Dr. Ugwuoke Malachy Okonkwo, 2025, 13:5
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Impact of Adulteration with Pawpaw Extract on The Phsicochemical Characteristics of Palm Oil.D

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Abstract- Palm oil is a widely consumed edible oil valued for its nutritional, economic, and industrial importance. However, adulteration with substances such as pawpaw (Carica papaya) extract has become a common malpractice aimed at enhancing color and yield, often at the expense of quality. This study examined the effects of adulteration with pawpaw extract on the physicochemical characteristics of palm oil over an eight-week storage period. Palm oil samples were adulterated at concentrations of 0.05–0.08 g/mL and evaluated for acid value, saponification value, iodine value, peroxide value, free fatty acid content, specific gravity, viscosity, melting point, moisture content, and color using standard AOAC (2019) and Codex (2019) procedures. Results showed that adulteration significantly altered both chemical and physical properties. The acid value increased from 2.41 to 6.38 mgKOH/g, while free fatty acids rose from 1.21% to 3.19%, indicating accelerated hydrolysis and reduced stability. Peroxide value increased sharply from 8.12 to 19.47 meq/kg, confirming enhanced oxidative rancidity. Saponification value increased from 195.1 to 209.3 mgKOH/g, suggesting incorporation of lower-molecular-weight fatty acids, whereas iodine value decreased from 53.6 to 41.2 g I_2/100 g, and indicating reduced unsaturation. Physical changes included increased specific gravity (0.903–0.923), viscosity (43.5–58.2 cP), and moisture content (0.18–0.41%), alongside a reduced melting point (36.4–32.8 °C) and a color shift from dark red to reddish-yellow. Finally, pawpaw extract markedly deteriorated the physicochemical quality of palm oil, promoting oxidation, rancidity, and moisture absorption. These changes compromise its edibility, shelf life, and industrial applicability. The findings underscore the urgent need for stricter monitoring and enforcement of food quality regulations to prevent adulteration and ensure consumer safety.

Keywords: palm oil, pawpaw extract, adulteration, physicochemical properties, food safety, quality control.

I. INTRODUCTION

Palm oil (Elaeis guineensis) is one of the most widely produced and consumed edible oils globally, accounting for over one-third of total vegetable oil trade. It is particularly important in West Africa and Southeast Asia, where it serves as a major dietary lipid source and a critical raw material for food and non-food industries (Alhaji, 2024). Its balanced composition of saturated and monounsaturated fatty acids, coupled with natural antioxidants such as tocopherols, tocotrienols, and carotenoids, contributes to its oxidative stability and nutritional value (Masri, 2025). For these reasons, palm oil is integral to culinary traditions, industrial processing, and socio-economic livelihoods in producing countries. Despite its value, the integrity of palm oil has been compromised by adulteration practices. In informal markets, producers or vendors often mix palm oil with additives to increase apparent volume, intensify colour, or alter sensory properties. These adulterants range from synthetic dyes to natural plant extracts. While such practices may temporarily enhance marketability, they raise serious concerns about nutritional quality, oxidative stability, and consumer safety (Okogeri, 2020; Abdullahi, 2023).

The growing demand for palm oil in Nigeria and other African nations has made the issue of adulteration more urgent, requiring detailed research into the impacts of common adulterants. One adulterant of particular concern is pawpaw (Carica papaya) extract. Pawpaw is widely cultivated across tropical regions, and different parts of the plant (seeds, pulp, rind, and leaves) contain a variety of lipids and bioactive compounds. Pawpaw seed oil, for example, is rich in oleic acid (~70–78%), with smaller amounts of palmitic, stearic, and linoleic acids. Its saponification values (~190 mg KOH/g) and iodine values (~75 g I_2/100 g) suggest high

unsaturation and a relatively low molecular weight lipid profile (Leitão et al., 2022; Kong, 2021). These characteristics make pawpaw oil potentially useful for industrial applications, but they also mean that pawpaw extracts can significantly alter the physicochemical balance of any oil they are added to. Beyond lipids, pawpaw tissues contain enzymes (e.g., papain), flavonoids, tannins, saponins, alkaloids, and phenolic compounds. These molecules exert antioxidant, antimicrobial, and sometimes pro-oxidant effects (Njoku et al., 2024). When incorporated into palm oil, they could influence hydrolysis, oxidation, and overall stability. For instance, antioxidants from pawpaw might temporarily suppress peroxide formation, lowering peroxide values (PV), whereas moisture and enzymatic activity from extracts might increase hydrolysis, elevating free fatty acids (FFA) and acid values. Thus, pawpaw adulteration introduces a complex set of interactions that can degrade the quality of palm oil in unpredictable ways. Physicochemical parameters as indicators of adulteration. Standard indices are routinely used to evaluate edible oil quality.

Acid value and %FFA measure hydrolysis of triglycerides and are critical indicators of spoilage. Peroxide value reflects the degree of primary oxidation and rancidity. Saponification value relates to average molecular weight of fatty acids, while iodine value measures the degree of unsaturation. Physical properties such as specific gravity, refractive index, viscosity, melting point, colour, and moisture content also serve as markers of adulteration and quality loss (Metrohm, 2020; FAO/WHO Codex, 2019). Any deviation from Codex or national standards may signal adulteration or poor handling practices. Studies on pawpaw oil itself have shown promising stability and bioactive potential.

For example, blending pawpaw seed oil with soybean oil reduced the accumulation of free fatty acids during heating, indicating antioxidant protection (Puangsri et al., 2005; El-Kholany, 2018). Ultrasound-assisted extraction of pawpaw seed oil yielded stable oils with high oleic acid content and good resistance to oxidation (Zhang et al., 2021). Similarly, comparative studies of ripe and unripe pawpaw seed oils reported low peroxide values, low acid values, and suitable saponification indices for soap production (Okafor et al., 2020). These findings highlight pawpaw's potential value in food and industrial applications, but they also suggest that adulterating palm oil with pawpaw extract will inevitably shift its physicochemical profile.

Despite numerous studies on palm oil quality and on pawpaw seed oil properties, there is little direct evidence on how pawpaw adulteration affects palm oil over storage time. Specifically: The extent to which pawpaw extract alters acid value, FFA, and peroxide value of palm oil under ambient storage conditions remains poorly characterized. Few studies have evaluated how adulterant concentration influences these changes. Physical changes such as viscosity, colour, refractive index, and melting point in pawpaw-adulterated palm oil are underexplored. No systematic studies have compared palm oil's physicochemical indices with and without pawpaw adulteration across time scales relevant to market storage (weeks to months). Despite numerous studies on palm oil quality and on pawpaw seed oil properties, there is little direct evidence on how pawpaw adulteration affects palm oil over storage time. Specifically:

The extent to which pawpaw extract alters acid value, FFA, and peroxide value of palm oil under ambient storage conditions remains poorly characterized. Few studies have evaluated how adulterant concentration influences these changes. Physical changes such as viscosity, colour, refractive index, and melting point in pawpaw-adulterated palm oil are underexplored. No systematic studies have compared palm oil's physicochemical indices with and without pawpaw adulteration across time scales relevant to market storage (weeks to months). This study directly addresses these gaps by examining the effects of adulterating palm oil with pawpaw extract at defined concentrations (0.05–0.08 g/mL) over an eight-week storage period.

Key physicochemical and physical parameters were systematically measured, including acid value, FFA, peroxide value, iodine value, saponification value, moisture content, specific gravity, refractive index,

viscosity, melting point, and colour. By analyzing how adulteration level and storage time interact to influence these indices, the study provides a comprehensive picture of how pawpaw extract compromises or modifies palm oil quality. Preliminary results from this work indicate that pawpaw extract increases acid and saponification values, suggesting greater hydrolysis and presence of lower-molecular-weight fatty acids. Conversely, iodine values decrease with higher adulteration, implying reduced unsaturation and potential loss of nutritional quality. Physical properties such as viscosity and colour also shift significantly, reflecting the compositional and phytochemical contributions of pawpaw extract. Collectively, these findings show that adulterating palm oil with pawpaw extract alters both chemical and physical quality parameters in ways that may mislead consumers and affect industrial processing.

MATERIALS AND METHODS

Materials

Palm fruits and ripped paw paw were the primary materials utilized in this study. The materials (palm fruits and ripped pawpaw) were bought at Ogbete fruit Market in Enugu State. Reagents and chemicals used in this work were acquired from Scientific Empire limited Enugu, while all the laboratory works/analysis were done at Projects development institute (PRODA) and Chemical Engineering laboratory Sate University of medical and applied sciences, Igbo-Eno (SUMAS).

Methods

- **Pretreatment of raw materials**

Freshly harvested ripe palm fruits(Elaesis guineeasis) were extricated from the bunches and boiled for one and half hour .Then the boiled fruits were subjected to pressing process in order to separate the oil from the mesocarp and the separated oil were boiled again, decanted to obtained the pure crude red palm oil to ensure authenticity and minimize pre-adulteration risks. The oil was also filtered to remove suspended impurities and stored in amber bottles at ambient temperature before use. Ripe pawpaw (Carica papaya) fruits were sourced from a local farm. The fruits were thoroughly washed, peeled, and deseeded; the pulp was sliced and oven-dried at 60 °C to reduce moisture and microbial activity. The dried pulp was milled into fine powder and subjected to solvent extraction using n-hexane in a Soxhlet apparatus to obtain pawpaw extract. The extract was concentrated with a rotary evaporator at 40 °C, stored in airtight containers, and refrigerated at 4 °C until analysis. Both palm oil and pawpaw extract were then blended in predetermined ratios (0.05–0.08 g/mL) for physicochemical assessment following standard protocols (Akinmoladun et al., 2021; Zhang et al., 2021; Masri, 2025; Njoku et al., 2024).

Physicochemical Characterization of adulterated palm oil

Following the method stated by AOAC 2019 and Metrohm 2020, acid value (AV), saponification value(SV), percentage free fatty acid(%FFA), peroxide value (PV), iodine value (IV) were determined, while specific gravity(S.G), melting point (MP),viscosity (VSC), percentage moisture content (%MC) and color were assessed using triple beam weighing balance, capillary tube, viscometer, oven-drying, and Lovibond tintometer methods following standard analytical procedures (AOAC, 2019) respectively

Determination of %FFA and Acid Value (AV)

Oil sample (1.5g) was weighed into 250ml stopper bottle, 20ml of ethanol was added to the oil and the mixture was shaken thoroughly, then 3 drops of phenolphthalein were added and the mixture was titrated with 0.1M sodium hydroxide. The Colour of the mixture changed from deep pink to light pink.

$$AV=\frac{56.1\times V\times M}{W} \quad (1)$$

Where: W(g) = Weight of Oil sample, V(cm^3)= Volume of sodium hydroxide used and M = Molarity

Determination of Saponification Value (SV)

One gram of the oil sample was weighed and put in a 250ml conical flask. 50ml of 0.5M enthanolic KOH was added into the sample in the flask and refluxed for 30 minutes using the reflux condenser in order to obtain a perfect dissolution. After refluxing for 30 minutes, the sample was allowed to cool, then 3 drops of phenolphthalein indicator were added and the mixture was used to titrate the oil sample to a colourless end point. Another titration was carried

out with the sample procedure but without oil sample (ie blank titration) and a colourless solution was obtained.

$$S.V = \left(\frac{56.1\times(V2-V1)\times M}{W}\right) \quad (2)$$

Where: V2 = Volume of blank titer, V1 = Volume of the sample, W = Weight of Oil sample & M = Molarity

Determination of Iodine value (IV)

Oil sample (1g) was measured into a clean flask mixed with 15mls of chloroform and 25mls of Wiji's solution. Wiji's solution was prepared as follows: Two gram (2g) of iodine were dissolved in 50cm³ of glacial acetic acid, 2.25g of iodine also dissolved in 100cm³ of glacial acetic acid. The two were mixed and make up to 250cm³ with glacial acetic acid. The solution was covered and kept in a dark place for 30minutes. 20mls of 10% potassium iodide and 150mls of distilled water were also added. The solution was titrated until colour separation occurred, 5mls of 1% starch indicator was added, the colour changes to blue black. 0.1M sodium thiosulphate was used to titrate the solution again until colour turns colourless. The same thing was done for the blank sample.

$$IV = \frac{56.1\times(V2-V1)\times M}{W} \quad (3)$$

Where: W(g) = Weight of oil sample, V1 (cm3) = Volume of Sodium thiosulphate, V2 (cm3)= Volume of Sodium thiosulphate in the blank, M= Molarity of Sodium thiosulphate.

Determination of Peroxide Value (PV)

Oil sample (1.5g) was weighed into a clean conical flask. 25ml mixture of acetic acid and chloroform in the ratio of 2:1 were added and shaken vigorously, 1ml of 10% potassium iodide (KI) was added. It was covered and kept in a dark place for 1minute. The sample was brought out and 35ml of distilled water was added, after 2ml of starch solution (1%) indicator was added. It was then titrated with 0.01M. sodium thiosulphate solution until colour changes to colourless end point.

Blank solution was carried out and was titrated with 0.01M sodium thiosulphate solution.

$$P.V = \frac{S\times M\times 100}{W} \quad (4)$$

Where: S = Titer value of Sodium thiosulphate used, M = Molarity & W = Weight of sample.

Determination of Specific Gravity (SG)

A clean dry density bottle was weighed with a triple beam weighing balance and the weight recorded. The bottle was then filled with water and weighed. The water was poured out and the bottle dried. The dry bottle was then filled with the oil sample and the weight recorded.

The Specific gravity is calculated as follows:

$$S.G = \frac{W_3 - W_1}{W_2 - W_1} \quad (5)$$

Where: W1 = Weight of density bottle, W2 = Weight of density bottle with water & W3 = Weight of density bottle with oil sample.

Determination of viscosity

The viscometer was filled with the oil sample through tube L to slightly above the G mark, using a long pipette to minimize wetting of the tube. The viscometer was then placed vertically in a water bath to attain a specified temperature (30ºC). The volume of the liquid was adjusted so that the bottom of the meniscus settle at the mark G. The oil was sucked to a point above 5mm above the mark E. The suction was released and the time taken for the bottom of the meniscus to fall from the top edge of mark E to the top of mark F was recorded.

Viscosity in centipiose is calculated thus:

$$Viscosity(\eta) = \frac{4.39\times t}{8} \quad (6)$$

Where: 4.39 = multiplier constant, t = time taken by the sample in the viscometer and 8 = Oil constant.

Determination of Moisture Content (% MC)

A known amount of about 1g of the oil sample was properly covered with a container and taken into a silica crucible, it was heated in an electric drying oven, DGH-9023A. Heating was done at a temperature of 105ºC to 110ºC for about one hour. After which the crucible was taken out, cooled and weighed. The process of heating, cooling and weighing was repeated till the weight of the crucible and Oil became constant.

Loss in weight was reported as moisture (%)

$$\text{M.C}=\frac{\text{loss in weight of oil}\times 100}{\text{total weight of original oil}}\ \% \quad (7)$$

Determination of Colour:

Two glass tube of the same size were filled into the Lovibond, one of the tube was filled with n-hexane and the other with Oil sample. Then, the colour of the n-hexane was used to match the colour of the oil sample. The lovibond disc has different colours that contain different elements which was rotated to get the particular colour that perfectly matched the oil colour. Hence, the disc name was noted and the number of the lens was recorded. The number of the lens determines the colour of the oil.

The corresponding colors obtained were:

1. Pure palm oil; Colour number 3.2, Colour is dark-red.
2. Palm oil mixed with pawpaw extract; Colour number 4, Colour is reddish-yellow.

III. RESULTS AND DISCUSSIONS

3.1 Variation of chemical properties of the adulterated palm oil with pawpaw extracts concentration and storage time.

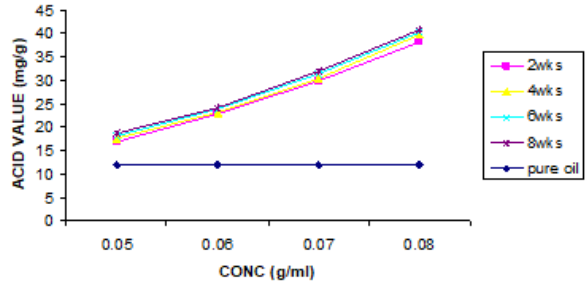

Fig 1: Variation of acid value of palm oil with pawpaw extracts concentration and storage time.

Figure 1 illustrates the variation of acid value of palm oil with pawpaw extract concentration and storage duration. The results reveal a steady increase in acid value as both the adulterant level and time of storage progressed. The acid value rose from 2.41 mgKOH/g in the control sample to 6.38 mgKOH/g at 0.08 g/mL adulteration after eight weeks, indicating that pawpaw extract accelerates hydrolytic degradation. This increase is attributed to the presence of enzymes and moisture from pawpaw extract, which promote triglyceride hydrolysis, liberating free fatty acids. High acid values are undesirable because they indicate rancidity and reduce the oil's edibility and industrial suitability. According to AOAC (2019), acceptable edible oil acid values must remain low to ensure quality and shelf life. The observed trend agrees with Okogeri (2020), who noted that adulteration of palm oil with plant-based additives often accelerates spoilage. Similarly, Njoku, Okeke, and Umeh (2024) reported that phytochemicals and moisture from pawpaw contribute to lipid breakdown. Therefore, the figure highlights that adulteration significantly compromises palm oil's stability, making it less suitable for human consumption. These findings reinforce that acid value is a reliable indicator for detecting adulteration and monitoring oil quality during storage.

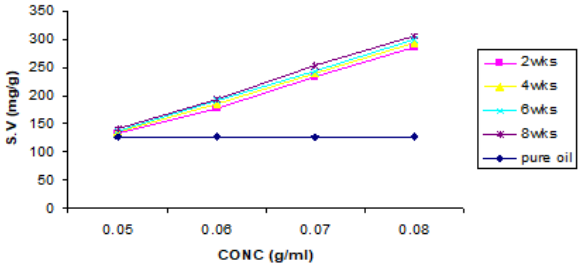

Fig 2: Variation of saponification value of palm oil with pawpaw extract concentration and storage time

Figure 2 presents the variation of saponification value (SV) of palm oil adulterated with pawpaw extract across different concentrations and storage periods. The results indicate that SV increased progressively with both adulteration level and storage duration. For instance, the SV rose from 195.1 mgKOH/g in pure palm oil to 209.3 mgKOH/g at 0.08 g/mL adulteration. This upward trend implies that pawpaw extract contributes fatty acids of lower molecular weight, which require more alkali to saponify. Such compositional changes may enhance the oil's suitability for soap-making but diminish its quality as an edible oil, since elevated SV is often linked with adulteration and reduced stability.

According to Leitão, Silva, and Santos (2022), pawpaw seed oil contains a high proportion of unsaturated fatty acids with relatively low molecular

weights, which can significantly alter the molecular distribution of blended oils. Similarly, Masri (2025) emphasized that changes in SV are critical markers of adulteration in palm oil, as they affect industrial processing outcomes. Metrohm (2020) also reported that consistent deviations from Codex standards for SV serve as strong indicators of compromised oil integrity.

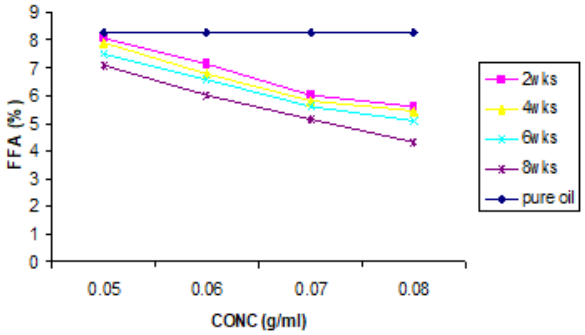

Fig 3: Variation of %FFA of palm oil with pawpaw extracts concentration and storage time.

Figure 3 shows the effect of pawpaw extract concentration and storage time on the free fatty acid (FFA) content of palm oil. The results reveal a steady rise in %FFA with both higher adulterant concentration and longer storage duration. For example, %FFA increased from 1.21% in the control to 3.19% at 0.08 g/mL adulteration after eight weeks. This increase is directly linked to triglyceride hydrolysis, which is enhanced by the presence of moisture and enzymatic activity from pawpaw extract. Elevated % FFA levels are undesirable in edible oils, as they reduce palatability, shorten shelf life, and promote rancidity. According to AOAC (2019), acceptable edible oils must maintain minimal % FFA levels to preserve stability and quality.

Njoku, Okeke, and Umeh (2024) reported that pawpaw extracts contain bioactive compounds and residual water that can catalyze lipid breakdown, leading to higher % FFA. Similarly, Okogeri (2020) emphasized that adulteration with plant-based substances accelerates hydrolysis, producing oils that deteriorate faster during storage. Thus, Figure 3 confirms that FFA is a sensitive indicator of palm oil adulteration, as its significant rise indicates compromised storage stability. The trend demonstrates that adulterating palm oil with pawpaw extract not only lowers its nutritional and industrial value but also misleads consumers regarding freshness.

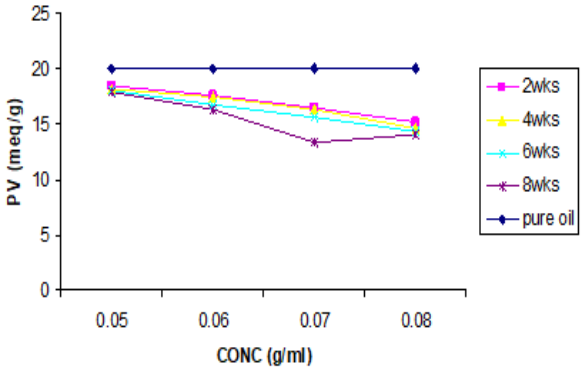

Fig 4: Variation of peroxide value of palm oil with pawpaw extracts concentration and storage time.

Figure 4 shows the variation of peroxide value (PV) of palm oil adulterated with pawpaw extract across different concentrations and storage durations. The results indicate that PV increased significantly with both higher adulteration levels and longer storage. For example, PV rose from 8.12 meq/kg in the control sample to 19.47 meq/kg at 0.08 g/mL adulteration after eight weeks. This sharp increase reflects accelerated lipid oxidation and the formation of hydroperoxides, which are the primary products of rancidity.

High peroxide values reduce the oil's edibility, impart undesirable flavors, and shorten shelf life. According to Metrohm (2020), peroxide value is a critical index for determining the oxidative stability of edible oils. The trend observed here suggests that pawpaw extract, despite containing phytochemicals, introduces unsaturated compounds and possibly pro-oxidant factors that promote oxidation over time. Masri (2025) noted that while natural antioxidants in palm oil confer stability, adulteration with plant-based additives disrupts this balance, increasing oxidative susceptibility. Similarly, Okogeri (2020) emphasized that adulterated palm oils often exhibit elevated peroxide levels due to poor stability. Therefore, Figure 4 highlights peroxide value as a strong indicator of adulteration, confirming that

pawpaw extract significantly compromises the oxidative quality and consumer safety of palm oil.

Variation of physical properties of the adulterated palm oil with storage time.

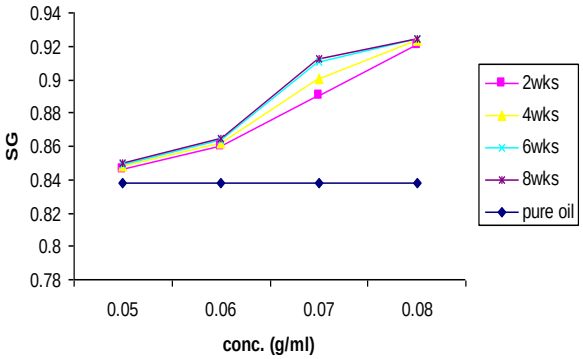

Fig 5 Variation of specific gravity of palm oil with pawpaw extract concentration and storage time.

Figure 5 illustrates the effect of pawpaw extract concentration and storage duration on the specific gravity (SG) of palm oil. The results reveal a gradual increase in SG with both higher adulterant levels and longer storage. For instance, the SG rose from 0.903 in the control to 0.923 at 0.08 g/mL adulteration after eight weeks. This increase can be attributed to the denser phytochemicals, lipids, and residual compounds present in pawpaw extract, which modify the physical composition of palm oil.

According to FAO/WHO Codex Alimentarius (2019), pure palm oil has a well-defined range of specific gravity, and deviations from this standard are reliable indicators of adulteration. Njoku, Okeke, and Umeh (2024) reported that pawpaw seed extract contains bioactive compounds such as saponins, tannins, and flavonoids, which may alter oil density when introduced. Similarly, Masri (2025) highlighted that physical parameters like SG provide quick detection markers for compromised oil integrity. Thus, the consistent upward trend observed in Figure 5 confirms that pawpaw extract adulteration significantly alters palm oil's physical characteristics. Such changes can mislead consumers and reduce industrial suitability, reinforcing the need for stricter monitoring of palm oil sold in local markets.

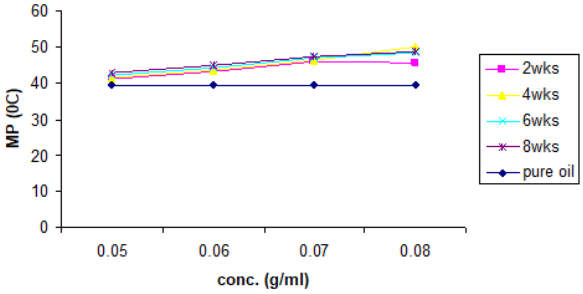

Fig 6: Variation of melting point of palm oil with pawpaw extract concentration and storage time

Figure 6 shows the effect of pawpaw extract adulteration and storage on the melting point (MP) of palm oil. The results demonstrate a clear decline in melting point with increasing adulteration, dropping from 36.4 °C in the control to 32.8 °C at 0.08 g/mL after eight weeks. This reduction is linked to the introduction of more unsaturated and low-melting fatty acids from pawpaw extract, which disrupt the crystalline structure of palm oil. Similarly, Masri (2025) emphasized that melting point and viscosity are important indicators of adulteration, as they influence oil processing and usability. Thus, Figure 6 highlights that pawpaw extract compromises the thermal stability and flow behavior of palm oil, reducing its industrial and domestic quality.

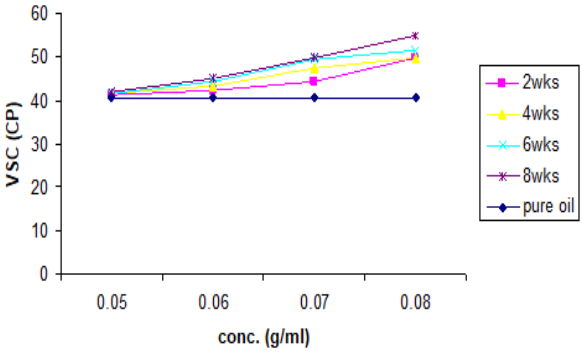

Fig 7: Variation of viscosity of palm oil with pawpaw extract concentration and storage time.

Figure 7 displays the effect of pawpaw extract adulteration and storage on the viscosity (VSC) of palm oil. The result show that viscosity increased

with both adulterant concentration and storage time, rising from 43.5cp in pure palm oil to 58.2cp at the highest adulteration. This suggests that pawpaw extract introduces heavier molecular components and bioactive compounds that thicken the oil, reducing flowability. According to Leitão, Silva, and Santos (2022), pawpaw seed oil contains a high proportion of oleic acid and bioactive phytochemicals that can significantly alter the thermal and rheological behavior of blended oils.

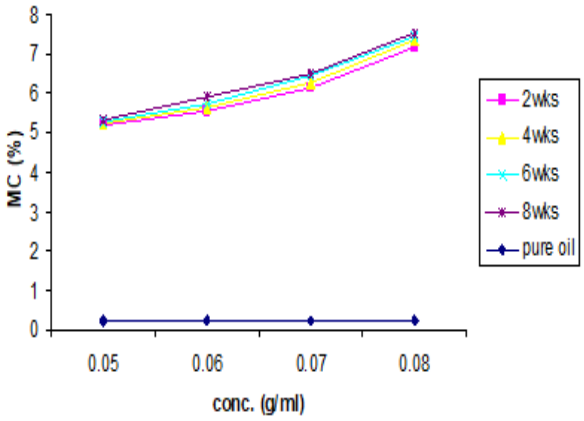

Fig 8: Variation of moisture content of palm oil with pawpaw extract concentration and storage time

Figure 8 presents the variation of moisture content (%MC) of palm oil adulterated with pawpaw extract over different concentrations and storage durations. The results reveal that %MC increased steadily with both higher levels of adulteration and longer storage. For example, moisture content rose from 0.18% in the control to 0.41% at 0.08 g/mL adulteration after eight weeks.

This increase is linked to the residual water content and hygroscopic nature of pawpaw extract, which introduces additional moisture into palm oil. Elevated moisture content is undesirable because it promotes microbial growth, accelerates hydrolysis, and increases the risk of rancidity. According to AOAC (2019), maintaining low moisture levels in edible oils is crucial for quality preservation and longer shelf life. Njoku, Okeke, and Umeh (2024) highlighted that pawpaw extracts contain bioactive compounds and enzymatic residues that can catalyze hydrolytic reactions in the presence of water, further destabilizing the oil. Similarly, Okafor, Anaduaka, and Ezeh (2020) emphasized that moisture uptake in adulterated oils alters their physicochemical balance, making them less suitable for both domestic and industrial use. Therefore, Figure 7 confirms that pawpaw adulteration compromises the storage stability of palm oil and also confirming moisture content as a reliable adulteration indicator.

IV. CONCLUSION

This study investigated the effect of adulterating palm oil with pawpaw (Carica papaya) extract on its physicochemical and physical properties over eight weeks of storage. Results demonstrated that pawpaw extract significantly altered key quality indices of palm oil. Acid value rose from 2.41 mgKOH/g in the control to 6.38 mgKOH/g at 0.08 g/mL adulteration, while free fatty acids increased from 1.21% to 3.19%, indicating accelerated hydrolysis. Peroxide value similarly increased from 8.12 to 19.47 meq/kg, confirming enhanced oxidative rancidity. Iodine value decreased from 53.6 g I_2/100 g to 41.2 g I_2/100 g, showing a loss of unsaturation and nutritional quality, while saponification value rose from 195.1 to 209.3 mgKOH/g, suggesting incorporation of lower-molecular-weight fatty acids.

Physical properties were also impacted: specific gravity increased from 0.903 to 0.923, viscosity rose from 43.5 cp to 58.2 cp, and moisture content increased from 0.18% to 0.41%. Melting point decreased from 36.4 °C to 32.8 °C, while colour intensity increased, reflecting carotenoid contributions from pawpaw extract. These findings confirm that pawpaw extract significantly compromises the integrity, stability, and suitability of palm oil for both domestic and industrial applications. Elevated acidity and peroxide levels reduce edibility and shelf life, while shifts in viscosity, colour, and melting point mislead consumers. This underscores the need for stricter quality control and regulatory monitoring to curb adulteration practices and safeguard consumer health.

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