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Slip Points and Absorbance of Tenera and Dura Palm Oil Blends with Coconut Oil

Okon D. Ekpa [1], Ibanga O. Isaac [2*]
[1] *Department of Pure and Applied Chemistry, University of Calabar, P.M.B 1115, Calabar, Cross River State, Nigeria*
[2*] *Department of Chemistry, Akwa Ibom State University, Ikot Akpaden, P.M.B 1167, Uyo, Akwa Ibom State, Nigeria*

Abstract: *The slip points and absorbance of tenera, dura palm oils and coconut oil as well as the blends of the two varieties of palm oil with coconut oil have been determined. The result of the study show that slip point decreased with increase coconut oil concentration for both unexposed tenera and dura oil blends, while increased in slip point with increase in coconut oil concentration were observed for the exposed tenera and dura oil blend samples. The slip point of unexposed tenera and dura palm oils were greater than the slip point of coconut oil. The slip points of both exposed and unexposed tenera and dura oils blends were the same when the coconut oil percent in the blends was 50%. On the other hand, the absorbance of exposed tenera palm oil at 350 nm and 450 nm wavelength were 1.130 and 1.525 respectively, while those of unexposed samples of 1.107 and 1.520 respectively were observed to be greater than those of the former. Reverse observation was made for dura palm oil sample. The absorbance of exposed tenera and dura oil blends were observed to be greater than those of unexposed samples at 350 nm wavelength. No significant difference was observed at 450 nm wavelength.*
Key words: *Absorbance, coconut oil, slip point, palm oil, polymorphism*

I. Introduction

The oil palm is a tropical monoecious tree with male and female inflorescence, hermaphrodite – developed in the axil of the leaves. The fruit is a drupe on a large compact bunch and the female inflorescence is reported to be a good source of potassium [1 and 2]. Abayeh e*t al.* [3] and Robbelen *et al.* [4] stated that oil crops are about the second most valuable commodity in world trade and are regarded as a vital part of the world's food supply. In Nigeria and other African countries, oil palm account for about 70% of the annual oil crops production and the palm oil contains inorganic elements and organic food substances, which if properly harness, could sustain life and industries. The oil palm produces two different fats namely, palm and kernel oils. Palm oil is processed from the fleshy mesocarp while the kernel oil is obtained from the kernels enclosed in the nuts [5]. Palm oil is unique oil, which has both industrial and domestic applications, but it most important use is in the production of edible oils and fats. Ekpa *et al.* [5], stated that palm oil apart from fatty acids, contain reasonable quantity of vitamins A and E, which are present in the crude oil as carotenoids and tocopherols. Manorama and Rukmini [6] also stated that about 70% of vitamin A in palm oil is preserved in foods after cooking or frying.

Palm oil is used in its crude form for cooking, deep frying and processing of cassava into garri, a popular stable food in Nigeria and other African countries and medicinally, as antidotes for poisons, and as surface protectants for minor wounds [1 and 5]. Various antioxidants have been added to foods with the aim of reducing autoxidation, with limited success in some cases, but palm oil contain tocopherols, which are natural antioxidants that confer protection and help to fight free radicals in the system, thereby reducing cellular degeneration. Hence, palm oil can act as anti – aging oil in human system. Ali *et al.* [7] stated that antioxidants are used to stabilize fats and fat-containing products against oxidation and thereby prolong their stability and storage time. Industrially, palm and kernel oils are used in the production of alkyd resin, which is a conventional binder, used in paint production [8]. It is also used in the production of biodiesel, production of driers used in the modification of some property of gloss paints, making soaps, production of vegetable oil and margarine, production of fatty acids, and animal feeds [1, 5, 9, 10 and 11].

There are two main varieties of oil palm – the dura and tenera varieties cultivated mainly in the tropical rainforest of South – Eastern Nigeria. The main fatty acid composition of these varieties are palmitic acid (C16: 0), stearic acid (C18:0) and oleic acid (C18:1) [5]. Studies also show that palm oils from the dura and tenera varieties of the oil palm differ in their percentage fatty acid composition [11]. The insignificant amount of unsaturated fatty acid such as linoleic acid (C18:2) in palm oil make it an outstanding edible oil as linoleic acid is susceptible to oxidation which may contribute to arteriosclerosis and carcinogenesis. Milovanović and Pićurić-Jovanović [12] stated that oils with substantial amounts of unsaturation, particularly C18:2 fatty acids, are susceptible to oxidation and may produce products that contribute to arteriosclerosis and carcinogenesis.

Coconut oil is lauric acid oil obtained from the endosperm of the coconut palm (*Cocos nucifera). Cocos nucifera* is also cultivated in the tropical rainforest of South – Eastern Nigeria.

In view of domestic and industrial applications of palm oil listed above, it is important to examine some parameters of the oil that will give a better understanding of the complexity of its fatty acid composition. Fat and oils can be characterised by a number of methods including the determination of certain important parameters such as free fatty acid, iodine, acid, and saponification values, among others [13]. None of these parameters can give information on the polymorphic nature of palm oil. Lusas and Rhee [14] stated that polymorphism of fats and oils could be better study by studying the melting, solidification and crystallization behaviour of the fats and oils. An awareness of crystal-packing characteristics and polymorphism helps one to understand incompatibility problems of different fats. Polymorphism has several industrial implications in use of fats as shortenings, margarines, and cocoa butter [7]. However, fats and oils due to complex nature of the glycerides present do not have sharp melting points unlike pure chemical substances. Slip melting point can therefore be employed in the studies of polymorphic nature of fats and oils. The slip melting point of fat was defined as the temperature at which a column of fat or oil in an open capillary tube move up the tube when it is subjected to controlled heating in a water bath. The use of slip melting point to study the properties of dura and tenera palm oil blends has not been reported elsewhere.

This work is therefore aimed at studying the polymorphic nature of dura and tenera palm oil blends with coconut oil by determining the absorbance and slip points of the blends as well as investigating the possible effects of light on the absorbance and slip points of these oil blends. This study will be of significance to the industrial sector (particularly cosmetic, pharmaceutical, food and chemical industries) and academia, as it will help widen the knowledge of chemistry of these oils.

II. Materials and Methods

2.1 Extraction of oils

Bunches of palm fruits from the dura and tenera varieties of the oil palm were obtained from Nsan Palm Estate in Akamkpa Local Government Area of Cross River State, Nigeria. The palm fruits were cut into sections with a stainless steel knife, sprinkled with water, and left for four days to enhance easy removal of the fruits from the stalk. The fruits were picked manually into clean polyethene bags labelled dura and tenera.

The palm fruit specimens were transported to the laboratory, boiled for about four hours the same day. The boiled fruits were mashed, using a wooden mortar and pestle to separate the nuts from the fleshy exocarp. The mashed mesocarp were thoroughly stirred in hot water and the crude oil which risen to the surface was skimmed off into another vessel. The remaining oil in the fibre was removed by pressing it with hands. The crude palm oil obtained was clarified by heating with one – third its volume of water after which the oil on the surface was skimmed off and dried by heating for 5 min at 105 ^{0}C. The dried oil was subsequently filtered to remove small suspended particles of matter and stored in stoppered plastic containers prior to analysis.

In addition, coconut fruits were bought from Okumits market in Akamkpa Local Government Area of Cross River State, Nigeria. The coconut was split open with a sharp stainless steel knife to remove the meat. The meat was grated and four litres of water was added to the coconut mesh. The oil globules, which floated on the surface, were separated. The milk was heated in a heating mantle until all the water had evaporated. The pale yellow oil was then separated from the fat. The oil was stored in stoppered plastic container prior to analysis.

2.2 Sample Preparation for Analysis

Tenera palm oil / coconut oil (TPO/CO) and dura palm oil / coconut oil (DPO/CO) blends were mixed to obtain the required percentage composition (w/w) of 100% TPO, 100% DPO, 100% CO using the method described elsewhere [13].

The measurements were made in four sets. Two sets of samples were left on the open laboratory desk where there was enough sun light for two weeks, while the remaining two sets of the oil blends were placed in a cupboard for the same period of two weeks to serve as control. At the end of the period of observation, each sample was thoroughly mixed before the determination of the required parameters.

2.3 Determination of Slip Point and Absorbance

Capillary tubes were inserted into the blended oil samples to obtain a 10±2 mm long columns of oil sample, the capillary tubes were then sealed at one end using a Bunsen flame. The capillary tubes with the oil sample were kept in a refrigerator for three days during which the oil became solidified. With the help of a thread, the capillary tube with the sample was tie to a thermometer and inserted into a water bath at 30 ^{0}C. The temperature at which the oil began to rise up in the tube was recorded as the slip point.

On the other hand, the absorbance of the blended oil samples were determined using the method described elsewhere [15]. The oil sample (0.1 ml each) was shaken thoroughly with 4 ml of hexane in a test tube. The absorbance of the mixed oil sample was determined using an HACH DR 3000 UV/visible spectrophotometer at different wavelengths.

III. Results and Discussion

3.1 Slip Point

Dura and tenera palm oils and coconut oil were mixed to obtained blends of the two varieties of palm oil with coconut oil. These and the individual oils were analysed for slip point after being exposed to normal room conditions (30 ^{0}C) for a period of two weeks. The results show that the slip point decreases with increased CO content for the unexposed tenera oil blends, while increased in slip point with increase CO content was observed for the exposed oil blend samples (Table 1). This may be attributed to atmospheric oxidation that took place in the exposed sample. Also, the slip point of exposed tenera palm oil of 14 ^{0}C was observed to be less than the unexposed value of 32 ^{0}C. This show that light is one of the factors that influence the slip point of triglyceride oils. Lusas and Rhee [14], listed factors affecting melting points of different fat samples to include the types of fatty acids present in the triacylglycerol and their location, chain length of the fatty acids. Others were number and location of cis and trans double bonds on the fatty acid chains, and compatibility of the different triacylglycerols in the mixture and the type of crystal present. On the other hand, the slip point of CO exposed of 34 ^{0}C was greater than the unexposed value of 16 ^{0}C. Reverse observation was obtained for dura palm oil blends for both exposed and unexposed (Table 2). The slip point for exposed dura palm oil of 16 ^{0}C was observed to be less than the unexposed value of 37 ^{0}C. The slip point of both TPO and DPO unexposed were observed to be greater than the slip point of CO. This suggests that TPO and DPO consists of fatty acids with chain length longer than that of CO as melting points increases with chain length of the individual fatty acids present in the fat or oil sample [7 and 14].

The plot of slip point against the percentage oil blends gave characteristic curves shown in Figs. 1 - 4. The graphs reveal a decrease in slip point for both the TPO/CO unexposed and DPO/CO unexposed as the percentage of CO increases. On the other hand, the slip point of both TPO/CO exposed and DPO/CO exposed samples increases with increased concentration of CO (Figs. 1 and 2). When the percentage of coconut oil was equal the percentage of tenera and dura palm oils in the blends (that is, 50% TPO or DPO/50% CO), the slip point of 24 ^{0}C was observed and this was the same for the tenera and dura oil blends for both exposed and unexposed samples (Figs. 1 and 2). This further verify that blending the two varieties of palm oil with coconut oil results in interaction between the two oils, which could lead to changes in some properties of the system that will affect the quality of the palm oil. For example, there is a possibility of interesterifcation occurring in the presence of CO, which could result in a redistribution of the triglyceride molecules in TPO and DPO respectively. Ali *et al.* [7] stated that interesterification results in fatty acid redistribution within and among triglyceride molecules, which can lead to substantial changes in the physical properties of fats and oils or their mixtures without altering the chemical structure of the fatty acids.

However, the decreased in slip point of the two oil blends when they were unexposed (Fig. 3) may be due to dilution by CO, since CO is mainly lauric acid with short chain fatty acids compared to TPO and DPO. The slip point of the unexposed DPO/CO samples were greater than that of TPO/CO unexposed counterpart up to 50% concentration of CO with no significant difference above 50% concentration of CO. This may be due to differences in fatty acid compositions present in the two varieties of palm oil. The result also suggests high level of unsaturation in DPO than in TPO. On the other hand, slip point of DPO/CO exposed samples were greater than that of TPO/CO exposed up to 50% concentration of CO and from 70% concentration of CO and above the slip point of both DPO/CO and TPO/CO exposed were the same (Fig. 4).

3.2 Absorbance

The absorbance behaviour of the samples (exposed and unexposed), were determined at 350 nm and 450 nm wavelengths. The absorbencies of TPO exposed at the two wavelengths were observed to be 1.130 and 1.525 respectively. These values were slightly greater than the values obtained for TPO unexposed (1.107 and 1.520 respectively) at the two wavelengths (Table 3). In addition, the absorbance of DPO exposed at 350 nm and 450 nm wavelengths were observed to be 1.638 and 1.672 respectively. These values were greater than those of DPO unexposed which were 1.500 and 1.586 respectively (Table 4). Generally, the absorbance at 350 nm and 450 nm wavelengths for tenera and dura palm oils were higher when the samples were exposed to normal laboratory conditions than the unexposed. In addition, the absorbance of DPO for the two wavelengths was more than that of TPO. This indicates differences in fatty acid compositions of the two varieties of palm oil. Nevertheless, the absorbance of coconut oil at the two wavelengths were observed to be 0.443 at 350 nm and 1.052 at 450 nm for the exposed sample and 0.438 at 350 nm and 0.533 at 450 nm for the unexposed sample respectively (Tables 3 and 4).

The plots of absorbance against the percent oil blends gave characteristic curves shown in Figs. 5 and 6. The graphs revealed decreased in absorbance as the percentage of coconut oil increases for both TPO/CO and

DPO/CO exposed and unexposed samples respectively. The absorbance for TPO/CO and DPO/CO exposed were greater than that of TPO/CO and DPO/CO unexposed (Fig. 5) at 350 nm wavelength. There was no significant difference between the absorbance of TPO/CO and DPO/CO exposed and unexposed samples at 450 nm wavelength.

The result indicates that CO has a substantial effect on the absorbance of palm oil, which tends to reduce the beta carotenoid (responsible for the colour of palm oil) especially when unexposed at normal room temperature. Blending coconut oil with palm oil may lead to degradation of carotenoid and tocopherols in the palm oil making it susceptible to auto-oxidation. Vegetable oils are more resistant to auto-oxidation than animal oils because of the presence of the naturally occurring antioxidant, tocopherol [17].

The results also indicate possible interactions between the fatty acids of the two oils, which apart from light can enhance auto-oxidation. This is so because the fatty acids of CO are different from those of DPO and TPO. The effect of these interactions may result in reorientation of the fatty acids of the individual glyceride molecules, which could be greater for the short chain fatty acids of coconut oil than are for the long chain fatty acids of palm oil. These interactions may also results in rearrangements of fatty acids of the glyceride molecules, with short chain fatty acids of coconut oil being more reactive than those of palm oil are. These reactions may therefore be responsible for the curve graphs observed for the blends of TPO/CO and DPO/CO in Figs. 5 and 6.

Table 1: Slip point profile for tenera oil blend sample

S/N	TPO %	CO %	Slip point (^0C) Exposed	Unexposed
1	100	0	14	32
2	90	10	16	31
3	80	20	18	28
4	70	30	20	26
5	60	40	24	24
6	50	50	24	24
7	40	60	26	22
8	30	70	28	20
9	20	80	30	19
10	10	90	32	18
11	0	100	34	16

Table 2: Slip point profile for dura oil blend sample

S/N	DPO %	CO %	Slip point (^0C) Exposed	Unexposed
1	100	0	16	37
2	90	10	18	34
3	80	20	20	31
4	70	30	22	28
5	60	40	24	26
6	50	50	24	24
7	40	60	28	22
8	30	70	28	20

9	20	80	30	18
10	10	90	32	18
11	0	100	34	16

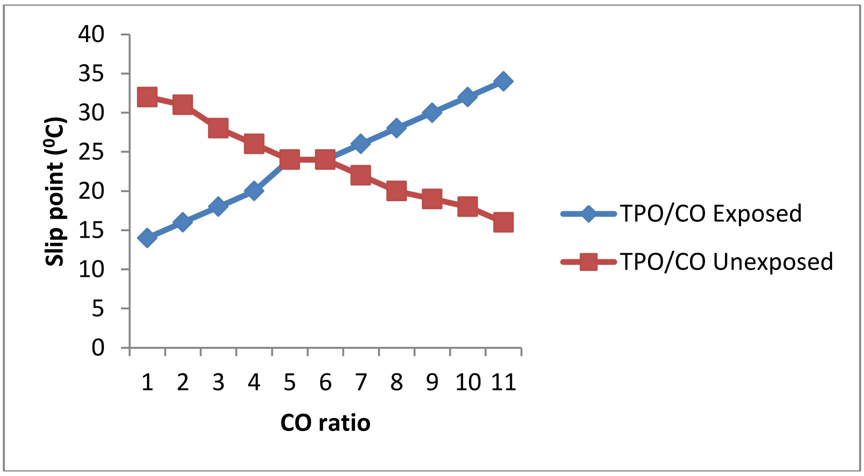

Figure 1: Graph of slip point of TPO/CO oil blends against CO concentration in the blends

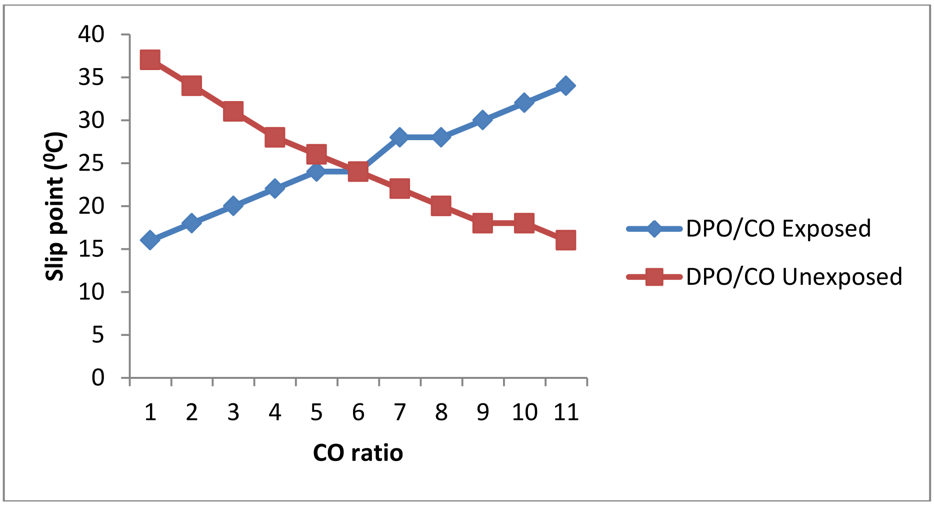

Figure 2: Graph of slip point of DPO/CO oil blends against CO concentration in the blend

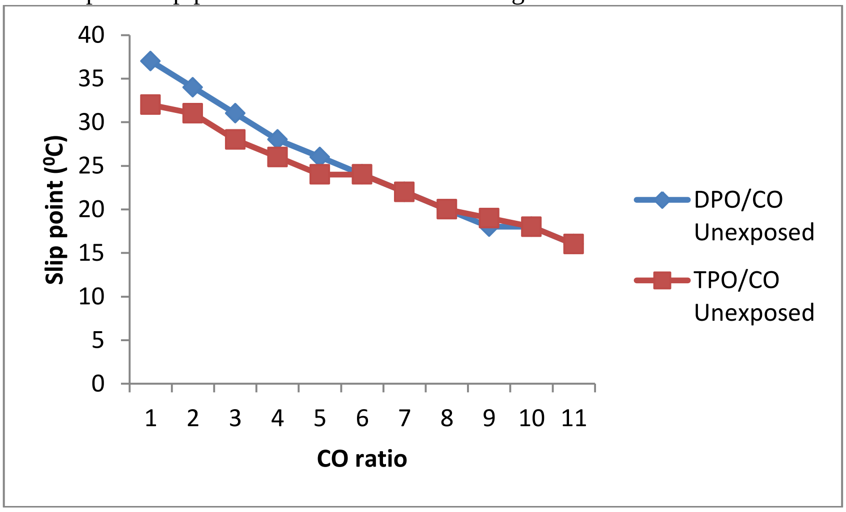

Figure 3: Graph of slip point of DPO/CO unexposed and TPO/CO unexposed against concentration of CO in the blend

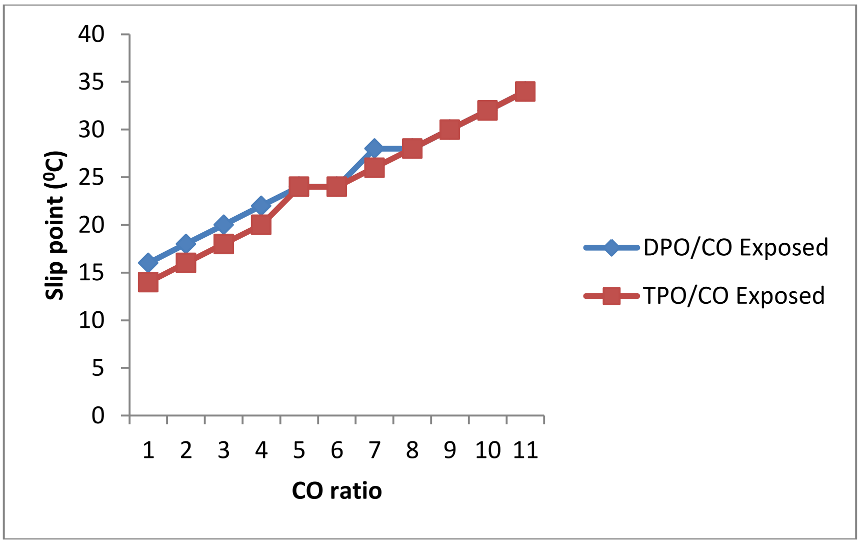

Figure 4: Graph of slip point of DPO/CO exposed and TPO/CO exposed against concentration of CO in the blend

Table 3: Absorbance for tenera oil blend sample

S/N	TPO %	CO %	TPO/CO Exposed Absorbance (350 nm)	TPO/CO Exposed Absorbance (450 nm)	TPO/CO Unexposed Absorbance (350 nm)	TPO/CO Unexposed Absorbance (450 nm)
1	100	0	1.130	1.525	1.107	1.520
2	90	10	1.025	1.522	0.936	1.516
3	80	20	0.901	1.510	0.928	1.514
4	70	30	0.878	1.507	0.885	1.511
5	60	40	0.797	1.470	0.861	1.476
6	50	50	0.760	1.468	0.857	1.471
7	40	60	0.706	1.438	0.751	1.424
8	30	70	0.604	1.193	0.616	1.308
9	20	80	0.549	1.190	0.544	1.206
10	10	90	0.546	1.075	0.460	1.106
11	0	100	0.443	1.052	0.438	0.533

Table 4: Absorbance for dura oil blend sample

S/N	DPO %	CO %	DPO/CO Exposed Absorbance (350 nm)	DPO/CO Exposed Absorbance (450 nm)	DPO/CO Unexposed Absorbance (350 nm)	DPO/CO Unexposed Absorbance (450 nm)
1	100	0	1.638	1.672	1.500	1.586
2	90	10	1.505	1.527	1.459	1.554
3	80	20	1.404	1.524	1.067	1.543
4	70	30	1.115	1.523	0.924	1.536
5	60	40	1.025	1.514	0.876	1.538
6	50	50	0.921	1.500	0.829	1.508
7	40	60	0.876	1.309	0.624	1.461
8	30	70	0.865	1.208	0.570	1.282

9	20	80	0.841	1.203	0.523	1.118
10	10	90	0.504	1.178	0.466	0.739
11	0	100	0.443	1.052	0.438	0.533

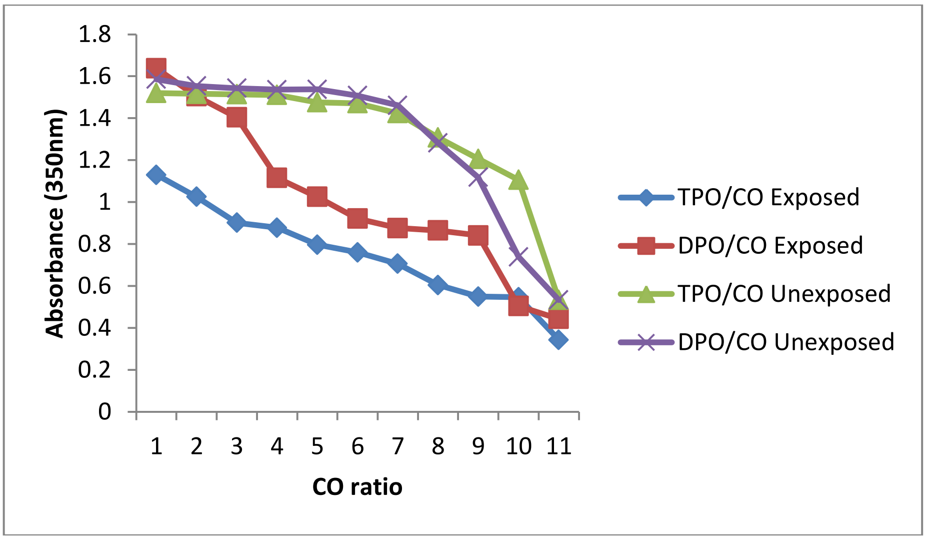

Figure 5: Graph of absorbance of TPO/CO and DPO/CO at 350 nm wavelength against CO concentration in the blend

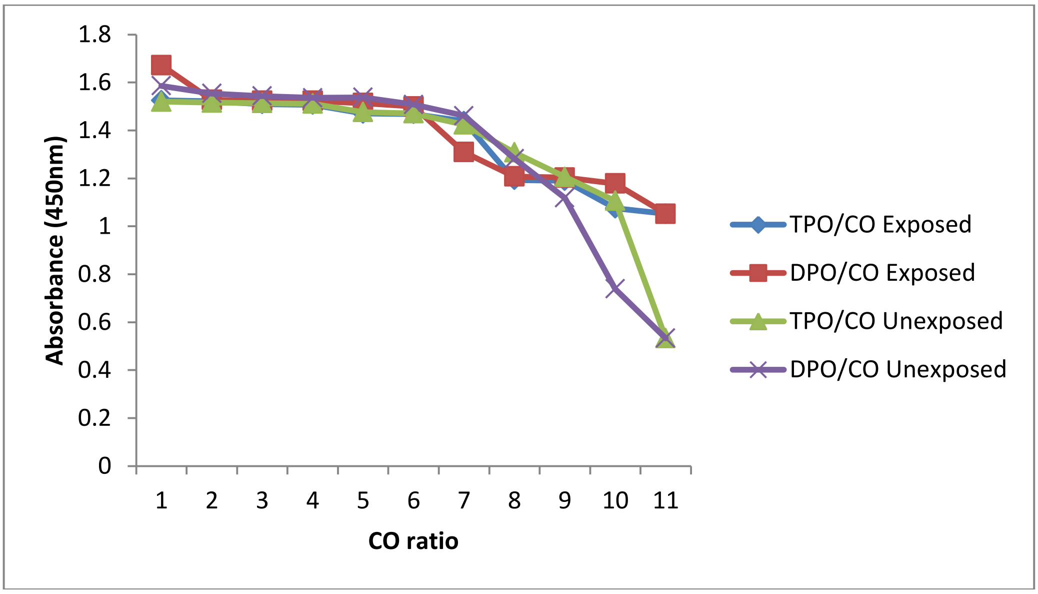

Figure 6: Graph of absorbance of TPO/CO and DPO/CO at 450 nm wavelength against CO concentration in the blend

IV. Conclusion

This study shows that coconut oil concentration has significant effects on the slip point and absorbance of TPO and DPO, especially when exposed to normal room temperature conditions. This effect could result in a reaction whose products may lead to degradation of palm oil. It is also observed that this reaction could be minimised, if the oil blends are stored under conditions that limit their exposure to adverse environmental factors such as light and air. The results also show that blending of palm oil with coconut oil may have adverse effect on the shelf – life and quality of palm oil as the exposure of such blends to normal room conditions as observed in this study show a substantial increase in slip point and decrease absorbance of the system. This may affect its application as edible oil, but will still be useful for industrial purposes like soap making and the likes.

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