Journal of Food Research; Vol. 4, No. 1; 2015
ISSN 1927-0887 E-ISSN 1927-0895
Published by Canadian Center of Science and Education

Mathematical Modeling of Drying Pattern of *Ogi* Produced From Two Types of Maize Grain

Bolaji O. T.[1], Olalusi A. P.[2] & Adesina B. S.[3]

[1] Department of Food Technology, Lagos State Polytechnic, Ikorodu, Lagos, Nigeria

[2] Department of Agricultural and Environmental Engineering Federal University of Technology, Akure, Nigeria

[3] Department of Agricultural and Environmental Enginering, Lagos State Polytechnic, Ikorodu, Nigeria

Correspondence: Bolaji O. T., Department of Food Technology, Lagos State Polytechnic, Ikorodu, Lagos, Nigeria. Tel: 234-802-972-0909. E-mail: olusholat@yahoo.com

Received: August 14, 2014 Accepted: October 27, 2014 Online Published: December 29, 2014

doi:10.5539/jfr.v4n1p174 URL: http://dx.doi.org/10.5539/jfr.v4n1p174

Abstract

This paper presents thin layer modeling of *ogi* produced from yellow and white maize at varying soaking period and dried in the cabinet and oven at 50 ºC. The moisture decrease for cabinet dried o*gi* produced from white maize from 49.0 11.5%, 49.5 to 11.32%, 46.5 to 12.33% and 46.12.29%. The drying rate for both oven and cabinet dried *ogi* produced from yellow maize decreased from 4.6 to 0.0525 kg/min, 4.5 to 0.0513 kg/min, 4.35 to 0.049 kg/min and 4.4 to 0.047 kg/min while for oven dried *ogi* followed a similar trend. The experimental data obtained were fitted to five thin layer models: Newton, Page, Herderson and Pabis, Two term and Wingh and Singh models. The values obtained for *ogi* produced from white maize and dried in the cabinet and oven at 50 ºC for Newton model gave a lower R^2, χ^2, RMSE compared with respective values obtained from Page, Herderson and Pabis, two term, Wing and Singh models. The two terms model appear to be the best model among the five models used in this work and had higher R^2, lower χ^2, and RMSE. The *ogi* produced from yellow maize at varying soaking period of 24, 48, 72 and 96 hours and dried in cabinet dryer and fitted with two term showed model constants a, $K_{0,}$ b, K_1 0.04315, 0.0388995, 0.919, 2.2×10^{-3} while the R^2, χ^2 RMSE were 0.9933, 5.85×10^{-4} and 4.85×10^5 for *ogi* produced for 24 hours soaking, respectively. The soaking period does not seem to affect the moisture ratio and the thin layer drying model. However, the initial moisture and equipment seems to affect significantly.

Keywords: modeling, drying, *ogi* slurry, thin layer, maize

1. Introduction

Dehydration is one of the oldest methods of food preservation and may be complicated process that involves simultaneous heat and mass transfer (Sarsavadia et al., 1999; Maskan et al., 2002; Shi et al., 2008). In this process, water is transferred by diffusion from interior part of the food material to outer surface and subsequently evaporated (Maskan et al., 2002; Sahin & Dincer, 2005; Hawlader et al., 2006). It is an important food processing condition aimed at producing a high-density product which when adequately packaged should prolong the shelf-life and be rapidly reconstituted without significant loss in quality charateristics (Sarsavadia et al., 1999; Lima et al., 2002; Maskan et al., 2002; Moraga et al., 2004; Maskan, 2001; Alves-Filho, 2002; Hawlader et al., 2006; Shi et al., 2008).

Drying process can be described using an appropriate drying models require adequate application of knowledge of material transport and properties (Karathanos, 1999; Alves-Filho, 2002; Shi et al., 2008). The common relevant properties useful in the application are moisture diffusivity, thermal conductivity, density, specific heat capacity; inter phase heat and mass transfer coefficients (Karathanos, 1999; Hernandez et al., 2000; Alves-Filho, 2002; Shi et al., 2008). Among many mathematical models, thin layer drying models have found wide application due to their ease of use. Time of application and assumptions of geometry of a typical food is always needed for computation (Madamba et al., 1996; Kingsly et al., 2007). Among semi theoretical thin layer drying models, the Newton model, Page model, the modified Page model (I and II), the Henderson and Pabis model, the logarithmic model, the two term model, the two-term exponential, the diffusion approach model have been used by many researchers (Lima et al., 2002; Maskan et al., 2002; Moraga et al., 2004; Maskan, 2001; Alves-Filho, 2002; Hawlader et al., 2006; Shi et al., 2008). Empirical models derive a direct relationship between average moisture content and drying time (Karathanos, 1999; Hernandez et al., 2000; Alves-Filho, 2002; Shi et al., 2008; Madamba et al., 1996; Kingsly et al., 2007). Drying kinetics is generally evaluated experimentally by measuring the weight of a drying sample as a function of time (Midilli, 2001; S. Erenturk & K. Erenturk, 2007; Khazaei et al., 2008). It has been established that Drying kinetics is greatly affected by air temperature, air velocity, material size, drying time (S. Erenturk & K. Erenturk, 2007; Khazaei et al., 2008).

Some of the thin layer models reported in literature were for drying of Toria seeds (Rangroo & Rao, 1992), Dates (Bakri & Hobani, 2000), chili pepper (Toyosi & Adeladun, 2010), varieties millet samples (Ojendiran & Raji, 2010), Srilankan paddy (Syamali et al., 2009), Sesame seeds (Khazaei & Daneshmandi, 2007), Amaranth grain (Ronoh et al., 2010), hazelnut (Ozdemir & Devres, 1999), green pepper, green bean and squash (Yaldiz & Ertekin, 2001), apricot (Togrul & Pehlivan, 2003; Sarsilmaz et al., 2000), green chilli (Hossain & Bala, 2002), pistachio (Midilli & Kucuk, 2003), apple (Sacilik & Elicin, 2005), pumpkin (Akpinar et al., 2003b), red pepper (Akpinar et al., 2003a), eggplant (Ertekin & Yaldiz, 2004), bay leaves (Gunhan et al., 2005), rosehip (Erenturk et al., 2004) and strawberries (Alvarez et al., 1995).

Ogi produced from maize is the product obtained by fermentation of corn (Akingbala et al., 1981; Bolaji et al., 2011). The softened corn is washed and wet milled, sieved and sedement (Banigo & Muller, 1972). There has not been any substantial difference between the traditional and commercial manufacturing of *ogi*. Some modification have been introduced such as dry milling of maize into a fine flour and subsequent inoculation of the flour – water mixture with a culture of lactobacilli and yeast this is still not in general practice compared with the traditional method (Akingbala et al., 1981). According to Maskan 2001, the use high quality dried foods with good rehydration properties has become an interesting alternative to chemicals preservatives in food. This can be applied to *ogi* which is widely consumed within the geographical segments of Nigeria.

In view of the importance of *ogi* in the Nigerian diet, large scale production is appearing indispensable. The *ogi* material could be dried and package in polythene bags for an increased shelf life. There are many different types and variation of dryers, and selecting the proper dryer is crucial to achieving the desired results. Different types of dryers may be necessary depending on capacity, product quality, size, consistency, hours of operation, quantity of water to be evaporated, acidity of the product, operational environment and volatility of its flavor (S. Erenturk & K. Erenturk, 2007; Khazaei et al., 2008; Midilli, 2001). In addition, the nature of contact with food material, source of energy and the nature of the food material.

In most cases of application of thin layer drying, a finer grain obtained as result of millied process is rarely considered. Past work has been limited to vegetables, fruits, grains (legumes, cereals, seeds which particle size are quite larger compared with the particle size of fine *ogi*. Also, literature is very scanty on the application of thin layer to finely- grind product made through a sieve meshes (0.6 micron and below)-fine grains like *ogi* slurry obtained from fermented, milled, sieved, sedimented slurry consumed as weaning food and adult gruel. This work is attempted to find out if some common thin layer drying models may be relevant in describing the drying behavior of *ogi*. This may be subsequently useful in predicting, designing or selecting appropriate drying process and equipment for this product.

2. Method

Maize used for this experiment was obtained from a local market at Ketu, Lagos, Nigeria. Four kilogram were divided into four and each (1 kg) of the maize was weighed into bowl after thorough cleaning. Water was added and soaked for 24, 48, 72 and 96 hours. The soaked maize at different period was wet milled and were sieved with muslin clothe. The sediment was put in Muslim cloth and squeezed to drain the water ready for drying in two different dryer (cabinet and hot air oven) at 50 ºC. The *ogi* paste was spread to form a uniform thickness in the dryer stray (10 mm). This selection was necessary considering the gelatinization temperature of most starches and *ogi* (Bolaji et al., 2011). The moisture contents of paste were monitored at an interval of 10 minutes for 240 minutes (4 hours) subsequently at an interval of 2 hours for additional 4 hours.

2.1 Moisture Determination

The method of A.O.A.C (1990) was used to determine the moisture content of the *ogi* paste. A known mass of the paste was placed in an oven at 110 ºC for 3 hours, weighing was done. The final weight was taken when the product had cooled down inside a desiccator and the moisture content determined as a ratio of weight of water to weight of wet paste expressed in % as shown in Equation (1).

$$Moisture\ contnent(\%) = \frac{weight\ of\ sample - weight\ after\ drying}{weight\ of\ sample} \times 100 \quad (1)$$

2.2 Thin Layer Models

Drying kinetics models employed in this work are as shown in Table 1. The drying constant and coeffiecints of the models were determined by non-linear regression analysis. Among the models tested to interpret the drying behavior of *ogi* slurry was Lewis model used to describe the drying of barley (Bruce, 1985) while page model is an empirical modification of Lewis model to overcome some of its shortcomings. It has been successfully used to describe the drying characteristics of some agricultural products (Menges & Ertekin, 2006).Wang and Singh model is a second order polynomial model, which has earlier been used to characterize the drying kinetics of rough rice (Wang & Singh, 1978).The two-term model is the first two terms of general series solution of Fick's second law regardless. According to Sacilik and Unal (2005) reported that it requires constant product temperatures during drying and assumes that diffusivity is constant. In this proposed models a, *b*, *c* and *n* are the drying coefficients and *k* is the drying constant (min^{-1}).

Table 1. Some thin layer models

s/no	Model name	Model equation	References
1	Newton	$MR = \exp(-kt)$	Bruce, 1985
2	Page	$MR = \exp(-kt)^n$	Page 1949
3	Herderson and Pabis	$MR = a.\exp(-kt)$	Herderson and Pabis(1961)
4	Two term model	$MR = a.\exp(-k_0t) + b.\exp(-k_1t)$	Herderson and Pabis(1974)
5	Wang ang Singh	$MR = 1 + at + bt^2$	Wang and Sing (1978)

2.3 Mathematical Modeling

According to Midilli (2001), Drying characteristics can be investigated by effectively modeling the drying behavior. Drying experiments were expressed in dimensionless form as moisture ratios MR with the following equation)

$$MR = \frac{M-M_e}{M_i-M_e} = \exp(-kt) \quad (2)$$

where M is the moisture content at any time, M_i is the initial moisture content and M_e is the equilibrium moisture content. The values of M_e may be relatively small compared to M and M_i, so the equation can be simplified to $MR = M/M_i$ (Thakor et al., 1999; Akgun & Doymaz, 2005; Togrul & Pehlivan, 2002).The non linear regression analysis in the present study was performed using the OriginPro 8. The goodness of fit of the tested mathematical models to the experimental data was evaluated with the correlation coefficient (R^2), the reduced chi square (χ^2) and the root mean square error (*RMSE*). The higher the values of the R^2 , and lowest values of the χ^2 and *RMSE*, the better the goodness of the fit (Yaldiz & Ertekin, 2001; Akpinar et al., 2003; Gunhan et al., 2005; Doymaz et al., 2004; Sacilik & Elicin, 2005). The χ^2 and *RMSE* were evaluated as as showin in Equations (2) and (3)

$$RMSE = \left[\frac{1}{N}\sum_{I=1}^{N}(MR_{pred,i} - MR_{exp,})^2\right]^{1/2} \quad (3)$$

$$\chi^2 = \frac{\sum_{i=1}^{n}\left(MR_{exp,i} - MR_{pre,i}\right)^2}{N-n} \quad (4)$$

Where MR_{pre} is predicted moisture ratio and MR_{exp} is experimental moistre ratio.

3. Results

The moisture decreased for cabinet dried *ogi* produced from white maize from 49.0 to 11.5%, 49.5 to 11.32%, 46.5 to 12.33% and 46.0 to 12.29% respecitively. While the moisture cotent for oven dried *ogi* produced from white maize decreased from 49.0 to 12.6%, 49.5 to 12.32%, 46.5 to 11.99% and 45.0 to 11.31%, rescpectively.

The moisture ratio in Figure 1 showed that moisture in *ogi* samples decreased continually with drying time.

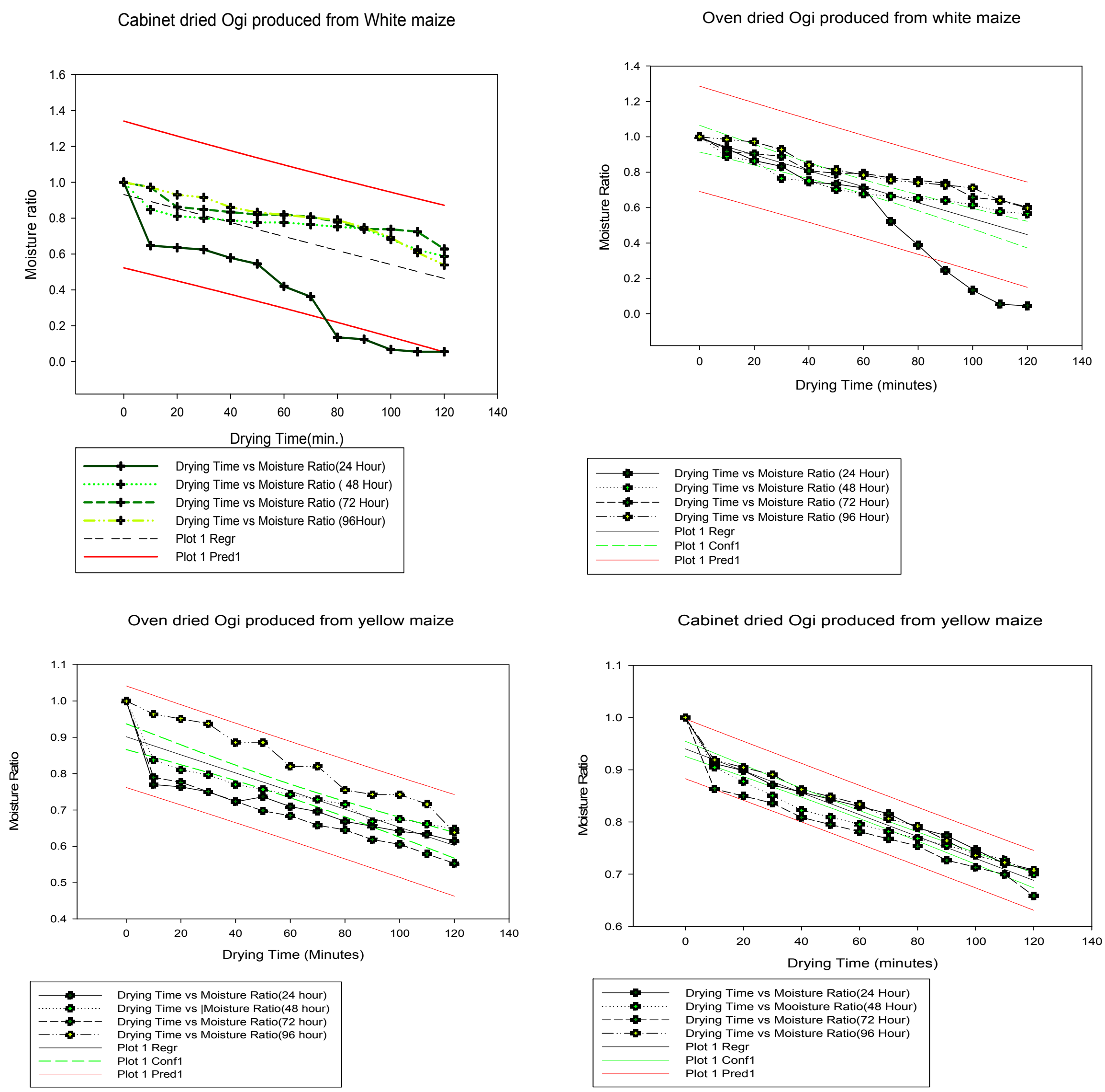

Figure 1. Moisture ratio relationship with drying time

The drying rate for both oven and cabinet dried *ogi* produced from yellow maize decreased from 4.6 to 0.0525, 4.5 to 0.0513, 4.35 to 0.049 and 4.4 to 0.047 kg/min. While the drying rate in cabinet dried *Ogi* decreased from 4.8 to 0.37, 4.7 to 0.36, 4.5 to 0.35 and 4.55 to 0.35 kg/min .The drying rate recorded for oven and cabinet dried *ogi* porudced from white maize also ranged from 3.35 to 0.02083, 4.3 to 0.047, 4.55 to 0.051 and 4.5 to 0.05 kg/min.

The statiscal parameters of five common drying models used and fitted with *RMSE* and χ^2 used to evaluate the best model were presented in Tables 2, 3, 4, 5 and 6. The drying constant k, obtained for Newton model for *ogi* produced from maize soaked for 24 hours and dried in a cabinet dryer were 3.06×10^{-3} with R^2 of 0.8963, χ^2 of 0.7071×10^{-4} and *RMSE* of 0.021. Also for *ogi* produced from maize soaked at 48 hours and dried in the cabinet at 50 ºC, k is 3.35×10^{-3} with R^2 of 0.77773, χ^2 of 1.5×10^{-3}, *RMSE* of 0.26. *Ogi* produced from maize Maize soaked for 72 and 96 hours of soaking followed similar trend as shown in Table 2. The result for Oven dried Ogi from yellow maize at 50 ºC and 24 hours soaking time, revealed a k value to be 3.06×10^{-3}, R^2 is 0.795, χ^2 is 3.167×10^{-3}, *RMSE* is 0.054; and k, at 48 hours soaking time, is 4.45×10^{-3} with R^2 of 0.882, χ^2 of 2.28×10^{-3}, RMSE of 0.044 for *ogi* produced from yellow maize. The values obtained for *ogi* produced from white maize and dried in the cabinet and oven at 50 ºC, respectively revealed a similar trend. The R^2 were lower, compared with respective values obtained in page, Herderson and Pabis, Wang ang Singh models and two term models. The χ^2 and RMSE were contrary, their values were higher.

Table 2. Newton models constants and statistical parameters

	k (× 10^{-3})	R^2	*RMSE* (×10^{-1})	χ^2 (× 10^{-3})
Cabinet dreid Ogi Produced from Yellow Maize				
	3.06	0.89683	2.1	0.707
	3.35	0.77773	2.6	1.5
	3.76	0.71574	3.5	2.5
	3.07	0.93906	5.81	4.53
Mean	3.31	0.83234	3.55	1.215
Oven dried Ogi produced from Yellow Maize				
	3.06	0.795	5.4	3.167
	4.45	0.882	4.4	2.25
	5.81	0.904	4.8	1.0
	3.19	0.964	2.8	3.583
Mean	4.13	0.88625	3.14	2.5
Cabinet dried Ogi produced from White Maize				
	3.03	0.89683	7.0	0.706
	3.05	0.77773	0.9	1.6.
	3.67	0.71574	3.2	2.4
	3.107	0.93906	1.6	5.53
Mean	3.30	0.83234	3.18	13.15
Oven dried Ogi produced from Yellow Maize				
	18.2	0.89151	5.7	9.71
	4.27	0.67199	2.6	3.42
	3.43	0.87952	2.8	1.19
	3.82	0.91815	2.5	1.52
Mean	7.43	0.840293	3.4	3.96

However, the Two term odel appears to be the best model among the five models used in this work with higher R^2, and lower $\chi^{2,}$ and *RMSE*. The *og*i produced from yellow maize at varying soaking period of 24 hours and dried with cabinet dryer and fitted with two terms is as shown in Table 5. The result revealed constants a, K_0, b, K_1 were 0.00594, 0.0202, 0.941, 0.00228, and R^2 , was 0.9901, χ^2 ,7.84 × 10^{-4}, *RMSE*, 8.22 ×10^{-5}, respectively.

The values for *ogi* produced from 48 hours were 0.0103, 0.0125, 0.891, 0.00195 while the R^2, χ^2 and, *RMSE* were 0.996823, 2.57 × 10^{-4} and 2.85 × 10^{-5}, respectively. *Ogi* produced from white maize and dried at the oven follow a similar trend. The R^2, χ^2 and *RMSE* obtained for all the models for *ogi* produced from white maize and dried in the cabinet at the temperature used in this research work were lower as revealed by Newton, Page, Herdeson and Pabis and Two term models. The values of R^2 and other statistical parameters were lower compared to the findings of several previous works in fitting the model to the experimental data and only the values obtained from Two term model falls within range obtained for drying of apple (R^2 = 0.99869, χ^2 = 2.68 × 10^{-4}) and pumpkin (R^2 = 0.98952 and χ^2 = 2.31×10-3) as reported by Akpinar (2006); green table olives (R^2 = 0.9890 to 0.9987, *RMSE* = 0.009341 to 0.025469, and χ^2 = 8.9 x10^{-5} to 6.54 ×10^{-4}) as reported by Demir et al. (2007); drying of figs (R^2 = 0.9912, χ^2 = 7.06 ×10^{-3}, and *RMSE* = 0.074918) as reported by Doymaz (2005); black grapes (R^2 = (0.9794 to 0.9989, χ2 = 1.01x10^{-4} to 1.772 ×10^{-3}) as reported by Doymaz (2006); prickly pear fruit (R^2 =

0.9993 and χ^2 = 1.1457×10^{-4}), drying shelled pistachios (R^2 = 0.9668, χ^2= 4.756 ×10^{-4}) and unshelled (R^2 = 0.970 and χ^2 = 4.737×10^{-4}); natural solar drying of shelled pistachios (R^2 = 0.9380, χ^2= 4.521×10^{-4}) and unshelled pistachios (R^2 = 0.9750 and χ^2= 3.360×10^{-4}), according to Midilli and Kucuk (2003); drying of single apricot: (R^2 = 0.990, *RMSE* = 0.0487 and χ^2 = 0.002395) by Togrul and Pehlivan (2003); solar drying of sultana grapes: (R^2 = 0.973 and χ^2 = 0.005) as reported by Yaldiz et al. (2001).

Table 3. Page models constants and statistical parameters

	k	n	R^2	*RMSE* (×10^{-2})	χ^2 (×10^{-3})
Cabinet Oven dried *ogi* produced from Yellow Maize					
	1.3399	0.548	0.945	5.4	1.833
	1.2499	0.497	0.992	3.9	2.75
	1.10889	0.415	0.925	3.9	4.0
	1.404	0.605	0.945	5.6	1.417
Mean	1.275673	0.516	0.95175	4.7	2.5
Oven dried *ogi* produced from yellow maize					
	0.732	0.264	0.87	3.5	3.292
	0.9861	0.373	0.954	6.1	1.917
	0.905	0.383	0.937	2.9	3.708
	1.79092	1.047	0.957	1.9	1.083
Mean	1.103505	0.51675	0.9295	7.875	2.5
Cabinet dried *ogi* produced from White Maize					
	1.2615	0.909	0.777	1.87	4.0
	1.0349	0.391	0.777	3.14	2.75
	1.604827	0.851	0.851	2.62	1.625
	1.81482	1.123	0.968	2.87	1.625
Mean	1.429012	0.8185	0.84325	2.625	2.5
Oven dried *ogi* produced from White Maize					
	1.909394	1.553	0.896	2.23	3.5
	1.293	0.645	0.97	2.1	3.417
	1.475678	0.734	0.928	2.26	1.583
	1.9796	1.4332	0.962	4.45	1.5
	Mean	1.664418	1.0913	9.39	1.96

The study showed that drying *ogi* smaples in the cabinet dryer and hot air oven showed decrease in moisture content with increased drying at the same temperature of 50 ºC for 240 minutes. Drying of *ogi* may be achieved within the drying time employed in this research work however this is dependent on the quantity. Soaking period however did not reveal a significant effect on the drying pattern of *ogi*.The two term model showed a best model fit with Higher R^2, lower χ^2 and *RMSE* followed by the Wang and Singh model. The values for R^2, χ^2 and *RMSE* were highest in cabinet and oven dried *ogi* produced from yellow maize in all the models compared with the white *ogi* produced from white maize.

Table 4. Herderson and Pabis models constants and statistical parameters

	A	k	R^2	*RMSE* ($\times 10^{-3}$)	χ^2 ($\times 10^{-4}$)
	Cabinet dried *ogi* produced from Yellow Maize				
	0.95899	-0.00252	0.95784	9	2.89
	0.93839	-0.00252	0.91691	8	5.59
	0.92475	-0.00274	0.89432	14	8.17
	0.96746	-0.00264	0.97435	9	1.91
Mean	0.947398	-0.00261	0.935855	10	4.64
	Oven dried *ogi* produced from Yellow Maize				
	0.86077	-0.00309	0.72608	13	26.6
	0.8993	-0.00304	0.84305	13	1.42
	0.88114	-0.00407	0.85675	9	1.96
	1.01414	-0.00337	0.96576	28	4.27
Mean	0.913838	-0.00339	0.84791	15.75	1.617
	Cabinet dried *ogi* produced from White Maize				
	0.88527	-0.01738	0.95714	33.58	10.27
	0.82248	-0.00314	0.91741	14.41	1.85
	0.89849	-0.003	0.96752	9.37	1.01
	0.91879	-0.00412	1.02328	5.04	1.51
Mean	0.881258	-0.00691	0.966338	15.6	3.66
	Oven dried *ogi* produced from White Maize				
	0.95714	-0.01738	0.88527	10.27	11.27
	0.91741	-0.00314	0.82248	18.0	1.85
	0.96752	-0.003	0.89849	1.02	3.01
	1.02328	-0.00412	0.91879	2.01	1.51
Mean	0.966338	-0.00691	0.881258	7.825	4.816

The drying process was affected substantially by the consistent changing temperature gradient most expecailly at the at the beginignof the experiment. This was consistent with several researchers report (Akendo et al., 2008; Belghit et al., 2000; Falade & Abbo, 2007; Methakhup et al., 2005) of free water present at the start is vary, the rate of water removal is always higher during this at this stage(Guine´ et al., 2007). As the drying proceeds, the free water presents decreases quite rapidly, until the final stages when water was hardly available and the drying becomes very slow. This was reflected in the drying rate.

Table 5. Two term models constants and statistical parameters

	a	k_0	b	k_1	R^2	*RSME* (× 10^{-5})	χ^2 (×10^{-4})
Cabinet dried *ogi* produced from Yellow Maize							
	0.00594	0.0202	0.941	0.00228	0.9901	8.22	7.84
	0.0103	0.0125	0.891	0.00195	0.996823	2.85	2.57
	0.109	0.000898	0.891	0.00226	0.99234	8.18	7.36
	0.0473	0.122	0.953	0.00245	0.993778	0.163	5.65
Mean	0.043135	0.0388995	0.919	0.002235	0.99326	4.852	5.85
Oven dried *ogi* produced from Yellow Maize							
	0.204	0.00141	0.797	0.0021	0.993362	8.60	7.73
	0.15	0.39	0.85	0.00231	0.993839	7.43	6.68
	0.178	0.0000145	0.822	0.00317	0.998202	3.28	2.98
	0.464	0.00337	0.55	0.0.337	0.968614	50.0	4.7
Mean	0.249	0.0986986	0.75475	0.002527	0.988504	17.3243	5.52
Cabinet dried *ogi* produced from White Maize							
	0.482	0.0174	0.475	0.0172	0.894828	1.26	1.1294
	0.31	0.00314	0.607	0.00314	0.837271	2.3	2.0372
	0.721	0.101	0.935	0.00258	0.928767	9	8.477
	0.486	0.00412	0.537	4.12E-03	0.925555	1.8	1.6664
Mean	0.49975	0.031415	0.6385	0.00676	0.896605	4.4	3.9613
Oven dried *ogi* produced from White Maize							
	0.593	0.0136	0.536	0.0136	0.848717	2.39	2.15057
	0.199	0.0477	0.8	0.0028	0.988634	3	2.29
	0.408	0.00371	0.569	3.71E-03	0.9608	7	6.379
	0.458	0.00412	0.564	0.00412	0.9716	7	6.861
Mean	0.4145	0.0172825	0.61725	0.006058	0.942438	8.3	5.7647

Drying of *ogi* occurred predominantly in the falling rate period. This is indicative of the dominance of diffusion as physical mechanism governing moisture movements in the samples. This was consistent with the report by some researchers for greenbean (Rosello et al., 1997), okra (Gogus & Maskan, 1999), red chilli (Gupta et al., 2002), Carrot (Prabhanjan et al.,1995) and eggplant (Ertekin & Yaldiz, 2004; Falade et al., 2007). Generally, in this experiment, drying rates decreased with decreased moisture contents. Initially, there were higher drying rates when moisture contents were largest, after which, the drying rate decreased steadily with decreased moisture contents. This trend could be due to the removal of free moisture near the surface of the *ogi* paste at the early stages of drying. Moisture ratio decreased with increasing drying time. The solid content of *ogi* may be unconnected with the drying behavior (King, 1988; Lewicki, 2004; Mate et al., 1998; Falade et al., 2007).

Table 6. Wang and Singh models constants and statistical parameters

	a	B	C	R^2	RSME (× 10^{-4})	χ^2 (× 10^{-3})
Cabinet dried *ogi* produced from Yellow Maize						
	-0.00263	0.00000454	0.963	0.961936	3	3.132
	-0.00371	0.0000142	0.962	0.957005	3	3.472
	-0.00339	0.0000105	0.94	0.915027	8	7.887
	-0.00272	0.000004.47	0.971	0.976798	3	2.062
Mean	-0.00311	9.74667E-06	0.959	0.952692	4.25	4.138
Oven dried *ogi* produced from yllowe Maize						
	0.00471	0.0000213	0.896	0.802636	23	22.885
	-0.00452	-0.00191	0.93	0.901261	11	10.712
	-0.0053	-0.0000212	0.91	0.897287	17	16.838
	-0.00249	-0.00000283	0.999	0.972763	4	3.542
Mean	-0.0019	-0.00047818	0.93375	0.893487	13.75	13.494
Cabinet dried *ogi* produced from White Maize						
	-0.00967	0.00001.89	0.89	0.933278	72	71.669
	-0.00246	0.000000515	0.91	0.83782	20	20.303
	-0.00302	0.00000049	0.97	0.906466	11	11.131
	-0.00158	-0.0000153	0.98	0.969203	7	6.881
Mean	-0.00418	-4.765E-06	0.9375	0.911692	275	27.496
Oven dreid *ogi* produced from White maize						
	-0.00437	0.0000357	0.990.9955	0.976467	33	0.033546
	-0.629	0.000026	0.967	0.972102	6	0.005601
	-0.00315	0.00000181.3	0.97	0.961829	6	0.61123
	-0.00387	0.00000046	1.02	0.971916	6	0.005795
Mean	-0.1601	0.00002072	0.98566667	0.970579	12.75	0.164043

4. Conclusion

The study has shown that drying pattern using the cabinet dryer and hot air oven decreased in moisture content with increased time of drying at the same temperature of 50 °C. Drying of *ogi* may be achieved within the drying time employed in this research work.However, the quantity and the maxium capacity of the drying equipment used determine will be important to determing the drying time.

The Two term model showed a best model fit with Higher R^2, lower χ^2 and *RMSE* in this experiment. The cabinet dried *ogi* had Higher R^2 and lower χ^2 and *RMSE* compared with values obtained for oven dried *ogi* produced from yellow and white maize. This is an indication of the possible effect of the rate and efficiency of dehydration method.

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