Association of Official Analytical Chemists.

Adegunwa, M.O., Bakare, H.A. and Akinola, O.F. 2012. Enrichment of noodles with soy flour and carrot powder. *Nigerian Food Journal*, **30**(1): 74-81.

Ali, M.A., Yusof, Y.A., Chin, N.L. and Ibrahim, M.N. 2016. Effect of different drying treatments on colour quality and ascorbic acid concentration of guava fruit. *International Food Research Journal*, **23**.

Al-Zubaidy, M.M. and Khalil, R.A. 2007. Kinetic and prediction studies of ascorbic acid degradation in normal and concentrate local lemon juice during storage. *Food Chemistry*, **101**(1): 254-259.

Anonymous, 2014. Area and Production of Fruits in Punjab. Directorate of Horticulture, Punjab. Chandigarh.

Celma, A.R., Cuadros, F. and Andlópez-Rodríguez, F. 2009. Characterisation of Industrial Tomato by-Products from Infrared Drying Process. *Food and Bioproducts Processing*, **87**(4): 282-291.

Chakraverty, A. 2005. Post-Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Edition, Oxford and Ibh publishing Co. Pvt. Ltd, New Delhi, pp. 54-55.

Chopda, C.A. and Barrett, D.M. 2001. Optimization of Guava Juice and Powder Production, Comparative Study. *Food Chemistry*, **103**: 1003 – 1008.

Costa, J.M., Felipe, É.M., Maia, G.A., Hernandez, F.F. and Brasil, I.M. 2009. Production and Characterization of the Cashew Apple (*Anacardium Occidentale L.)* and Guava (*Psidium Guajava L.*) Fruit Powders. *Journal of Food Processing and Preservation*, **33**: 299-312.

Crank, J. 1975. Mathematics of diffusion, second edition, London: Oxford university press.

Das, B.C., Chakraborty, A., Chakraborty, P.K., Maiti, A., Mandal, S. and Ghosh, S. 1995. Comparative performance of guava cultivars under red and laterite soils of West Bengal. *Journal of Horticulture,* **8**: 141-46.

Demir, K. and Sacilik, K. 2010. Solar Drying of Ayaș Tomato Using a Natural Convection Solar Tunnel Dryer. *Journal of Food, Agriculture and Environment,* **8**(1): 7-12.

Diamante, L.M. and Munro, P.A. 1991. Mathematical Modeling of Hot air Drying of sweet Potato slice. *International Journal of Food Science and Technology,* **26***:* 99-109.

Erbay, Z. and Icier, F. 2009. Optimization of hot air drying of olive leaves using response surface methodology. *Journal of Food Engineering*, **91**(4): 533-541.

Erenturk, S., Gulaboglu, M.S. and Gultekin, S. 2005. The effect of cutting and drying medium on vitamin C content of rosehip during drying. *Journal of Food Engineering,* **68***:* 513–518.

Falade, K.O. and Solademi, O.J. 2010. Modelling of air drying of fresh and blanched sweet potato slices. *International Journal of Food Science and Technology*, **45**(2): 278-288.

Fernandez-Lopez, J., Zhi, N., Aleson-Carbonell, L., Pérez-Alvarez, J.A. and Andkuri, V. 2005. Antioxidant and Antibacterial Activities of Natural Extracts: Application In Beef Meatballs. *Meat Science*, **69**(3): 371-380.

Ghosh, S.N. and Chattapadhyay, N. 1996. Performance of some guava cultivars under rainfed semi-arid region of West Bengal. *Journal of Horticulture,* **9**: 121-27.

Goula, A.M. and Adamopoulos, K.G. 2006. Retention of Ascorbic acid during darying of tomato halves and tomato pulp. *Drying Technology*, **24**(1): 57-64.

Hawlader, M.N., Perera, C.O., Tian, M. and Yeo, K.L. 2006. Drying of guava and papaya: Impact of different drying methods. *Drying Technology*, **24**(1): 77-87.

Henderson, S.M. and Pabis, S. 1961. Grain drying theory. I. Temperature effect on drying coefficient. *Journal of Agricultural Engineering Research,* **6**: 169-174.

India Stat, 2016. http://www.indiastat.com DOA16/7/2018.

Inchuen, S., Narkrugsa, W. and Pornchaloempong, P. 2010. Effect of drying methods on chemical composition, color and antioxidant properties of Thai red curry powder. *Kasetsart J. (Nat. Sci.)*, **44**: 142-151.

Jiménez-Escrig, A., Rincón, M., Pulido, R. and Saura-Calixto, F. 2001. Guava fruit (*Psidium guajava L.*) as a new source of antioxidant dietary fiber. *Journal of Agricultural and Food Chemistry*, **49**(11): 5489-5493.

Kondo, S., Kittikorn, M. and Kanlayanarat, S. 2005. Pre-harvest Antioxidant Activities of Tropical Fruit and The Effect of Low Temperature Storage on Antioxidants and Jasmonates. *Post harvest Biology and Technology*, **36:** 309 – 318.

Kumar, A. 2012. Importance for life (*Psidium guajava). Int. J. Res. Pharm. Biomed. Sci*., **7**: 316 -24.

Kundu, S. Ghosh, S.N. and Mitra, S.K. 1995. Physico-chemical characters of twelve guava cultivars in the laterite tract of West Bengal. *Indian Food Packer,* **49**: 11.

Kshetrimayum, R., Shukla R.N. and Mishra, A. 2015. Study on Quality characteristics of Tray and Microwave dried Guava slices. *International Journal of Science, Engineering and Technology,* **3**(4): 965-969.

Latapi, G. and Barrett, D.M. 2006. Influence of Pre-drying Treatments on Quality and Safety of Sun-dried Tomatoes. Part I: Use of Steam Blanching, Boiling Brine Blanching, and Dips in Salt or Sodium Metabisulfite. *Journal of Food Science*, **71**(1): S24-S31.

Leite, K.M., Tadiotti, A.C., Baldochi, D. and Oliveira, O.M. 2006. Partial purification, heat stability and kinetic characterization of the pectin methylesterase from Brazilian guava, Paluma cultivars*. Food Chemistry*, **94**(4): 565-572.

Lopez, A., Iguaz, A., Esnoz, A. and Virseda, P. 2000. Thin Layer Drying Behavior of Vegetable Waste from Whole Sale, Market. *Drying Technology,* **18**(4 and 5): 995-1006.

Mandge, H.M., Sharma, S. and Dar, B.N. 2014. Instant multigrain Porridge; Effect of Cooking Treatment on Physico chemical and Functional Properties. *Journal of Food Science and Technology,* **51**(1): 97-103.

Maskan, A., Kaya, S. and Maskan, M. 2002. Hot air and sun drying of grape leather (pestil). *Journal of Food Engineering,* **54**: 81–88.

Mudgal, V.D. and Pandey, V.K. 2007. Dehydration Characteristics of Cauliflower. *International Journal of Food Engineering,* **3**(6): DOA 23/3/2017.

Patil, V., Chauhan, A.K. and Singh, R.P. 2014. Optimization of the spray-drying process for developing guava powder using response surface methodology. *Powder Technology*, **253**: 230-236.

Pommer, C.V. and Murakami, K.R. 2009. Breeding guava (*Psidium guajava L.*). In *Breeding Plantation Tree Crops: Tropical Species* (pp. 83-120). Springer, New York, NY.

Qing-Guo, H., Min, Z., Mujumdar, A.S., Wei-hua, D. and Jin-cai, S. 2006. Effects of different drying methods on the quality changes of granular edamame. *Drying Technology,* **24**(8): 1025-1032.

Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata Mcgraw-Hill Education.

Rathore, D.S. 1976. Effect of season on the growth and chemical composition of guava fruits. *Journal of Horticulture Science*, **51**: 41-47.

Roberts, S. 2008. Transform your data. *Nutrition*, **24**(5): 492.

Sehgal S. 1999. Indian Economic Data. Shivam OffsetPress, Naraina, New Delhi.

Sharaf-Elden, Y.I., Blaisdell, J.L. and Hamdy, M.Y. 1980. A model of ear corn drying. *Transactions of the ASAE*, **5**: 1261–1265.

Shishir, M.R., Taip, F.S., Aziz, N.A., Talib, R.A. and Sarker, M.S. 2016. Optimization of spray drying parameters for pink guava powder using RSM. *Food Science and Biotechnology*, **25**(2): 461-468.

Sonawane, S.K. and Arya, S.S. 2015. Effect of drying and storage on bioactive components of jambhul and wood apple. *Journal of Food Science and Technology*, **52**(5): 2833-2841.

Sosulski, F.W., Garratt, M.D. and Slinkard, A.E. 1976. Functional Properties of Ten Legume Flours. Canadian Institute of *Food Technology Journal*, **9**: 66-69.

Suarez, C.,Viollaz, P. and Chirife, J. 1980. Diffusional analysis of air drying of grain sorghum. *International Journal of Food Science and Technology*, **15**(5): 523-531.

Sun, T. and Tanumihardjo, S.A. 2007. An integrated approach to evaluate food antioxidant capacity. *Journal of Food Science*, **72**(9): R159-R165.

Tanwar, B. Andallu, B. and Chandel, S. 2014. Influence of processing on physicochemical and nutritional composition of *Psidium guajava L.*(guava) products. *International Journal of Agriculture Food Science Technology*, **5**: 47-54.

Torgul, I.T. and Pehlivan, D. 2002. Mathematical modelling of solar drying of Apricots. *Journal of Food Engineering*, **55**(3): 209-21.

USDA, 2010. National Nutrient Database for Standard Reference. The Nutrient Data Laboratory, United States Department of Agriculture. DOA 5/4/2018.

Vega-Gálvez, A., Miranda, M., Díaz, L.P., Lopez, L., Rodriguez, K. and Di Scala, K. 2010. Effective Moisture Diffusivity Determination and Mathematical Modelling of the Drying Curves of the Olive-Waste Cake. *Bioresource Technology*, **101**(19): 7265-7270.

Verma, A.K., Rajkumar, V., Banerjee, R., Biswas, S. and Das, A.K. 2013. Guava (*Psidium guajava L.*) powder as an antioxidant dietary fibre in sheep meat nuggets. *Asian-Australasian Journal of Animal Sciences*, **26**(6): 886.

Wang, Z., Sun, J., Liao, X., Chen, F., Zhao, G., Wu, J. and Hu, X. 2007. Mathematical Modeling on Hot Air Drying of Thin Layer Apple pomace. *Food Research International*, **40**(1): 39-46.

Xiao, H., GAO, Z., Lin, H. and Yang, W. 2010. Air impingement drying characteristics and quality of carrot cubes. *Journal of Food Process Engineering*, ***33***(5); 899-918.

Zogzas, N.P., Maroulis, Z.B. and Marinos-Kouris, D. 1996. Moisture diffusivity data compilation in foodstuffs. *Drying technology*, **14**(10): 2225-2253.