



ELSEVIER

Contents lists available at ScienceDirect

## Data in Brief

journal homepage: [www.elsevier.com/locate/dib](http://www.elsevier.com/locate/dib)

## Data Article

Drying kinetic of industrial cassava flour:  
Experimental data in view

Oluwole A. Odetunmibi<sup>a</sup>, Olujemisi A. Adejumo<sup>b</sup>,  
Pelumi E. Oguntunde<sup>a</sup>, Hilary I. Okagbue<sup>a,\*</sup>,  
Adebowale O. Adejumo<sup>a,c</sup>, Esivue A. Suleiman<sup>a</sup>

<sup>a</sup> Department of Mathematics, Covenant University, Ota, Nigeria

<sup>b</sup> AIDE Department, National Centre for Agricultural Mechanization, Ilorin, Nigeria

<sup>c</sup> Department of Statistics, University of Ilorin, Ilorin, Nigeria

## ARTICLE INFO

## Article history:

Received 25 July 2017

Received in revised form

13 September 2017

Accepted 4 October 2017

Available online 7 October 2017

## Keywords:

Drying rate

Drying time

Drying kinetic

Industrial cassava flour

Temperature

Velocity

Dewatering

Moisture content

Grated unfermented cassava mash

## ABSTRACT

In this data article, laboratory experimental investigation results on drying kinetic properties: the drying temperature ( $T$ ), drying air velocity ( $V$ ) and dewatering time ( $T_e$ ), each of the factors has five levels, and the experiment was replicated three times and the output: drying rate and drying time obtained, were observed. The experiment was conducted at National Centre for Agricultural Mechanization (NCAM) for a period of eight months, in 2014. Analysis of variance was carried out using randomized complete block design with factorial experiment on each of the outputs: drying rate and drying times of the industrial cassava flour. A clear picture on each of these outputs was provided separately using tables and figures.

It was observed that all the main factors as well as two and three ways interactions are significant at 5% level for both drying time and rate. This also implies that the rate of drying grated unfermented cassava mash, to produce industrial cassava flour, depend on the dewatering time (the initial moisture content), temperature of drying, velocity of drying air as well as the combinations of these factors altogether. It was also discovered that all the levels of each of these factors are significantly difference from one another. In summary, the time of drying is a function of the dewatering time which was responsible for the initial moisture content. The higher the initial moisture content the longer the time of drying, and the lower the initial moisture content, the

\* Corresponding author.

E-mail address: [hilary.okagbue@covenantuniversity.edu.ng](mailto:hilary.okagbue@covenantuniversity.edu.ng) (H.I. Okagbue).

lower the time of drying. Also, the higher the temperature of drying the shorter the time of drying and vice versa. Also, the air velocity effect on the drying process was significant. As velocity increases, rate of drying also increases and vice versa. Finally, it can be deduced that the drying kinetics are influenced by these processing factors.

© 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

### Specification Table

Subject area	Engineering and Bio-system
More specific subject area	Post harvest, Food process
Type of data	Tables and figures
How data was acquired	Unprocessed secondary data
Data format	Laboratory experimental investigation results on temperature, drying air velocity, dewatering (initial moisture content), and the outputs (drying rate and drying time of industrial cassava flour)
Experimental factors	Temperature, drying air velocity, dewatering (initial moisture content)
Experimental features	Computational analysis: Analysis of variance (ANOVA), Randomized complete block design with factorial experiment ( $5^3$ ), Histogram
Data source location	National Centre for Agricultural Mechanization (NCAM), Idoian, Ilorin, Nigeria.
Data accessibility	All the data are in this data article as a <a href="#">Supplementary data</a> file
Software	SPSS Statistical program and Microsoft Excel

### Value of the data

- The data on drying rate of industrial cassava flour will be useful for the industries that are planning to embark on large production of cassava flour.
- The data on drying time of industrial cassava flour will be useful also for the industries to know the time needed for the cassava flour to dry at different levels of temperature and velocity.
- The data can be useful for the quality assurance of any cassava flour processing company.
- The data will be useful in food processing, post harvest and bio-system engineering studies.
- The data can be useful for educational purposes and nutrition assessment studies.
- The data is useful in the study of drying kinetic of food processing into powdered particle.
- Several known statistics, for example, root mean squared error (RMSE), linear regression, and complete randomized design (CRD) can be applied which provides alternatives to analysis with randomized complete block design (RCBD) with factorial experiment used in this paper.

### 1. Data

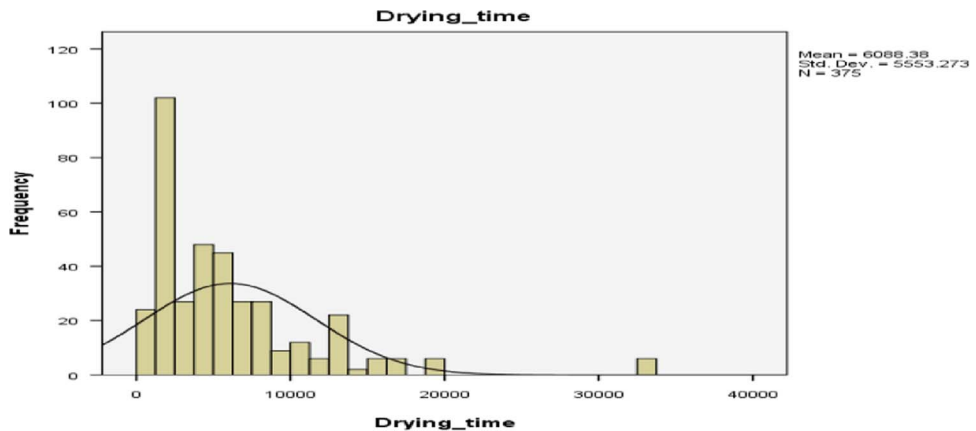
The data describes the kinetic properties of industrial cassava flour. The raw data which consist of 375 rows, with each row having five columns: dewatering, temperature, velocity, and two outputs (drying time and drying rate) can be assessed as [Supplementary data](#).

**Table 1**

Summary statistics of the drying time and drying rate distributions of the industrial cassava flour.

Statistics			
N	Valid Missing	Drying time	Drying rate
		375	375
		0	0
Mean		6088.38	0.03667
Median		4800.00	0.01405
Mode		1980 <sup>a</sup>	0.00923
Std. deviation		5553.273	0.05143
Variance		30,838,840.151	0.003
Skewness		2.330	1.656
Std. error of skewness		0.126	0.126
Kurtosis		7.681	1.308
Std. error of kurtosis		0.251	0.251
Minimum		870	0.00172
Maximum		33,300	0.18209
Percentiles	25	2160.00	0.00455
	50	4800.00	0.01405
	75	7830.00	0.03195

<sup>a</sup> Multiple modes exist. The smallest value is shown.

**Fig. 1.** Drying time distribution of industrial cassava flour.

Statistical summary of the drying time and drying rate distributions of industrial cassava flour are presented in Table 1. It was observed that the average drying time of industrial cassava flour is 6088 s equivalent to 2 h : 9 min. The least and the highest drying time so far recorded in the experiment are 870 and 33,300 s respectively.

Histogram for the drying time distribution is presented in Fig. 1. It can be observed from Fig. 1 that the Drying time distribution is not normally distributed, it skewed to right. The histogram for the Drying rate of industrial Cassava Flour is presented in Fig. 2, which also skewed to right.

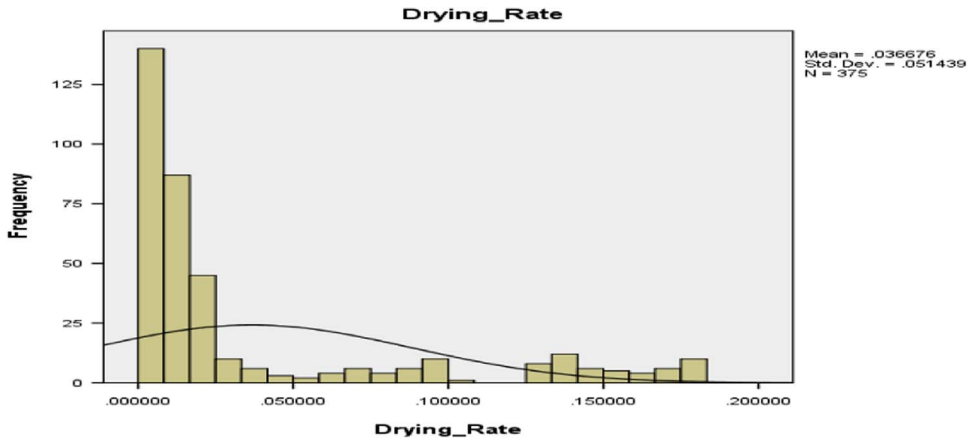


Fig. 2. Drying rate distribution of industrial cassava flour.

**Table 2**  
Analysis of variance for drying time.

Source	Type III sum of squares	DF	Mean square	F	Sig.
Corrected model	11,533,920,843.091 <sup>a</sup>	124	93,015,490.670	31,344.591	0.000
Intercept	13,881,352,745.395	1	13,881,352,745.395	4,677,772.662	0.000
Dewatering	8,561,751,074.970	4	2,140,437,768.743	721,290.026	0.000
Temperature	760,368,437.328	4	190,092,109.332	64,057.710	0.000
Velocity	84,553,288.708	4	21,138,322.177	7123.244	0.000
Dewatering * Temperature	1,342,065,338.778	16	83,879,083.674	28,265.782	0.000
Dewatering * Velocity	195,116,311.236	16	12,194,769.452	4109.424	0.000
Temperature * Velocity	104,662,325.630	16	6,541,395.352	2204.336	0.000
Dewatering * Temperature * Velocity	435,720,716.436	64	6,808,136.194	2294.223	0.000
Error	741,878.333	250	2967.513		
Total	25,434,735,642.000	375			
Corrected total	11,534,662,721.424	374			

<sup>a</sup> R Squared = 1.000 (Adjusted R Squared = 1.000), Dependent Variable: drying time.

**Table 3**  
Post hoc test for significant differences in dewatering under drying time in seconds.

Dewatering	N	Subset				
		1	2	3	4	5
60 min	75					14,853.8800
90 min	75				6963.6000	
120 min	75			4816.2000		
150 min	75		2407.2000			
180 min	75	1400.4000				

**2. Methods and materials**

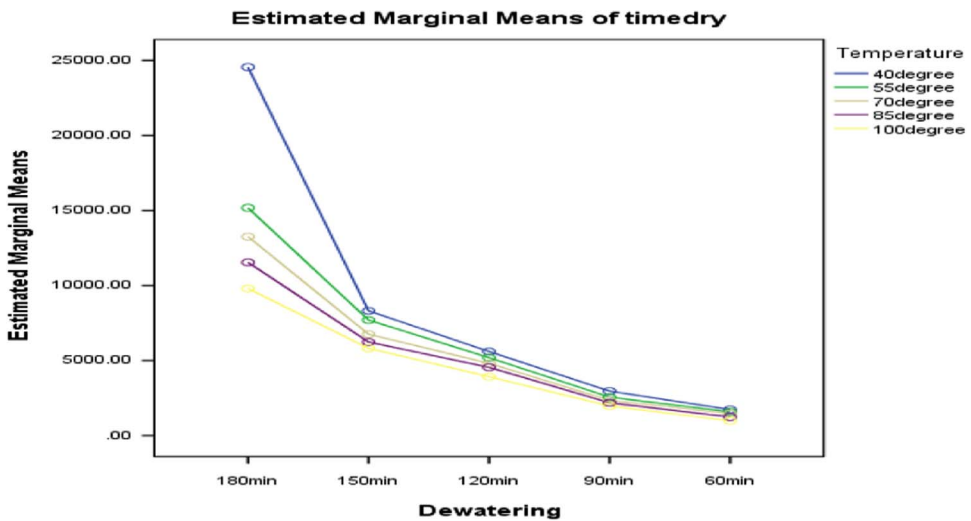
Randomized complete block design with factorial experiment (5<sup>3</sup>) was used for this analysis. The 5<sup>3</sup> factorial experiment means three (3) factors (dewatering, temperature, and velocity) each at five (5) levels. The levels for dewatering are: (60 mins, 90 mins, 120 mins, 150 mins, 180 mins); temperature are: (40 °C, 55 °C, 70 °C, 85 °C, 100 °C) and air velocity are: (1.0 m/s, 1.5 m/s, 2.0 m/s, 2.5 m/s,

**Table 4**  
Post hoc test for significant differences in temperature under drying time in seconds.

Temperature	N	Subset				
		1	2	3	4	5
40°	76					8632.0000
55°	74				6442.1467	
70°	75			5728.1333		
85°	75		5078.3108			
100°	75	4567.5000				

**Table 5**  
Post hoc test for significant differences in air velocity under drying time in seconds.

Velocity	N	Subset				
		1	2	3	4	5
1.0 m/s	75					6715.3333
1.5 m/s	75				6579.6000	
2.0 m/s	75			5938.2400		
2.5 m/s	75		5692.8133			
3.0 m/s	75	5515.2933				



**Fig. 3.** Graph of interactions between dewatering and temperature for drying time.

3.0 m/s). Each of these experiments was replicated three times. The total units of experiment were  $5 \times 5 \times 5 \times 3$  which is 375 altogether. Analysis of variance (ANOVA) table was derived on each output.

Several studies have been conducted on the cassava [1–21]. Similar data articles on cassava that applied statistical tools can be helpful, readers are refer to [22–24].

Table 2 presents the analysis of variance results for drying time; it was observed that all the main factors as well as two and three ways interactions are significant at 5% level. This also implies that the time for grated unfermented cassava mash to get dry depends on the dewatering (the initial moisture content) of the grated unfermented cassava mash, temperature of the dryer, the air velocity of the machine as well as the combinations of these factors altogether.

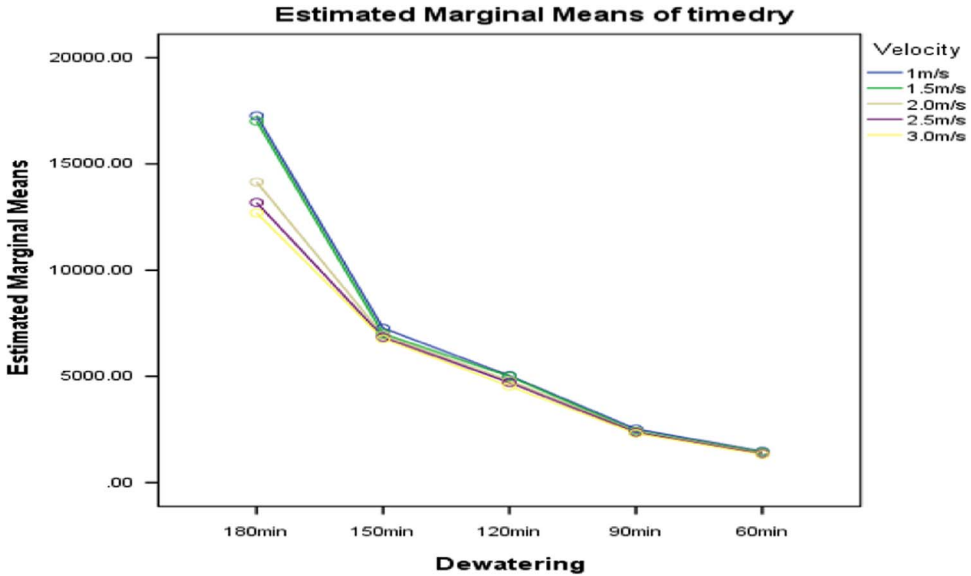


Fig. 4. Graph of interactions between dewatering and air velocity for drying time.

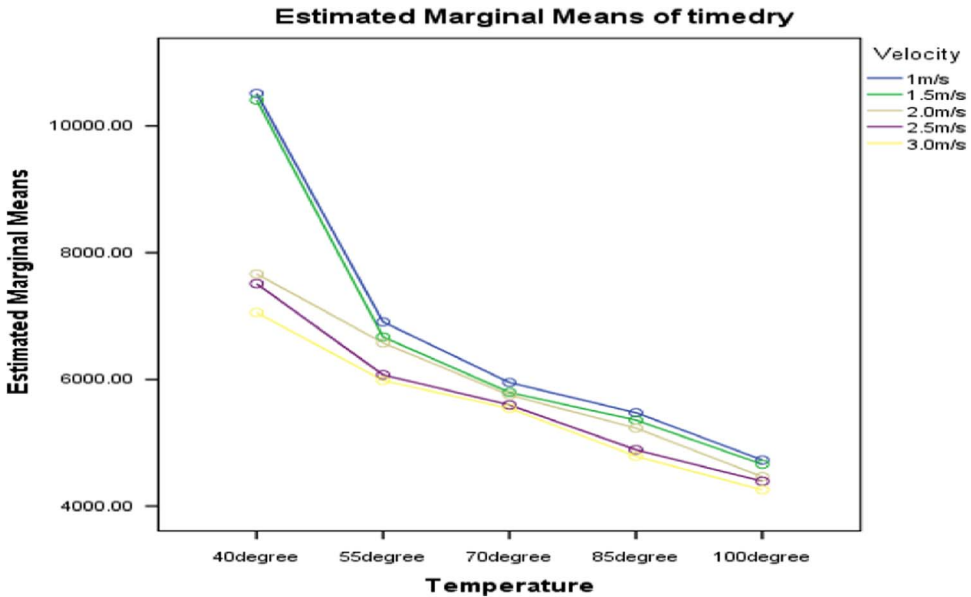


Fig. 5. Graph of interactions between temperature and air velocity for drying time.

Tables 3–5 present further tests, refer to as post hoc tests, to determine if there are differences in the mean results of levels of dewatering, temperature, and air velocity respectively. It was observed that all the levels of each of these factors are significantly different from one another. It was observed that the time of drying reduces with increase in the temperature levels. At the lowest temperature level 40 °C, the highest average time of drying was observed to be 2 h: 57 min. This was followed by temperature level 55 °C with average drying time of 2 h: 22 min observed, then by 70 °C, and the average time of drying was 1 h: 47 min. At the next temperature level which is 85 °C, the time of

**Table 6**  
Analysis of variance for drying rate of industrial cassava flour.

Source	Type III sum of squares	Df	Mean square	F	Sig.
Corrected model	0.990 <sup>a</sup>	124	0.008	8638.111	0.000
Intercept	0.503	1	0.503	544,968.220	0.000
Dewatering	0.886	4	0.221	239,727.010	0.000
Temperature	0.037	4	0.009	9915.007	0.000
Velocity	0.002	4	0.000	513.202	0.000
Dewatering * Temperature	0.059	16	0.004	4006.150	0.000
Dewatering * Velocity	0.003	16	0.000	197.766	0.000
Temperature * Velocity	0.000	16	2.850E-005	30.846	0.000
Dewatering * Temperature * Velocity	0.002	64	3.114E-005	33.707	0.000
Error	0.000	250	9.238E-007		
Total	1.494	375			
Corrected total	0.990	374			

<sup>a</sup> R Squared = 1.000 (Adjusted R Squared = 1.000), Dependent Variable: drying rate.

**Table 7**  
Post hoc test for significant differences in dewatering under drying rate.

Dewatering	N	Subset				
		1	2	3	4	5
60 min	75	0.0034711				
90 min	75		0.0057808			
120 min	75			0.0132115		
150 min	75				0.0285983	
180 min	75					0.1323260

**Table 8**  
Post hoc test for significant differences in temperature under drying rate.

Temperature	N	Subset				
		1	2	3	4	5
40°	75	0.0231224				
55°	75		0.0299855			
70°	75			0.0366016		
85°	74				0.0422645	
100°	76					0.0512933

drying was 1 h:30 min. The highest temperature level, which was 100 °C, the average time of drying was 1 h: 25 min.

Figs. 3–5 present the graphs indicating the magnitude of interactions between each pair of these factors, that is, dewatering and temperature; dewatering and velocity; temperature and velocity respectively.

Likewise, Table 6 presents the analysis of variance results for drying rate. It was also observed that all the main factors as well as two and three ways interactions are significant at 5% level. This also implies that the drying rate of cassava flour depends on the dewatering (the initial moisture content) of the grated unfermented cassava mash, temperature of the dryer, the air velocity of the machine as well as the combinations of these factors combined.

**Table 9**  
Post hoc test for significant differences in air velocity under drying rate.

Velocity	N	Subset				
		1	2	3	4	5
1 m/s	75	0.0336577				
1.5 m/s	75	0.0350140				
2.0 m/s	75	0.0363696				
2.5 m/s	75	0.0384764				
3.0 m/s	75	0.0398699				

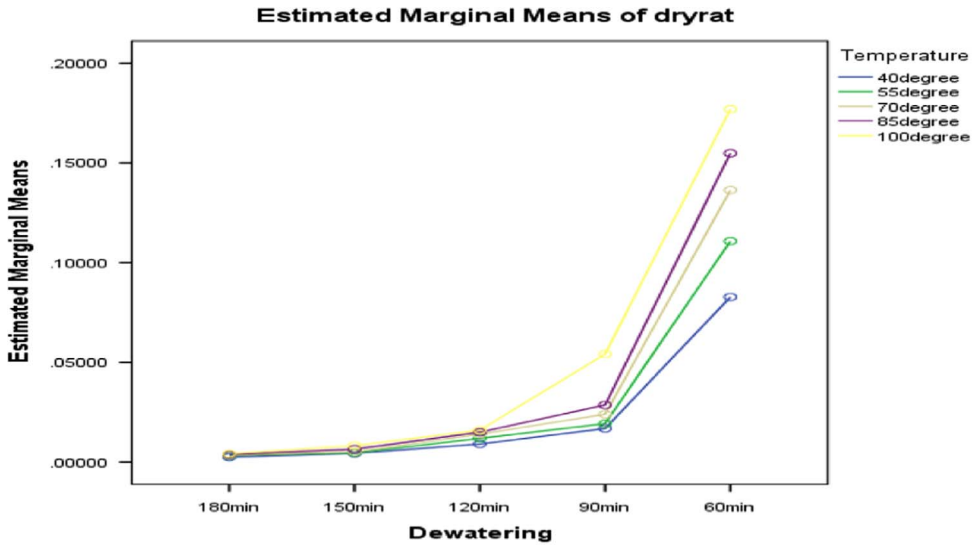


Fig. 6. Graph of interactions between dewatering and temperature for drying rate.

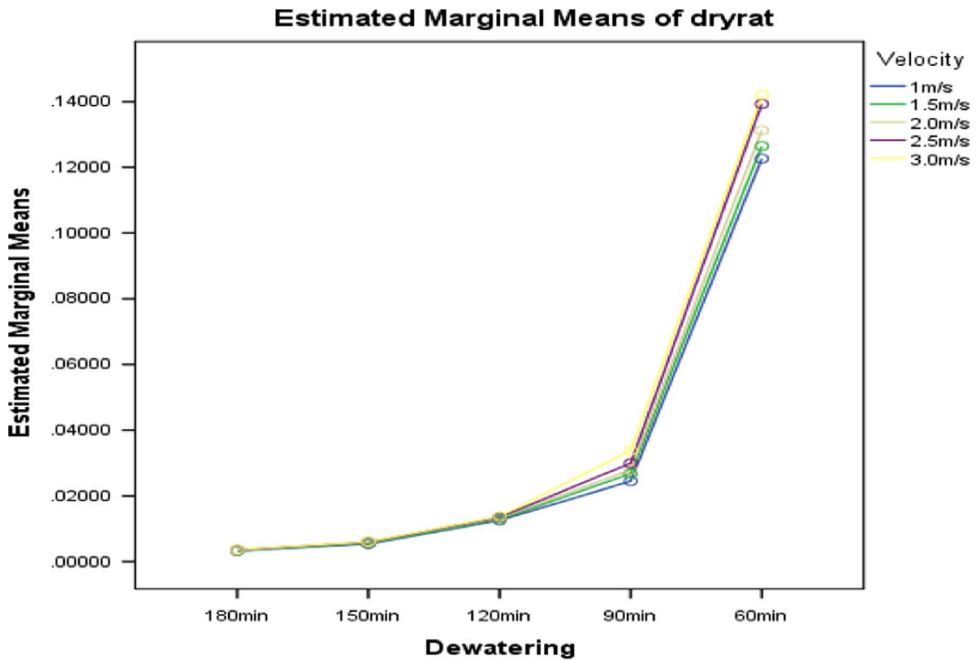


Fig. 7. Graph of interactions between dewatering and air velocity for drying rate.



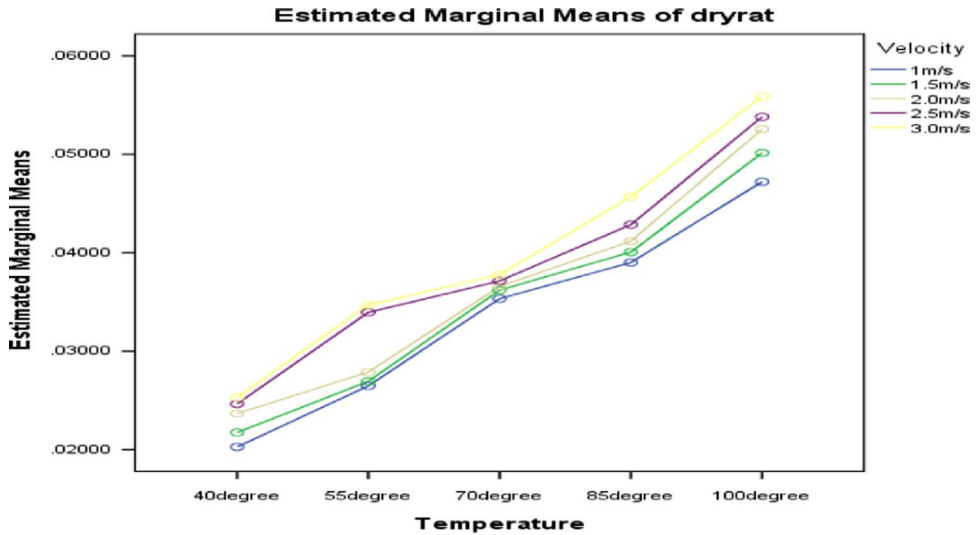


Fig. 8. Graph of interactions between temperature and air velocity for drying rate.

Tables 7–9 present post hoc tests for dewatering, temperature, and air velocity respectively. Again it was observed that all the levels of each of these factors are significantly difference from one another. It was observed that drying rate of the grated unfermented cassava mash increases as the dewatering time increases at different air velocity levels of the drying process. In addition, the temperature increases with the drying rate of grated unfermented cassava mash.

Figs. 6–8 present the graphs indicating the level of interactions between each pair of these factors, that is, dewatering and temperature; dewatering and velocity; temperature and velocity respectively.

In summary, both the drying time and drying rate of any quantity of grated unfermented cassava mash depend on the initial moisture content (dewatering) of the mash, the temperature of the dryer, the air velocity of the machine and the effects of their interactions in pairs and the three factors altogether.

## Acknowledgement

This work is a benefit of sponsorship from the Centre for Research, Innovation and Discovery, Covenant University, Ota, Nigeria. Also, we thank the management of National Centre for Agricultural Mechanization (NCAM) Idofian, Ilorin, for making the data available for us.

## Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.dib.2017.10.008>.

## Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.dib.2017.10.008>.

## References

- [1] A.L. Adejumo, A.F. Aderibigbe, S.K. Layokun, Cassava starch: production, physicochemical properties and hydrolysis, *J. Adv. Food Energy Secur.* 2 (2011) 8–17.
- [2] N.A. Aviara, L.N. Onuoha, O.E. Falola, J.C. Igbeka, Energy and exergy analyses of native cassava starch drying in a tray dryer, *Energy* 73 (2014) 809–817.
- [3] N.T. Dzedzoave, A.B. Abass, W.K.A. Amoa-Awua, M. Sablah, in: G.O. Adegoke, L. Brimer (Eds.), *Quality Management Manual for Production of High Quality Cassava Flour*, xii, International Institute of Tropical Agriculture (IITA), Ibadan, 2006, p. 68.
- [4] M.T. Lahai, J.B. George, I.J. Ekanayake, Cassava (*Manihot esculenta* Crantz) Growth indices, root yield and its components in upland and inland valley ecologies of Sierra Leone, *J. Agron. Crop Sci.* 182 (4) (1999) 239–248. <http://dx.doi.org/10.1046/j.1439-037x.1999.00299.x>.
- [5] A.O. Obadina, O.B. Oyewole, S.S. Abiola, L.O. Sanni, Short Communication-fungal Enrichment of Cassava Peels Proteins, 2006. Retrieved from (<https://tspace.library.utoronto.ca/handle/1807/6679>).
- [6] E.O. Okunade, O.A. Olaniyi, K.Y. Ogunleye, Adoption of improved cassava technologies among farmers in Surulere local government area of Oyo state, in: Proceedings of the 39th Annual Conference of Agricultural Society of Nigeria, University of Benin, Benin, October, 2005, pp. 15–18.
- [7] S. Lertworasirikul, Drying kinetics of semi-finished cassava crackers: a comparative study, *LWT-Food Sci. Technol.* 41 (8) (2008) 1360–1371.
- [8] E.C. Osoka, B.I. Onuh, Mathematical modelling of the garification of fermented cassava Mash, *J. Food Technol.* 5 (2) (2007) 139–142.
- [9] O.B. Oyewole, S.A. Odunfa, Characterisation and distribution of lactic acid bacteria in cassava fermentation during fufu production, *J. Appl. Bacteriol.* 68 (1990) 145–152.
- [10] T.P. Phillips, D.S. Taylor, L. Sanni, M.O. Akoroda, *A Cassava Industrial Revolution in Nigeria: The Potential for a New Industrial Crop*, FAO, 2004.
- [11] T.Y. Tunde-Akintunde, A.A. Afon, Modelling of hot-air drying of pretreated cassava chips, *Agric. Eng. Int.: CIGR* 12 (2) (2010) 34–41.
- [12] M.C. Uchegbu, A.A. Omede, E.B. Etuk, C.P. Okpala, C.I. Okoli, M.N. Opara, Effect of replacing maize with cassava root meal and maize/sorghum brewers/dried grains on the performance of starter broilers, *Trop. Subtrop. Agroecosyst.* 14 (1) (2010) 363–368.
- [13] J.O. Akingbala, B. Oguntimehin, A.B. Abass, Effects of processing methods on the quality and acceptability of fufu from low cyanide cassava, *J. Sci. Food Agric.* 57 (1) (1991) 151–154.
- [14] K. Adebayo, R.I. Lamboll, A. Westby, Contextualizing environmental, social and behavioral issues in the cassava post-harvest system in Africa, *Anthropologist* 5 (2009) 137–146.
- [15] S. Romuli, A. Abass, J. Müller, Physical properties of cassava grits before and after pneumatic drying, *J. Food Process. Eng.* 40 (2) (2017) (Article number e12397).
- [16] E. Rodriguez-Sandoval, L.Y. Polanía-Gaviria, G. Lorenzo, Effect of dried cassava bagasse on the baking properties of composite wheat bread, *J. Texture Stud.* 48 (1) (2017) 76–84.
- [17] J.M. Bindzi, V.D. Guiama, R. Ndjouenkeu, Combined smoking and drying kinetics of retted cassava pulp and effects on the physicochemical and pasting properties of the extracted starch, *Food Bioprocess Technol.* 7 (9) (2014) 2749–2758.
- [18] C.K. Yong, M.R. Islam, A.S. Mujumdar, Mechanical means of enhancing drying rates: effect on drying kinetics and quality, *Dry. Technol.* 24 (3) (2006) 397–404.
- [19] L.A. Handoyo, S. Zefanya, Y. Christanto, Drying performance of fermented cassava (fercaf) using a convective multiple flash dryer, in: *AIP Conference Proceedings*, vol. 1840(1), 2017. (Article number 060002).
- [20] G.O. Oluwadare, O. Agbaje, Corrosion of steels in steel reinforced concrete in cassava juice, *J. Appl. Sci.* 7 (17) (2007) 2474–2479.
- [21] A.O. Eni, D.K. Fasasi, Molecular detection of two cassava Begomoviruses in some parts of Southern Nigeria, *Afr. J. Agric. Res.* 8 (16) (2013) 1350–1353.
- [22] S.N. Aso, A.A. Teixeira, B.A. Welt, Physical properties of cassava flour made from solar convection-dried cassava chips, *Appl. Eng. Agric.* 31 (4) (2015) 655–660.
- [23] K. Waha, B. Zipf, P. Kurukulasuriya, R.M. Hassan, An agricultural survey for more than 9500 African households, *Sci. Data* 3 (2016) 160020.
- [24] V.G. Uarrota, R. Moresco, E.C. Schmidt, Z.L. Bouzon, E.C. Nunes, E.O. Neubert, L.A.M. Peruch, M. Rocha, M. Maraschin, Data supporting the role of enzymes and polysaccharides during cassava postharvest physiological deterioration, *Data Brief* 6 (2016) 503–506.