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MODELING OF THREE TOMATO VARIETIES UNDER MICROWAVE DRYING

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ABSTRACT

: Drying experiments of thin layer tomato samples were carried out by using microwave drying. The drying experiments were carried out at 120, 250, 420 and 520 W of microwave power.. The drying rates increased with the increasing microwave power levels. There was a reduction in moisture content with increased drying time and microwave power while drying took place in the falling rate period. Dying processes were completed between 20 and 180 min for tomato samples depending on the microwave power level. All the three and four parameter models predicted well the drying characteristics of all varieties of tomato studied with R^2 values greater than 0.99. The Demir and Midilii models were the best models selected based on R^2, RMSE and Chi square values.

Keywords: *Microwave drying, Modeling, Tomato, Diffusivity, Energy utilization*

INTRODUCTION

Drying technique is one of the oldest and most important methods of food preservation practiced by humans. The removal of moisture prevents the growth and reproduction of microorganisms which cause decay, and minimizes many of the moisture-mediated deteriorative reactions. Drying methods include sun drying, solar drying, oven hot air drying, foam mat, cabinet drying and more recently the infrared and microwave drying methods. Artificial drying is one of the most common drying techniques employed in food processing. The advantages of this technique are uniform drying and better quality of the dried product (Parakash *et al.,* 2004).

Tomato is one of the widely grown and consumed vegetables throughout the world. It is an important source of minerals, iron, phosphorus, organic acid, essential amino acids, dietary fibers, beta-carotene pigments, antioxidants such as lycopene, phenolics, and vitamins (A and C) and has been linked with reduced risk of prostate cancer and heart diseases (Abushita *et al.,* 1997; Clinton, 1998). Rajkumar *et al.*(2007) reported that sun drying has been used for many years for drying tomato slices, the quality of tomato slices may be seriously affected due to long drying times, which may further have adverse effect on the product quality as the final product may be contaminated with dirt and microbes leading to enzymatic and microbial activity. The resulting loss of food quality in the dried products may have adverse economic effects on tomatoes domestic and international markets (Lahsasni *et al.,* 2004). According to Demir and Sacilik (2010) using this method, a more uniform, hygienic and attractively coloured dried product can be produced rapidly. However, it is an energy consuming operation and low-energy efficiency, so more emphasis is on the efficient utilization of energy in drying crops (Demir and Sacilik , 2010).

In order to make tomatoes last longer after harvesting, preservation method is needed to drying tomatoes while retaining flavor. Dried tomatoes are usually consumed in Nigeria, USA, and Greece as processed food and sweetmeat which packed with nutrients that deliver health benefits. The drying process requires heat to decrease the moisture content from a tomato. Normally, drying process is conducted by exposing tomato to the sun. On the other hand, artificial drying is done by using engineered equipment.

Drying is defined as a process of moisture removal due to simultaneous heat and mass transfer. The moisture can be either transported to the surface of the product and then evaporated or evaporated internally at a liquid vapour interface then transported as vapour to the surface (Gogus, 1994). In microwave drying, drying time is shortened due to quick absorption of energy by water molecules, causes rapid evaporation of water, resulting in high drying rates of the food. The aim of this study was to investigate the influence of microwave output power on drying kinetics, fit resulting data to available models and consequently determine the best model describing the drying characteristic of three varieties of tomato.

MATERIALS AND METHODS

Sample preparation

Tomatoes varieties would beere procured from local vegetable markets in Oyo and Ogun states. The varieties were identified as UC-82B, Yoruba-Kerewa and a hybrid variety identified as EVA-F1 which was procured from the University Green House. Tomatoes that appeared damaged were removed by hand picking, manually sorted into sizes and graded visually into red, orange and green colours. Only clean, equal sized red and orange tomatoes were used as samples, packed into nine places of equal quantities and stored at 5 ± 0.5°C before use in any experimental run. Prior to commencement of experiment required pack was brought out and allowed to thaw before use. The tomatoe were then cut into slices of approximately 10 ± 0.1 mm thick using a sharp stainless steel knife. The direction of cut was perpendicular to the vertical axis of the tomato while a micrometre was used to check the thickness and uniformity of each slice at three different locations. About 50 to 60 g of tomatoe slices ranging from 2 to 4 cm in diameter was carefully arranged as a single layer on a sample tray for use in the drying experiment. The initial moisture content of the tomatoe slices, expressed in g water /g dry matter was determined using gravimetric method by oven drying at 105 ± 2^{o}C until there was no appreciable weight change (Aghbashlo, *et al.,* 2009; Darvishi *et al.,* 2013) and ranges between 987.4 and 1124.5% d.b

Pre-treatment

All tomatoes varieties were divided into two batches; one batch was blanched in water at 85^{o}C for three minutes and drained for five minutes. This was regarded as blanched samples while the other batch was used fresh without any pre-treatment and was referred to as raw or unblanched samples.

Equipment Setup and Drying Procedure

Microwave Drying

The drying setup consisted of a domestic microwave oven (Mikrowelle Model D70D 17R, Mikrowelle

Company, Germany) with a cavity of 29 cm x 25 cm x 18 cm and a rotating glass plate. It operates at 2450 MHz and a maximum power of 700 W. Drying experiments were carried out with four power levels of 120, 250, 420 and 520 W corresponding to four(P1, P2, P3 & P4) of the five power settings on the microwave control panel. Three microwave compatible plastic trays (10 cm in diameter and 1 cm deep) containing between 35 and 45 g of sample each were arranged on the rotating tray to allow good absorption of the microwave energy. The temperature in the microwave cabinet was intermittently measured with a thermometer through a slot provided at the top of the cabinet. The change in mass during the microwave drying was recorded by removing the sample and weighing it with a digital balance (Model PE1600, Mettler Instruments Corporation, Zurich, Switzerland) with a resolution of ± 0.01g at 2 min intervals of drying time until there was no appreciable change in weight for three consecutive readings.

All experiments were carried out in triplicates for both blanched and unblanched samples and the mean value was used for analysis.

Moisture Ratio

The changes of moisture content of agricultural products during the drying process was correlated to the drying parameters for the development of thin layer drying models, where the dimensionless Moisture Ratio (MR) usually obtained using Equation (1) as used by several researcher(Akpinar, 2006; Sobukola *et al.,* 2007; Dairo *et al.,* 2015)

$$MR = \frac{M_t - M_e}{M_0 - M_e} \quad \text{.....1}$$

where, MR is the moisture ratio, Mt is the moisture content at a specific time (g water per g dry matter), M_0 is the initial moisture content (g water per g dry matter) and Meis the equilibrium moisture content (g water per g dry matter).

Drying Rate

The drying rate, DR, is expressed as the amount of the evaporated moisture over time. The drying rates of tomatoe slices for all varieties and drying methods were calculated by using Equation 2 as commonly used by several researchers (Akpinar *et al.,* 2003)

$$DR = \frac{M_{t+\Delta t} - M_t}{\Delta t} \quad \text{.....2}$$

where M_t and $Mt+\Delta t_a$ are the moisture contents at time t and time t $+\Delta t$ respectively in g H_2O/g dry matter and time in minutes.

Mathematical Model

The drying data obtained was fitted to commonly used thin-layer drying models presented in Table 1 using a nonlinear least squares regression analysis of Data Fit curve fitting software. Indices of fitness or suitability of models were values of Coefficient of Determination (R^2), reduced chi-square (x^2) and Root Mean Square Error (RMSE).

Table 1. Thin layer models Selected for drying of tomato slices

S/N	Model Name	Equation	Number of Parameters
1	Page	MR = Exp (–kt^n)	2
2	Demir	MR = AExp(-kt)^n + C	4
3	Wang and Singh	MR=1+At+bt	4
4	Diffusion	MR = AExp(-kt) + (1 - A)Exp(-kbt)	3
5	Henderson and Pabis	MR=A exp(-kt)	2
6	Midilli et al.,	MR_= Aexp(-kt^n) +bt	4
7	Modified page	MR=exp[-(kt)^n]	2
8	Newton	MR = Exp(-kt)	1

$$R^2 = 1 - \frac{\sum_{i=1}^{N}(MR_{pre,i} - MR_{exp,i})^2}{\sum_{i=1}^{N}(\overline{MR_{pre,i}} - MR_{exp,i})^2}$$

$$\chi^2 = \frac{\sum_{i=1}^{N}(MR_{pre,i} - MR_{exp,i})^2}{N - |z}$$

$$RMSE = \left(\frac{\sum_{i=1}^{N}(MR_{pre,i} - MR_{exp,i})^2}{N}\right)^{\frac{1}{2}}$$

RESULTS AND DISCUSSIONS

Microwave Drying

The drying curve obtained from the experimental data for microwave drying of Eva_F1, Yoruba and UC-82B varieties are presented in Figures 1, 2 and 3 respectively for both blanched and unblanched samples. It was observed that increase in microwave heating power led to a reduction in drying time of the tomatoe slices. The shows that mass transfer within the sample was more rapid during higher microwave power heating because more heat was generated within the sample, resulting in a substantial difference in the vapour pressure between the centre and the surface of the product due to the characteristic microwave volumetric heating (Darvishi *et al.,* 2012). All drying occurred in the falling rate period. There was no constant rate drying period and this may be due to thin layer of the crop which did not provide a constant supply of water for the applied period of time (Darvishi and Hazbavi, 2012.). The Uc-82B varieties had the shortest drying times at all levels of microwave drying power in comparison to other varieties. This is also evident in the drying curves

presented in Figures 4 to 9. Decreased drying time with increase in microwave output power have been reported by Harish *et al.,* (2014) for microwave drying of elephant foot yam, Soysal (2004) for parsley, Derya and Mehmet (2010), Sorour and El-Mesery (2014), and Dairo *et al.,* (2017) for drying of onions.

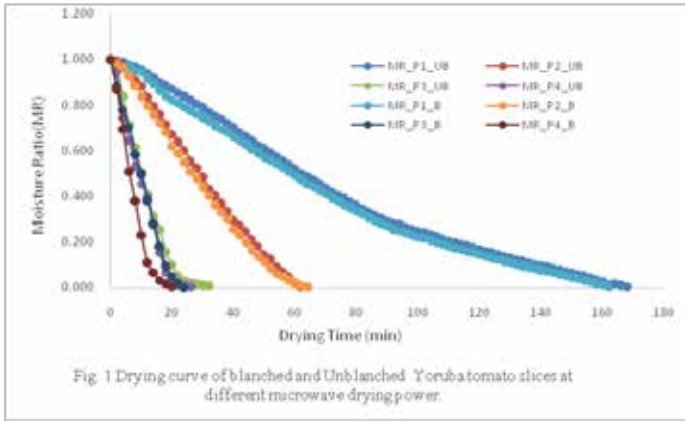

Fig. 1 Drying curve of blanched and Unblanched Yoruba tomato slices at different microwave drying power.

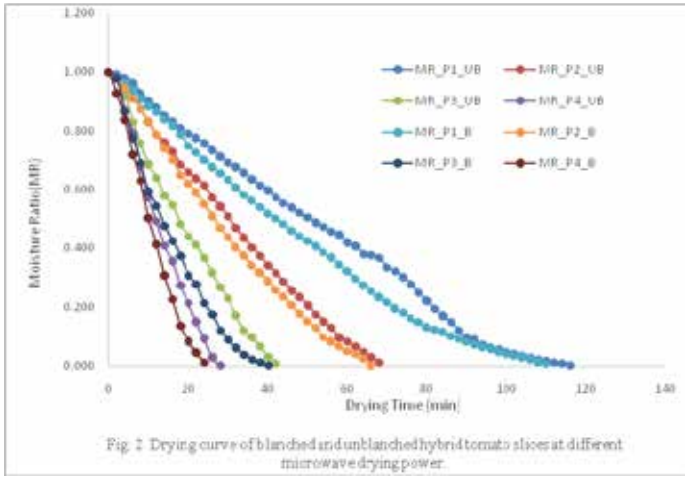

Fig. 2 Drying curve of blanched and unblanched hybrid tomato slices at different microwave drying power.

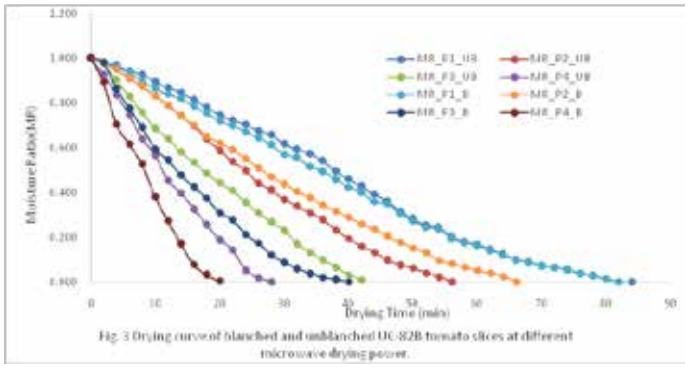

Fig. 3 Drying curve of blanched and unblanched UC-82B tomato slices at different microwave drying power.

Drying rate decreased with time for all varieties and this could be due to decrease in rate of migration of surface water to air of evaporation (karathanos and belessiotis, 1997). According to Darvishi *et al.,* (2012) the high moisture content of the material during the initial phase of the drying resulted in higher absorption of microwave power and higher drying rates due to the higher moisture diffusion. As drying progressed, the loss of moisture in the product causing a decrease in the absorption of microwave power and resulted in a fall in the drying rate (Fig. 4). There was a visual difference in the drying rate at all the microwave power (P1, P2, P3& P4) studied as shown in Fig. 4. The higher drying rates experienced in microwave drying could also be due to more heating energy which speeds up the movement of water molecules and results in higher moisture diffusivity.

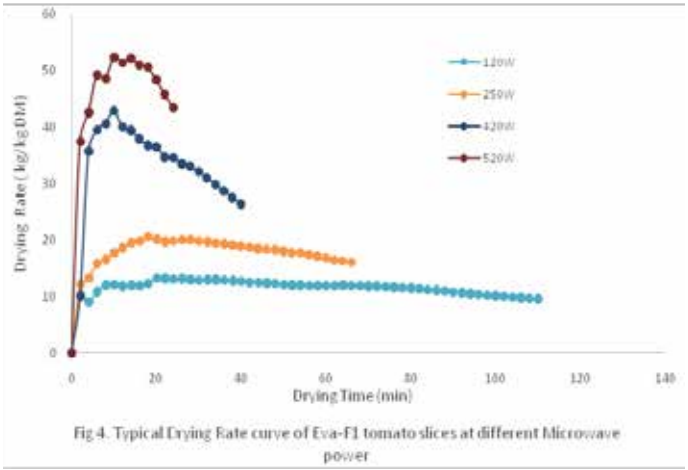

Fig 4. Typical Drying Rate curve of Eva-F1 tomato slices at different Microwave power

Fig 4. Typical Drying Rate curve of Eva-F1 tomato slices at different Microwave power

THIN LAYER MODELING

The data obtained from the thin layer drying of three varieties of tomato dried at four microwave power levels was fitted to the selected eight models earlier described in Table 1. The goodness of fit in terms of R^2, RMSE and x^2 for the selected models are presented in Tables 2, 3 and 4 for UC-82B, Eva-F1 and Yoruba varieties of tomato respectively. The Demir and Midilli *et al.,* year??? models generally had the highest values of R^2 and the lowest values of RMSE and x^2 as evident in Tables 2 to 4. It was observed that all the models selected had the coefficient of determination values greater than 0.95 with the exception of the Newton model which had lower values in some cases. This observation shows that any of the models could adequately describe the drying curves of all the tomato varieties under microwave drying, however the Demir model could be considered as the best model

Table 2 . Drying Model Parameters for Unblanched and Blanched UC-82B tomato slices at Various Microwave Power.

		Unblanched			Blanched		
Power	**Model**	**R^2**	**RMSE**	**x^2**	**R^2**	**RMSE**	**x^2**
P1(120W)	Demir	0.9981355	0.0081905	0.0000692	0.9988977	0.0060051	0.0000372
	Diffusion	0.9822291	0.0252861	0.0006494	0.9867381	0.0208296	0.0004441
	Henderson &Pabis	0.9348106	0.0484301	0.0023821	0.9492791	0.0407353	0.0016853
	Midilli *et al*	0.9981602	0.0081361	0.0000683	0.9988844	0.0060414	0.0000377
	Modified Page	0.9934888	0.0153059	0.0002379	0.9935217	0.0145582	0.0002153
	Newton	0.9041056	0.0587386	0.0034770	0.9257529	0.0492853	0.0024479
	Page	0.9934888	0.0153059	0.0002379	0.9935217	0.0145582	0.0002153
	Wang & Singh	0.9887830	0.0200894	0.0004131	0.9944351	0.0134930	0.0001849
P2(250W)	Demir	0.9995357	0.0039551	0.0000164	0.9997373	0.0031147	0.0000102
	Diffusion	0.9903256	0.0180549	0.0003334	0.9918533	0.0173452	0.0003112
	Henderson &Pabis	0.9503010	0.0409220	0.0017127	0.9637721	0.0365773	0.0013683
	Midilli *et al*	0.9995364	0.0039524	0.0000163	0.9997331	0.0031395	0.0000103
	Modified Page	0.9959391	0.0116976	0.0001399	0.9949802	0.0136155	0.0001896
	Newton	0.9233023	0.0508364	0.0026134	0.9438507	0.0455368	0.0020969
	Page	0.9959391	0.0116976	0.0001399	0.9949802	0.0136155	0.0001896
	Wang & Singh	0.9931183	0.0152275	0.0002399	0.9972947	0.0099954	0.0001022
P3 (420W)	Demir	0.9988404	0.0060300	0.0000387	0.9981052	0.0079109	0.0000666
	Diffusion	0.9872446	0.0199994	0.0004125	0.9924920	0.0157473	0.0002598
	Henderson &Pabis	0.9646171	0.0333094	0.0011442	0.9729805	0.0298734	0.0009203
	Midilli *et al*	0.9988803	0.0059253	0.0000374	0.9980571	0.0080106	0.0000683
	Modified Page	0.9896248	0.0180372	0.0003408	0.9942174	0.0138200	0.0001970
	Newton	0.9502164	0.0395106	0.0015851	0.9591098	0.0367498	0.0013713
	Page	0.9896248	0.0180372	0.0003355	0.9942174	0.0138200	0.0001970
	Wang & Singh	0.9984146	0.0070509	0.0000513	0.9965637	0.0106535	0.0001170
P4(520W)	Demir	0.9988787	0.0062706	0.0000432	0.9959330	0.0104854	0.0001207
	Diffusion	0.9876985	0.0207697	0.0004514	0.9944375	0.0122626	0.0001574
	Henderson &Pabis	0.9556286	0.0394461	0.0016284	0.9530819	0.0356139	0.0013273
	Midilli *et al*	0.9988661	0.0063057	0.0000436	0.9958039	0.0106505	0.0001245
	Modified Page	0.9917128	0.0170473	0.0003114	0.9879622	0.0180394	0.0003487
	Newton	0.9411425	0.0454311	0.0021109	0.9430214	0.0392469	0.0015753
	Page	0.9917128	0.0170473	0.0003041	0.9879622	0.0180394	0.0003406
	Wang & Singh	0.9973720	0.0095998	0.0000964	0.9951197	0.0114861	0.0001381

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Table 3 . Drying Model Parameters for Unblanched and Blanched Eva-F1 tomato slices at Various Microwave Power.

		Unblanched			Blanched		
Microwave Power	**Model**	**R^2**	**RMSE**	**x^2**	**R^2**	**RMSE**	**x^2**
P1(120W)	Demir	0.9957318	0.0117544	0.0001413	0.9988377	0.0058873	0.0000354
	Diffusion	0.9739789	0.0290227	0.0008518	0.9906339	0.0167120	0.0002840
	Henderson &Pabis	0.9405083	0.0438838	0.0019474	0.9652073	0.0322100	0.0010491
	Midilli et al	0.9956671	0.0118430	0.0001434	0.9987666	0.0060646	0.0000376
	Modified Page	0.9813655	0.0245603	0.0006134	0.9936722	0.0137364	0.0001908
	Newton	0.9193432	0.0510971	0.0026255	0.9482076	0.0392989	0.0015530
	Page	0.9813655	0.0245603	0.0006100	0.9936722	0.0137364	0.0001908
	Wang & Singh	0.9952610	0.0123857	0.0001551	0.9973605	0.0088717	0.0000796

Table 3 . Drying Model Parameters for Unblanched and Blanched Eva-F1 tomato slices at Various Microwave Power. ***-continued***

		Unblanched			Blanched		
Microwave Power	**Model**	**R^2**	**RMSE**	**x^2**	**R^2**	**RMSE**	**x^2**
P2(250W)	Demir	0.9993686	0.0042287	0.0000185	0.9997373	0.0027555	0.0000079
	Diffusion	0.9860038	0.0199096	0.0004034	0.9918557	0.0153422	0.0002417
	Henderson &Pabis	0.9555447	0.0354829	0.0012813	0.9637721	0.0323582	0.0010656
	Midilli et al	0.9993421	0.0043164	0.0000193	0.9997331	0.0027773	0.0000080
	Modified Page	0.9904738	0.0164254	0.0002770	0.9949802	0.0120449	0.0001476
	Newton	0.9371196	0.0422003	0.0017965	0.9438507	0.0402842	0.0016371
	Page	0.9904738	0.0164254	0.0002746	0.9949802	0.0120449	0.0001476
	Wang & Singh	0.9986868	0.0060984	0.0000378	0.9972947	0.0088424	0.0000796
P3(420W)	Demir	0.9977573	0.0084516	0.0000760	0.9981052	0.0079109	0.0000666
	Diffusion	0.9857560	0.0212997	0.0004679	0.9924919	0.0157475	0.0002598
	Henderson &Pabis	0.9627938	0.0344242	0.0012221	0.9729805	0.0298734	0.0009203
	Midilli et al	0.9978027	0.0083657	0.0000745	0.9980571	0.0080106	0.0000683
	Modified Page	0.9884205	0.0192044	0.0003864	0.9942174	0.0138200	0.0001970
	Newton	0.9465487	0.0412606	0.0017286	0.9591098	0.0367498	0.0013713
	Page	0.9884205	0.0192044	0.0003803	0.9942174	0.0138200	0.0001970
	Wang & Singh	0.9970550	0.0096849	0.0000967	0.9965637	0.0106535	0.0001170
P4(520W)	Demir	0.9986816	0.0069274	0.0000527	0.9992579	0.0048906	0.0000263
	Diffusion	0.9902514	0.0188373	0.0003713	0.9897936	0.0181375	0.0003525
	Henderson &Pabis	0.9515260	0.0420050	0.0018465	0.9471157	0.0412861	0.0017838
	Midilli et al	0.9986880	0.0069106	0.0000524	0.9992407	0.0049470	0.0000269
	Modified Page	0.9941865	0.0145468	0.0002215	0.9959939	0.0113632	0.0001351
	Newton	0.9282724	0.0510964	0.0026702	0.9287114	0.0479348	0.0023500
	Page	0.9941865	0.0145468	0.0002215	0.9959939	0.0113632	0.0001351
	Wang & Singh	0.9932434	0.0156824	0.0002635	0.9926127	0.0154307	0.0002492

Table 4 . Drying Model Parameters for Unblanched and Blanched Yoruba tomato slices at Various Microwave Power.

		Unblanched			Blanched		
Microwave Power	**Model**	**R^2**	**RMSE**	**x^2**	**R^2**	**RMSE**	**x^2**
P1(120W)	Demir	0.9993604	0.0045530	0.0000211	0.9993582	0.0043502	0.0000192
	Diffusion	0.9972281	0.0094785	0.0000909	0.9964922	0.0101698	0.0001047
	Henderson &Pabis	0.9728837	0.0296458	0.0008858	0.9767281	0.0261945	0.0006916
	Midilli et al	0.9993944	0.0044303	0.0000199	0.9993666	0.0043215	0.0000190
	Modified Page	0.9986102	0.0067116	0.0000454	0.9976612	0.0083041	0.0000695
	Newton	0.9487257	0.0407660	0.0016684	0.9605166	0.0341194	0.0011687
	Page	0.9986102	0.0067116	0.0000454	0.9976612	0.0083041	0.0000695
	Wang & Singh	0.9929415	0.0151253	0.0002306	0.9970515	0.0093238	0.0000876
P2(250W)	Demir	0.9997571	0.0028990	0.0000088	0.9994179	0.0046170	0.0000222
	Diffusion	0.9882176	0.0201891	0.0004207	0.9887118	0.0203323	0.0004267
	Henderson &Pabis	0.9437894	0.0440971	0.0019859	0.9510706	0.0423311	0.0018300
	Midilli et al	0.9997399	0.0029998	0.0000094	0.9993799	0.0047654	0.0000237
	Modified Page	0.9953075	0.0127410	0.0001658	0.9947739	0.0138345	0.0001955
	Newton	0.9092474	0.0560313	0.0031726	0.9240593	0.0527365	0.0028104
	Page	0.9953075	0.0127410	0.0001658	0.9947739	0.0138345	0.0001955
	Wang & Singh	0.9930520	0.0155035	0.0002455	0.9935149	0.0154111	0.0002426

Table 4 . Drying Model Parameters for Unblanched and Blanched Yoruba tomato slices at Various Microwave Power. ***-continued***

		Unblanched			**Blanched**		
Microwave Power	**Model**	**R^2**	**RMSE**	**x^2**	**R^2**	**RMSE**	**x^2**
P3(420W)	Demir	0.9984331	0.0078700	0.0000672	0.9964683	0.0100127	0.0001088
	Diffusion	0.9942999	0.0150105	0.0002394	0.9819448	0.0226392	0.0005446
	Henderson &Pabis	0.9603630	0.0395826	0.0016307	0.9450020	0.0395124	0.0016250
	Midilli et al	0.9983625	0.0080452	0.0000702	0.9963960	0.0101147	0.0001110
	Modified Page	0.9978068	0.0093108	0.0000902	0.9889426	0.0177169	0.0003267
	Newton	0.9427243	0.0475816	0.0023093	0.9332776	0.0435207	0.0019319
	Page	0.9978068	0.0093108	0.0000902	0.9889426	0.0177169	0.0003267
	Wang & Singh	0.9885335	0.0212897	0.0004718	0.9938443	0.0132190	0.0001819
P4(520W)	Demir	0.9910435	0.0186501	0.0003844	0.9987416	0.0062989	0.0000439
	Diffusion	0.9819536	0.0264732	0.0007547	0.9955199	0.0118850	0.0001521
	Henderson &Pabis	0.9532689	0.0426005	0.0019055	0.9635699	0.0338911	0.0012060
	Midilli et al	0.9907732	0.0189294	0.0003960	0.9987004	0.0064011	0.0000453
	Modified Page	0.9861935	0.0231555	0.0005630	0.9982218	0.0074877	0.0000589
	Newton	0.9404242	0.0481001	0.0023701	0.9535217	0.0382808	0.0015012
	Page	0.9861935	0.0231555	0.0005630	0.9982218	0.0074877	0.0000589
	Wang & Singh	0.9886194	0.0210230	0.0004641	0.9920573	0.0158249	0.0002629

Table 5 presents the values for the model parameters for Demir model which was chosen as the best of all the models tested. It was found that the drying constant k increased as the microwave power increased from 120 to 520W while parameter n appears to be within some undetermined range for all the microwave power used

Table 5. Demir Model Parameters For UC-82B, Eva-F1 and Yoruba unblanched and blanched Tomato Slices At Different Microwave Drying Power

UTC								
	Unblanched				Blanched			
Microwave Power	A	C	k	n	A	C	k	n
P1(120W)	1.096144	-0.12306	0.019477	1.693481	1.167414	-0.18732	0.018717	1.457924
P2(250W)	1.183943	-0.18562	0.027371	1.443787	1.265417	-0.26066	0.021859	1.244266
P3(420W)	1.810576	-0.34581	0.046973	1.219359	1.165573	-0.14916	0.047630	1.188856
P4(520W)	1.34652	-0.79414	0.059611	1.024048	1.306493	-0.31016	0.069872	1.216382
			Eva-F1					
P1(120W)	1.925334	-0.92703	0.00692	1.13546	1.18610	-0.19598	0.01470	1.27056
P2(250W)	1.657533	-0.65808	0.01373	1.152221	1.26542	-0.26066	0.02186	1.24427
P3(420W)	1.834199	-0.81268	0.01943	1.026871	1.16557	-0.14916	0.04763	1.18886
P4(520W)	1.281762	-0.26559	0.05020	1.323808	1.13097	-0.13925	0.06798	1.49677
			Yoruba					
P1(120W)	1.069715	-0.064290	0.011592	1.388547	1.086521	-0.092078	0.011685	1.294255
P2(250W)	1.323286	-0.312960	0.020771	1.417800	1.204634	-0.203454	0.024292	1.403777
P3(420W)	1.019009	-0.024048	0.077285	1.592789	1.162759	-0.187851	0.067126	1.413626
P4(520W)	1.115761	-0.117233	0.077583	1.346273	1.012149	-0.020473	0.125148	1.552383

A typical plot of the experimental data and values predicted by Demir model for Eva-F1, Yoruba and UC-82B varieties are presented in Figs. 4 , 5 and 6 for blanched and Fig. 7, 8 and 9 for unblanched tomatoe slices at all microwave power levels used in the study.

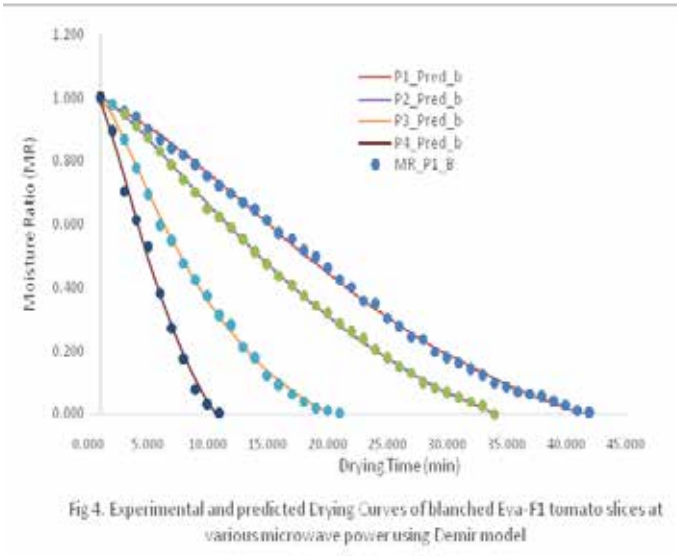

Fig 4. Experimental and predicted Drying Curves of blanched Eva-F1 tomato slices at various microwave power using Demir model

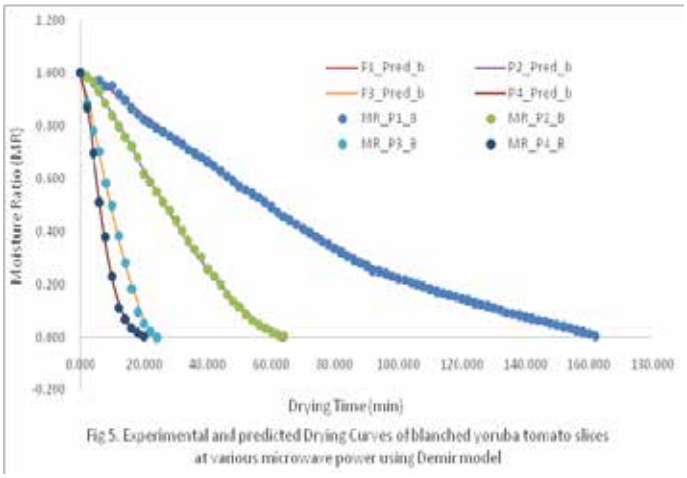

Fig 5. Experimental and predicted Drying Curves of blanched yoruba tomato slices at various microwave power using Demir model

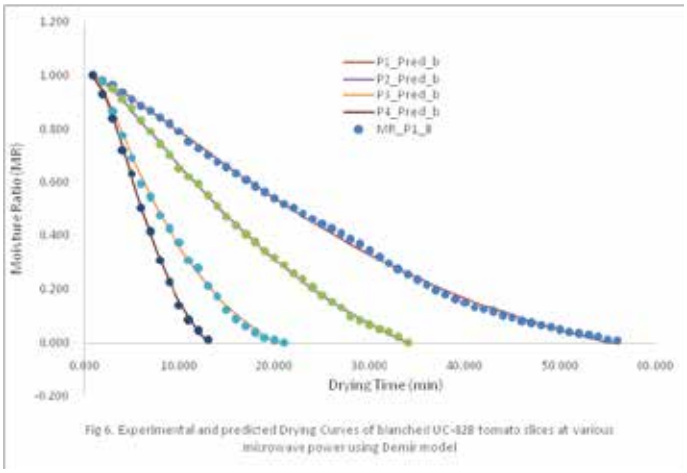

Fig 6. Experimental and predicted Drying Curves of blanched UC-82B tomato slices at various microwave power using Demir model

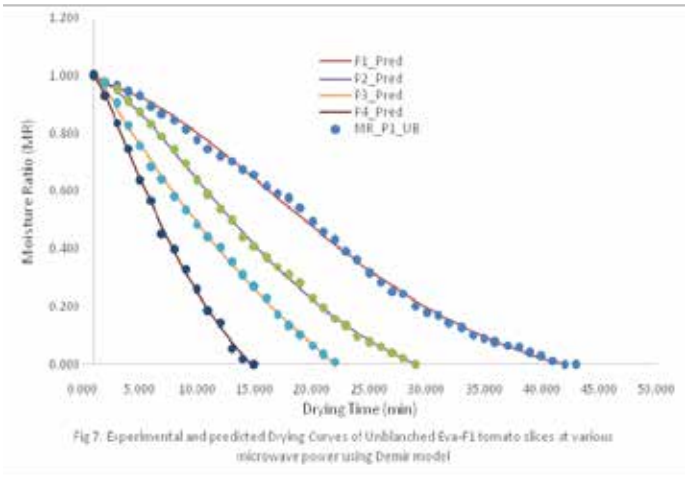

Fig 7. Experimental and predicted Drying Curves of Unblanched Eva-F1 tomato slices at various microwave power using Demir model

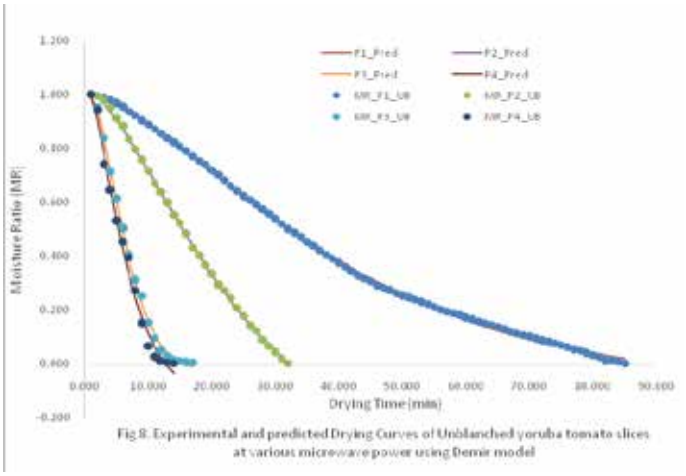

Fig 8. Experimental and predicted Drying Curves of Unblanched yoruba tomato slices at various microwave power using Demir model

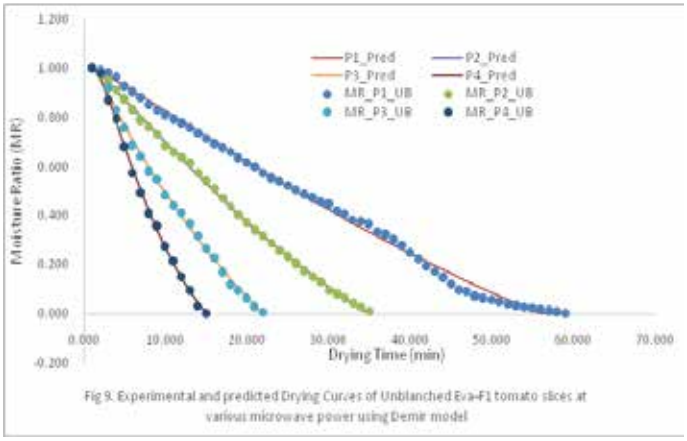

Fig 9. Experimental and predicted Drying Curves of Unblanched Eva-F1 tomato slices at various microwave power using Demir model

CONCLUSIONS

From the study conducted on the thin layer drying of Tomato slices using three varieties for sun drying, microwave and infra-red drying methods, it the following can be concluded that for all varieties there was a reduction in moisture content with increased drying time. It is to be noted that the drying took place in the falling rate period for all tomatoe varieties. Also, the drying time for all varieties reduced as the microwave power increased from 120 to 520W. Consequently, all the three and four parameter models predicted well the drying characteristics of all varieties of tomato studied with R2 values in which all were greater than 0.99. The Demir and Midilii models from this study were the best models selected based on R2, RMSE and Chi square values.

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