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INFLUENCE OF HYDROPHOBIC FLUID (PALM OIL) VARIETIES ON HYGROSCOPIC POTENTIALS OF FOUR VARIETIES OF CASSAVA GARRI AT VARYING STORAGE TEMPERATURES

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ABSTRACT

This study examined the effects of palm oil varieties (Dura and Pisfera) and their quantities (15 ml, 30 ml, and 45 ml) on the hygroscopic properties of four garri varieties (Poundable, Gamechanger, TMS 1632, and TME 419) at temperatures of 35°C, 45°C, and 55°C. Moisture absorption was assessed by placing 5 g samples of each garri in water baths set at the specified temperatures. The weight of each sample was measured at 30-minute intervals until three consecutive measurements indicated equilibrium. Results revealed that palm oil significantly ($p<0.05$) reduced moisture absorption across all samples, with Dura oil generally providing a more effective moisture barrier than Pisfera. At 45 ml, Dura oil caused a slight increase (11.63%) in moisture uptake, suggesting saturation, while Pisfera stabilized, indicating different chemical interactions. TME 419 exhibited the lowest (1.8%) moisture absorption, demonstrating superior resistance, whereas TMS 1632 absorbed the most moisture. Elevated temperatures increased moisture uptake, especially in control samples without oil. Kinetic parameters (absorption rate constant, K_1 and absorption capacity, K_2) varied with temperature and variety, reflecting changes in diffusion rates. The K_1 for Pisfera oil decreased from 19.67358 at 35°C to 7.388 at 55°C, while Dura oil decreased from 17.41483 to 10.866 over the same temperature range; conversely, K_2 for Pisfera increased from 0.058013 to 0.096799, whereas Dura's capacity decreased from 0.112241 to 0.058681 with rising temperature. Activation energy analyses showed Dura oil created a more resistant barrier, with values of 1.21 J/mol (TMS 1632), -0.5595 J/mol (TME 419), -0.4489 J/mol (Poundable), and 1.45 J/mol (Gamechanger). The findings suggest that palm oil improves garri's moisture resistance, with Dura oil being more effective, especially at lower quantities, informing optimal storage practices in humid environments.

Keywords: Rate Constant, Diffusivity, Peleg, Palm Oil, Absorption

1.0 INTRODUCTION

Cassava (Manihot esculenta Crantz) is a versatile tuberous crop with numerous varieties, serving as a primary dietary staple in various nations. Its domestication originated in Latin America, where it was initially cultivated by indigenous peoples over 4,000 years ago (Akinpelu et al., 2001). Following its European discovery, the crop was disseminated to Africa and Asia to enhance food security and for starch extraction purposes (Akinpelu et al., 2001). Nigeria stands as the leading global producer of cassava, with an estimated output of approximately 57.1 million metric tonnes in 2016 (FAOSTAT, 2018). The plant is capable of cultivation throughout the year and exhibits resilience under harsh environmental conditions, thriving in nutrient-deficient soils and tolerating drought stress (Burrell, 2003). Among staple carbohydrate sources, cassava provides a yield that exceeds rice by roughly 40% and surpasses maize by 25% (Tonukari, 2004). Additionally, it supplies vital micronutrients, including vitamins A, B, and C, as well as minerals such as iron and zinc, indicating a comprehensive nutritional profile despite its classification as a starchy tuber (Adenle et al., 2012). Cassava is also used as food following some of deformation during

processing, usually by fermentation that results in breakdown and removal of linamarin (Balagopalan, 1996; Ikediobi and Onyike, 2018)

However, cassava tubers contain significant levels of cyanogenic glycosides, which release cyanide upon hydrolysis. Ingesting cyanide-rich cassava or its derivatives can lead to health issues such as endemic goiter, cretinism, and tropical ataxic neuropathy (Abu et al., 2016). Consequently, appropriate processing methods are essential prior to consumption. Common processing techniques include conversion into flour, starch, fufu, and garri (Mtunguja et al., 2019; Teeken et al., 2018). Garri, an alternative to fufu, is produced by peeling, washing, grating, drying, sieving into granules, and frying the grated material. Often, oil is incorporated into the grated cassava during processing to enhance its sensory appeal and nutritional value. Garri is rich in dietary fiber and contains several vital vitamins. It can be consumed directly as a snack in its raw form, soaked in cold water and served with condiments, or rehydrated with hot water to produce a dough-like consistency, which is typically consumed alongside soup, sauce, or stew as a primary meal (Olumide, 2014). The addition of palm oil, which contains significant levels of saturated and unsaturated fats, vitamins, and antioxidants (Ndife, 2016), during garri production has been shown to reduce or mitigate cyanide content and to enhance both the nutritional and organoleptic qualities (Akpan., 2024). This process involves water removal or binding to improve microbiological stability and chemical preservation. The primary limitation affecting the shelf life of foods is microbial proliferation; thus, various preservation strategies are employed to ensure microbial stability and prolong product longevity. Garri, a starchy food, exhibits significant hygroscopicity, characterized by a high affinity for moisture absorption. This property is a major constraint to its shelf life and quality. Under normal atmospheric conditions, garri can equilibrate with relative humidity (RH) and absorb moisture up to 10-17% of its dry weight. Hygroscopicity refers to the ability of a substance to absorb water vapor from the surrounding environment, typically observed in humid conditions. Garri's hygroscopic nature leads to unpredictable moisture absorption when exposed to environments with varying relative humidity (RH). As a result, garri can become a breeding ground for fungi, causing it to clump together, become sticky, and lose its desirable texture. The moisture absorption capacity of garri is sufficient to support the growth of microorganisms and compromising its quality. To prevent spoilage, garri must be stored in a dry environment with controlled humidity levels. However, even with proper storage, garri's hygroscopic nature remains a challenge to its keeping quality. Effective management of garri's moisture absorption is crucial to maintaining its texture, appearance, and nutritional value. Palm oil can be added as an additive to garri to reduce its hygroscopic properties. It acts as a moisture barrier and forms a protective coating on the surface of garri flakes, limiting moisture absorption (Ndife, et al., 2019). The hydrophobic nature of palm oil helps repel water and reduce the tendency of garri to absorb moisture. This addition enhances the texture, mouth feel, and shelf life of garri. Proper application and balance of palm oil as an additive are important to achieve the desired reduction in hygroscopicity without compromising the flavor or quality of garri being produced.

The hygroscopic potentials of garri over time have been investigated through various studies, including Udensi et al. (2024) on white garri; Akume et al. (2019) examining garri supplemented

with mango fruit mesocarp flour; Ahaotu et al. (2021) and Obinna-Echem, P. C., and Amgbeye, 2021) analyzing malted soy-garri; Oghenechavwuko et al. (2013) compared cassava chips dried via sun-drying and oven-drying at 50°C and 70°C; Amadi and Adebola (2018); Amaefula et al. (2025); Adesokan et al. (2023) on gari derived from cassava flakes; Ndife et al. (2019) assessed the quality of garri from white and yellow cassava varieties mixed with palm oil; Anthony et al. (2023) evaluated garri produced from mixtures of different cassava cultivars; and Hasmadi et al. (2023) studied cassava flour cultivated in diverse locations in Sabah, Malaysia. Despite extensive research on the water absorption characteristics of garri, there remains a gap in understanding how palm oil influences garri's water absorption behavior under varying storage conditions.

Therefore, this study aims to examine the effects of hydrophobic fluid (palm oil) on the hygroscopic properties of garri stored at different temperature regimes.

2.0 METHODOLOGY

The cassava varieties (Poundable, Gamechanger, TMS 1632 and TME 419) and palm oil (Dura and Pisfera) used for this study was procured for the National Root Crop Institute, Umudike, and palm plantation of Micheal Okpara University of Agriculture, Umudike respectively, Abia State, Nigeria. The cassava tubers were manually peeled, thoroughly washed, grated, and then allowed to ferment in bags for 24 hours. From each variety, 15 kg of grated cassava was measured and divided into three equal portions of 5 kg each. Correspondingly, each variety of palm oil was split into three portions of 15 mL, 30 mL, and 45 mL, which were used to coat each of the 5 kg grated cassava samples before pressing to reduce moisture content and produce a friable texture. The dewatered grated cassava was then sieved and fried using an open-air method over a firewood fire. Samples of each garri variety weighing 5 grams were carefully measured from the dried, oiled garri and placed into moisture cans. To determine their moisture content, these cans were subjected to a controlled environment using a modern water bath (model WB02A11B-2). The water bath was preheated and maintained at temperatures of 35°C, 45°C, and 55°C, and allowed to stabilize for about 1 hour to ensure a uniform humid environment. The samples were weighed manually at 10-minute intervals until no further weight gain was observed, indicating moisture equilibrium. The moisture content was determined at each point as Eq 1. (Mohsenin, 1986)

$$M_t = \frac{w_{t+1} - w_t}{w_{t+1}} \qquad \text{..... 1}$$

Where;

M_t = moisture content at time t;
w_t = weight of sample at time t;
w_{t+1} = weight at t+1

The entire procedure was repeated three times for each treatment condition to ensure accuracy and reproducibility. After the water bath treatment, the samples were removed, and their final weights were recorded carefully. This method was employed to obtain precise and reliable measurements of moisture content across different treatment conditions. The **kinetics** of moisture absorption in garri during storage was analyzed using:

Diffusion model: Water uptake kinetics was modeled using Fick's second law of diffusion as Eq 2 (Cai et al., 2023):

$$\frac{M_t - M_o}{M_{eq} - M_o} = 1 - e^{\frac{-D\pi^2 t}{4L^2}} \quad \ldots\ldots\ldots\

lower, indicating that moderate oil addition enhances the material's resistance to moisture uptake. The samples with 45 ml of oil still show reduced moisture levels, but the decrease is less consistent, especially in the TME 419 variety, suggesting a possible saturation point where additional oil no longer provides significant benefits. The control sample's high moisture content confirms that without oil, the material remains highly susceptible to moisture absorption in humid environments. The trend of moisture decreases in Gamechange and TMS 1632 varieties with increasing oil quantity further supports the idea that oil enhances the barrier properties of the material. The hydrophobic nature of the oils prevents water molecules from diffusing into the sample matrix, thus improving storage stability. However, at higher oil levels, the effectiveness slightly diminishes, possibly due to oil saturation on the surface or uneven distribution. The slight increase in moisture absorption at the highest oil level in some varieties may also be attributed to excess oil creating imperfections that trap moisture. These findings suggest that optimal oil addition enhances moisture resistance by forming a protective coating, but excessive amounts may lead to diminishing returns or even counterproductive effects.

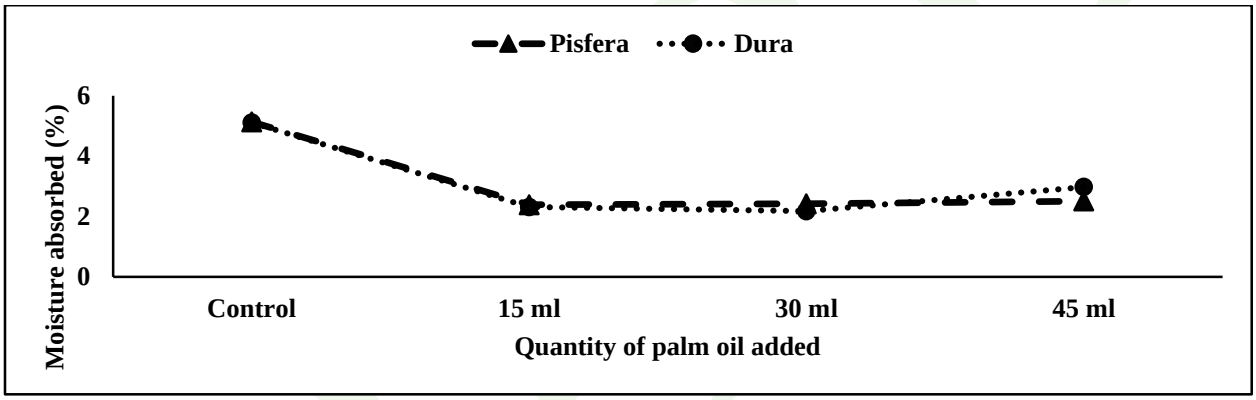


Figure 1: The Plot of Percentage Moisture Absorbed Against Quantity of Palm Oil Variety Added

Table 1: The absorption capacity and rate constant of cassava varieties at different temperatures

Palm oil	^{0}C	Variety 1 (TMS 1632)						Variety 2 (gamechanger)					
		15ml		30ml		45ml		15ml		30ml		45ml	
		K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2	K_1	K_2
Pisfera	35	21.03	-0.0088	22.11	0.0311	6.08	0.0587	18.81	-0.0192	30.8	-0.2858	19.37	-0.0227
	45	22.11	0.03108	21.02	0.0138	11.55	0.0601	11.69	0.0369	13.06	0.0469	8.453	0.0312
	55	6.084	0.05867	5.60	0.0750	5.216	0.0849	6.518	0.0574	7.337	0.0574	7.717	0.0595
Dura													
	35	9.289	0.1647	9.29	0.1647	7.14	0.0287	18.9	-0.0557	27.09	-0.2316	36.57	-0.285
	45	12.74	0.0734	7.33	0.0376	8.31	0.0164	15.93	-0.0206	12.21	0.0704	16.25	-0.0189
	55	12.74	0.0734	20.86	0.0105	21.32	0.105	5.892	0.0785	6.424	0.0766	6.751	0.0403
		Variety 3 (TME 419)						Variety 4 (Poundable)					
Pisfera	35	14.35	0.1593	5.439	0.1738	15.61	0.1	52.12	0.1951	13.94	0.1786	16.42	0.1362
	45	10.46	0.1714	9.079	0.1717	8.174	0.1611	11.2	0.1197	20.43	-0.0652	11.99	0.0843
	55	8.148	0.0677	9.519	0.069	8.107	0.1495	4.428	0.2312	9.375	0.0737	10.62	0.1776
Dura													
	35	18.05	0.1028	20.99	0.4149	17.67	0.1532	14.95	0.3046	18.19	0.3177	10.94	0.2314
	45	21.13	0.1417	10.87	0.08834	4.18	0.2073	9.641	0.1157	13.75	0.125	11.81	0.1035
	55	16.26	-0.0626	9.119	0.0757	8.04	0.148	6.631	0.06745	7.509	0.0833	8.22	0.0291

ml = the quantity of palm oil added

The varying quantity of palm oil (15 ml, 30 ml, 45 ml) added to different gari varieties does not lead to statistically significant ($p<0.05$) differences in their absorption rate and capacity, indicating that the oil quantity does not markedly influence these parameters across the tested levels. However, an exception was observed with the K_1 of the TMS 1632 cassava variety, which has the lowest average value of 9.932, suggesting that for this specific variety, the initial absorption rate (represented by K_1) is notably lower compared to others. The lack of significant differences ($p<0.05$) implies that the absorption kinetics both K_1 and K_2 are relatively stable regardless of the oil quantity added, except for certain specific measurements like K_1 in TMS 1632. This indicates that the process of absorption in these gari varieties is not heavily dependent on the amount of oil within the tested range, possibly pointing to inherent properties of the varieties that govern absorption behavior more than the oil quantity.

3.2 The Effect of Cassava Variety on the Hygroscopic Characteristics of Garri

Figure 2 revealed that the choice of cassava variety significantly ($p<0.05$) influences the hygroscopic properties of the resulting garri.

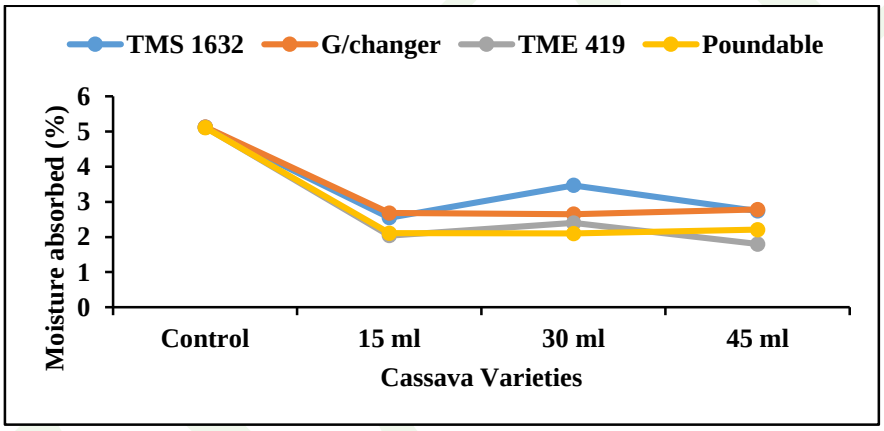


Figure 2: Cassava variety effect on the percentage moisture absorbed

Based on the results, TME 419 exhibited the least tendency to absorb moisture among the cassava varieties while TMS 1632 had the highest. This is likely because TME 419 has a lowest moisture content across the different oil treatments except at 30 ml of oil added, indicating a better inherent resistance to moisture absorption. The chemical composition of TME 419, such as its starch structure or fiber content, may contribute to its reduced water affinity, making it less susceptible to moisture uptake. Additionally, TME 419 might have a more effective natural barrier or surface characteristics that limit water penetration compared to TMS 1632, Gamechanger and Poundable varieties. The specific molecular interactions between water molecules and the cellular components of TMS 1632 could also play a role in its lower moisture absorption tendency.

Therefore, TME419's inherent properties make it more resistant to moisture, which is advantageous for storage and processing in humid conditions. The results also demonstrate that adding oil to garri produced from different cassava varieties effectively reduces their moisture uptake compared to the control, which exhibits the highest moisture levels. This reduction is likely due to the oil creating a hydrophobic barrier on the surface of the garri samples, which limits water

penetration and absorption. Abiodun et al., (2015) conducted a water absorption comparison between two crops plantain and cocoyam in controlled storage condition, from their findings, the specific patterns of water adsorption kinetics, shedding light on crucial factors influencing cocoyam's ability to retain moisture during storage. This result held similar trend when compared to the factors affecting water absorption in garri. The effect of variety on kinetic parameters indicated that TMS 1632, whether using Dura or Pisfera oil, generally shows moderate to high K_1 mean values, particularly at higher temperatures like 55°C, with some increases observed at this temperature (Table 1). Its K_2 mean values tend to be positive but fluctuate slightly, with Pisfera at 35°C showing K_2 values close to zero or slightly negative, indicating variable capacity. TME 419 displays more variability in K_1, with higher values at 35°C that tend to decrease as temperature rises, while its K_2 remains positive in most cases but can turn negative at 55°C, suggesting potential capacity limitations. Gamechanger exhibits lower K_1 at 35°C but demonstrates increases at 45°C, while its K_2 is mostly negative or near zero, implying reduced efficiency or lower capacity. Poundable, particularly with Pisfera oil, tends to have high K_1 values at 35°C and consistently positive, relatively high K_2 values, indicating strong capacity. These trends suggest that variety and temperature significantly influence the kinetic parameters

3.3 The Effect of Temperature on the Hygroscopic Characteristics of Garri

The influence of temperature on the hygroscopic characteristics of garri is presented in Fig 3. The result obtained showed that temperature has a substantial impact on the hygroscopic properties of garri.

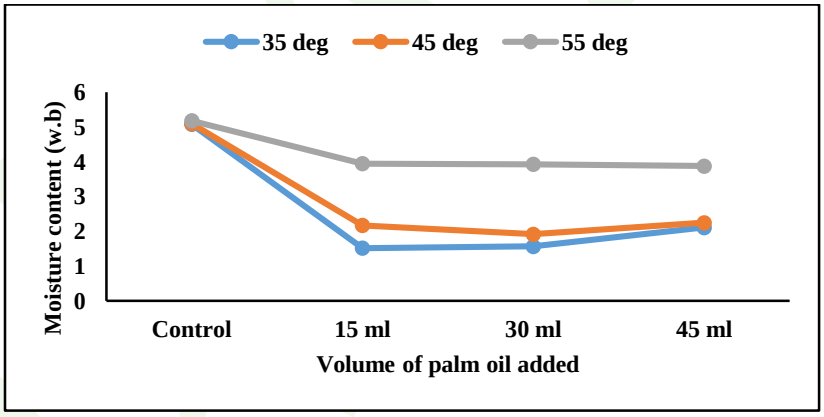


Figure 3: Temperature Effect on the Percentage Moisture Absorbed

The moisture absorbed by garri increases with temperature, indicating that higher temperatures promote moisture uptake. This may affect garris' texture and shelf life. Meanwhile similar result was gotten by Titilope et al., (2018), the team studied the effect of temperature on the physical properties (moisture content) of cocoyam. Their study revealed that the absorption of water by processed cocoyam is significantly ($p<0.05$) influenced by temperature variations. Garri samples mixed with palm oil demonstrated significantly ($p<0.05$) lower moisture absorption compared to the control, highlighting the oil's role as a moisture barrier. At 35°C, the control absorbs the most moisture, while the oil-treated garri absorb much less, with similar values for 15 ml and 30 ml of palm oil. As temperature rises to 45°C and 55°C, moisture absorption continues to increase across

all samples, possibly due to the increased kinetic energy of water molecules, which enhances their diffusion into the garri. The garri oiled with 30 ml of palm oil tends to offer slightly better moisture resistance at higher temperatures. The presence of palm oil effectively reduces hygroscopicity in garri, especially at elevated temperatures. This suggests that palm oil can be used as a natural moisture barrier to improve storage stability. The possible cause of this behavior is the hydrophobic nature of palm oil, which limits water diffusion into the garri, particularly when used in larger volumes. The data in Table 1 also showed that the effectiveness of oil in garri to prevent moisture absorption and storage capacity varies with temperature and oil quantity. At lower oil quantity of 15 ml, the capacity (K_2) decreases as temperature increases, suggesting that higher temperatures may reduce the oil's ability to maintain a protective barrier. Specifically, K_2 drops from mean values of 0.1053 at 35°C to 0.0715 at 55°C, indicating that the oil film becomes less effective at higher temperatures in preventing moisture infiltration. Conversely, at higher oil volumes like 45 ml, the capacity slightly increases at elevated temperatures, from mean values of 0.0500 at 35°C to 0.0993 at 55°C, implying that a thicker oil layer provides better protection in warmer conditions. The absorption rate (K_1) also decreases with increasing temperature at lower oil quantity, indicating that the oil's initial adherence efficiency diminishes as temperature rises. At higher oil volumes, the absorption rate remains relatively stable or slightly improves at higher temperatures, which could help maintain a consistent barrier. The results suggest that using larger amounts of oil enhances the garri ability to resist moisture at different temperatures, especially as temperature increases.

3.4 The Effect of Palm Oil Variety on the Hygroscopic Properties of Garri

The summary of the effect of two varieties of palm oil (dura and pisfera) on the hygroscopic nature of garri is presented in Fig 4 and Table 1. The result showed that no significant effect exists between the two palm oil varieties on the hygroscopic properties of garri.

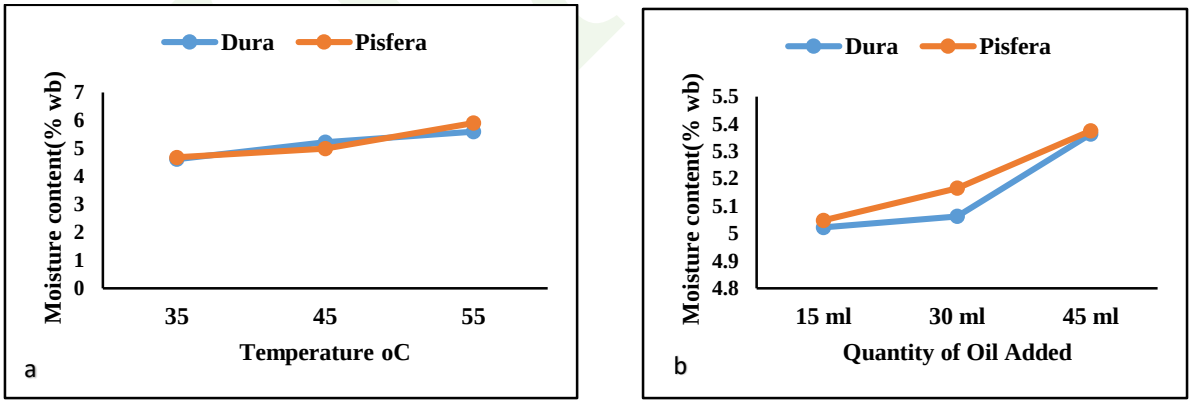


Figure 4: The palm oil variety interaction with (a) Temperature and (b) quantity of oil added

As the temperature increases from 35°C to 55°C, the percentage of moisture absorbed in both Dura and Pisfera varieties also increases. Specifically, Dura's moisture absorption rises from approximately 4.62% to 5.61%, while Pisfera's increases from about 4.68% to 5.91%. This trend suggests that higher temperatures promote greater moisture absorption in both oil varieties, likely due to increased molecular activity and moisture diffusion at elevated temperatures. Between the

two, Pisfera consistently exhibits higher moisture absorption across all temperatures, indicating it is less effective at preventing moisture uptake. Therefore, Dura oil appears to be the better choice for minimizing moisture absorption when storing garri at varying temperatures. Fig 4b also indicates that as the quantity of oil increases from 15 ml to 45 ml, the percentage of moisture absorbed by the garri also increases slightly for both Dura and Pisfera varieties. Specifically, Dura's moisture absorption rises from about 5.02% at 15 ml to 5.36% at 45 ml, while Pisfera's increases from approximately 5.05% to 5.38%. This trend also suggests that higher quantities of oil may contribute to increased moisture absorption, possibly because excess oil creates a barrier that traps moisture or affects the moisture diffusion process. Between the two, Dura generally has slightly lower moisture absorption values across all quantities, indicating it is more effective at preventing moisture uptake. Therefore, using a lower quantity of Dura oil, such as 15 ml, is better for minimizing moisture absorption in garri. Moisture absorption rate (k_1) decreases with increasing temperature for both Pisfera and Dura oils (Table 1), indicating reduced moisture uptake at higher temperatures. Pisfera oil shows a sharp decline from 19.67358 at 35°C to 7.388 at 55°C, suggesting it is more sensitive to temperature changes. Dura oil decreases from 17.41483 at 35°C to 10.866 at 55°C, but its reduction is less pronounced, indicating greater stability across temperatures. The decreasing trend in both oils may be due to lower moisture affinity or evaporation during heating. Conversely, moisture absorption capacity (k_2) increases with temperature for Pisfera, rising from 0.058013 to 0.096799, while Dura's capacity decreases from 0.112241 to 0.058681, indicating different chemical behaviors. Hence, Dura oil is more effective at reducing both moisture absorption rate (k_1) and capacity (k_2) at higher temperatures, making it the better choice for controlling moisture in garri under varying temperature conditions.

3.5 Palm Oil and Garri Variety Influence on the Effective Diffusivity and Activation Energy of Garri

The effective diffusion values for garri mixed with dura oil decrease from 1.022892 at 35°C to 0.725567 at 45°C, then slightly increase again at 55°C (Fig 4), indicating variable moisture diffusion behavior with temperature. In contrast, garri mixed with pisfera oil shows a steady increase in diffusion values from 0.641142 at 35°C to 0.733558 at 55°C, suggesting enhanced moisture movement at higher temperatures. This implies that dura oil initially hinders moisture diffusion at moderate temperatures before a slight rise at higher temperatures, whereas pisfera oil consistently promotes moisture diffusion as temperature increases. In all, dura oil appears to create a more resistant barrier to moisture transfer in garri, likely due to its composition or viscosity, which impedes moisture movement more effectively than pisfera oil. These differences highlight the influence of oil type on moisture transfer properties in garri across various temperatures.

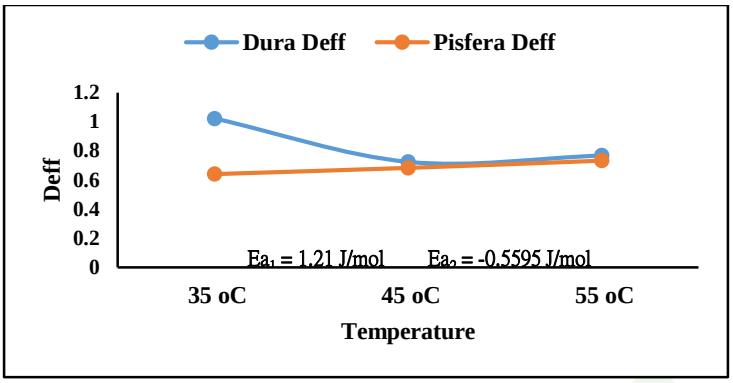


Figure 5: The plot of D_{eff} dependence on palm oil variety *(Ea_1 and Ea_2, are activation energy for Dura and pisfera respectively)*

The effective diffusion values for different garri varieties as presented in Fig 6, increase with temperature, indicating that higher temperatures generally promote moisture diffusion. TMS 1632 shows a slight increase from 1.9953 at 35°C to 2.237 at 55°C, suggesting moderate sensitivity to temperature changes. TME 419 exhibits relatively stable diffusion values around 2.33 at 35°C and 45°C, but a decrease to 1.95975 at 55°C, which may imply reduce moisture diffusion at higher temperatures for this variety. Poundable displays a consistent increase in diffusion values from 1.97375 at 35°C to 2.2004 at 55°C, indicating a steady response to temperature elevation. Gamechanger has the highest diffusion values among the varieties, peaking at 3.6812 at 35°C, then decreasing at higher temperatures, which could suggest a different moisture absorption mechanism or barrier effect at elevated temperatures. The E_a values in Figs 5 and 6 represent the energy barrier for moisture diffusion in different garri varieties when mixed with palm oil. Positive E_a values (e.g., TME 419, Gamechanger, DURA) indicate that higher temperatures increase moisture diffusion, meaning more energy is needed for moisture to penetrate the garri. The highest positive E_a for Gamechanger suggests it is most sensitive to temperature changes in terms of moisture absorption. Negative E_a values (e.g., TMS 1632, Poundable, PISFERA) imply that increasing temperature might actually reduce the rate of moisture diffusion in those varieties, possibly due to the oil forming a barrier or other inhibitory effects. Such negative values could also indicate that moisture absorption is more favorable at lower temperatures or that the process is unconventional.

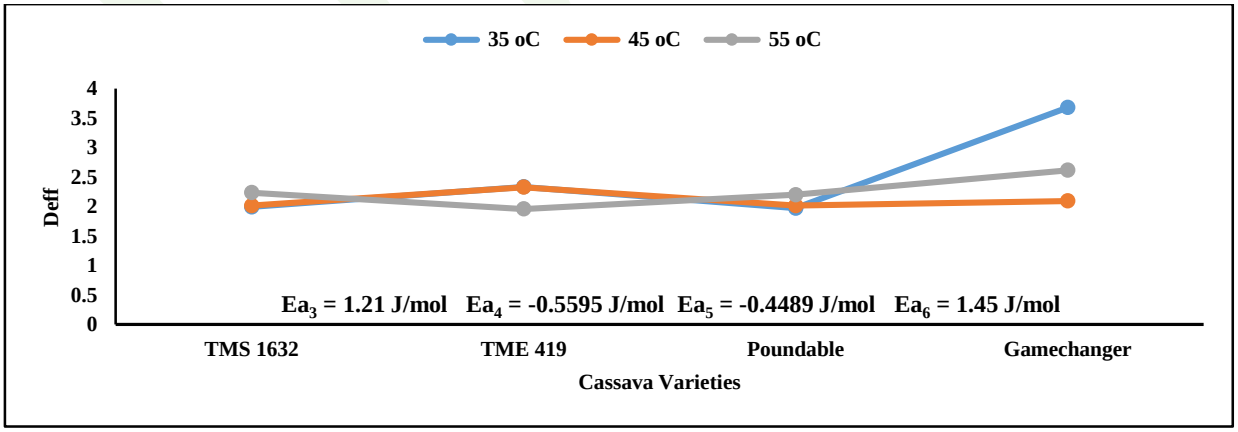


Figure 6: The plot of D_{eff} dependence on garri variety. (*Ea_3, Ea_4, Ea_5, and Ea_6 are aectivation energy for TMS1632, TME419, Poundable and Gamechanger respectively)*

These findings suggest that some garri varieties respond differently to temperature changes in the presence of palm oil, affecting their moisture stability. Therefore, the negative $E_a$values highlight varieties where temperature increase may hinder moisture absorption, likely due to the interaction with palm oil.

4.0 CONCLUSION

This study demonstrates that the addition of palm oil, particularly Dura and Pisfera varieties, significantly reduces the moisture absorption of garri, thereby enhancing its storage stability in different temperature conditions. Dura oil generally provides a more effective moisture barrier compared to Pisfera, although increasing oil quantities beyond 15 ml may slightly elevate moisture uptake in Dura. The hygroscopic behavior varies among different cassava varieties, with TME 419 showing the lowest tendency to absorb moisture, attributed to its inherent structural properties. Temperature positively influences moisture absorption in garri, with higher temperatures promoting increased moisture diffusion, especially in samples treated with palm oil. Oil-treated garri consistently exhibits lower moisture absorption rates and capacities than untreated controls, confirming the hydrophobic role of palm oil. The kinetic parameters indicate that moisture absorption processes are relatively stable across oil quantities, but vary with temperature and variety, affecting diffusion and activation energy. In all, the interaction between oil type, quantity, cassava variety, and temperature plays a crucial role in determining garri's hygroscopic properties and storage potential. These findings can inform optimal processing and storage strategies for garri in varying climatic conditions.

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