TREATMENT AND BLEACHING OF PALM OIL WITH ACID ACTIVATED PLANTAIN AND BANANA STEMS

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Abstract: The bleaching performance of crude palm oil (CPO) using pulverized acid activated banana and plantain stems as bleaching agent was the main goal of this research. The best bleaching performance was obtained from banana stem (X_2/1.00M) with percentage colour removal (%CR) of 98% at 80ºC for 30 min and a sample to oil ratio of 0.20. The least %CR was obtained from plantain stem (X_1/0.50M) with a value of 1.5% at 80ºC for 30 min and sample to oil ratio of 0.04. The highest refractive index (RI) value of 1.3985 was obtained at a bleaching time of 30 min, temperature of 100ºC while the lowest RI value of 1.3341 was obtained by plantain stem (X_1/100M) at bleaching time of 30 min at a temperature of 80ºC and sample to oil ratio of 0.2. Lorentz-Lorentz transformed linear equation showed graphically that for every 35 ml of treated palm oil (TPO) used for bleaching, 8.0 ml was left unbleached. This equation is a resourceful mathematical tool for predicting the economy of CPO refining.

Keywords: Bleaching, β-carotene, pulverized, refining, refractive index

Introduction

Palm oil is derived from the fleshy part of the mesocarp of the fruit of the palm species *Elaesisguineensis*. The mesocarp of the palm fruit accounts for about 60% of the total composition of palm oil fruit and crude palm oil (CPO) is derived from this part (Noor, 1995). Several processes such as sterilization, stripping, extraction and purification results in the production of treated palm oil (TPO). Crude vegetable oil commonly consists of triglycerides, unsaponifiable matter together with small amount of impurities (Higuchi, 1983). Most of these impurities contribute undesirable effects to the oil such as the colour, odour, instability and even foaming. These objectionable substances or impurities in palm oil may either be biogenic that is synthesized by the plant themselves, or taken up by the plant from the environment. Some of the impurities may be acquired during the bleaching process (Borner *et al*., 1999).

Refining of crude palm oil into stable edible products is a very important step as it also involves the removal of impurities which will affect the quality of the finished products (Leong, 1992). Bleaching is an essential part of the refining process of edible oil. Bleaching refers to the treatment that is given to remove colour producing substances and to further purify the oil (Patterson, 1992). Bleaching is a process of selective removal of pigments by physical and chemical interaction of an adsorbent with oils in order to retain its quality (Brooks, 1999). Oils are bleached in order to remove undesirable colourants which can negatively affect the taste of the oil, limit its use and marketability. Furthermore, some pigments that promote deterioration to oil quality are also being removed during bleaching process mainly due to their pro-oxidative properties that promotes oxidation (Bockish, 1998).

During bleaching, the oil is brought in contact with a surface-active adsorbent and then the undesirable particles are selectively retained on the pore surface thus removing the triglycerides. Adsorption bleaching is mainly used in the refining processes and this operation involves the use of an absorbate which does the bleaching, thus removing impurities and pigments from the oil without damaging the oil itself (Ibemesi and Achife, 1990; Rossi *et al*., 2001; Bera *et al*., 2004; Kaynak *et al*., 2004). Many clay minerals such as montmorillonites, sepiolite and other silicates and carbon products with typical desirable properties such as specific surface area, porosity, and surface acid-base sites have been used for adsorption bleaching and documented in literature. However, to our knowledge, no study has appeared on the adsorption of β-carotene using banana or plantain stems. It is therefore, the objective of this study to investigate the fluid absorbing capacity and retention ability of banana and plantain stems when treated and activated. This study also attempts to convert waste to wealth, since the banana and plantain stems used are usually left to rot after the harvest of the edible part of the fruits.

Materials and Methods

Materials

The plantain and banana stems used in the study were collected from already harvested and discarded stems around the stands within the University of Benin Campus. The hydrochloric acid (HCl), sodium hydroxide (NaOH) and phenolphthalein indicator (Analytical grade) were purchased from Stimpex, Limited (a local supplier, but manufactured by British Drug House (BDH). The alcohol and iso-propanol were obtained from Rovet Limited, a product of sigma-Aldrich (Poznah, Poland). The palm oil used was purchased directly from the Nigerian Institute for Oil palm Research (NIFOR), Benin City.

Methods

2.2 and 0.25M NaOH solutions were prepared by weighing 88 and 10 g of NaOH with an analytical weighing balance (Mettler H80, England). 5M HCl solution was prepared by taken volumes 436.89 ml analar grade HCl and making up to 1litre (1000 ml) with distilled water. 1.0M, 0.75M, and 0.50M HCl were prepared by taken appropriate volumes of the 5M HCl and making up to 1litre with distilled water. Neutralized alcohol and iso-propanol solutions were prepared by placing 50 ml each of iso-propanol and alcohol in a flask, heat to boil and 0.5 ml phenolphthalein solution was used to neutralize by drop-wise addition of 0.1N Potassium Hydroxide (KOH) to obtain a faint but permanent pink colouration (AOAC, 1990).

Sample collection

Plantain and banana stems were collected at the Junior Staff Quarters of the University of Benin, Benin City. The stems were cut into small pieces, sun-dried for three weeks and ground to powder with a mortar and pestle. The samples were soaked in water for 24 h after which it was strained with a 40 µm sieve (Endecotts Ltd, London, England) to remove stones and other impurities. The filtrate was allowed to settle and carefully decanted. The processed stems were oven dried at 110ºC for 4 h.

Pretreatment of plantain and banana stem

30 g of the processed plantain stem was weighed into a conical flask and 300 ml of water added. The conical flask was covered with a cork which had two holes. A thermometer was inserted into one and the other was left open to allow for escape of water. The mixture was heated to about 80ºC and stirred continuously. 32.9 cm^3 of 5M HCL was added. The temperature of the mixture was raised to 105ºC and maintained for 2 h with constant stirring throughout the process of activation. The process was repeated for the other samples. At the end of the acid activation, the samples were filtered and washed several times with water to remove the excess acid. The washed activation samples were oven dried for 4 h. The activated samples were allowed to cool and later ground into fine powder and stored in plastic bottles. The process of activation was repeated for the samples but at various concentrations of acid (HCl) and activation time.

Pretreatment of the palm oil

CPO was pretreated by degumming and de-acidification 400 ml was measured using a measuring cylinder into a beaker, heated to a temperature of 80ºC, 60 ml of water was added at intervals over a period of 30 min. The degummed oil formed a top layer while a greenish yellow-coloured layer formed at the bottom of the beakers. The degummed oil was poured into a separation funnel and carefully decanted. In the de-acidification of the palm oil NaOH was used to neutralize the FFA content of the palm oil. 17.2 ml of 2.2M NaOH was added to the degummed oil and then allowed to settle for 24 h. NaOH combines with FFA to form soap stock. The soap stock coagulated at the bottom of the funnel and the neutralized oil was decanted off.

Assay of free fatty acid (FFA) of the treated palm oil (TPO)

7 g of TPO was weighed into a conical flask and then placed on a hot plate preset at 40ºC. 50 ml of neutralized alcohol was added to the oil the temperature of the hot plate was raised to 60ºC for complete mixing. 1 ml of phenolphthalein indicator was added and then titrated against 0.2519 NaOH, with vigorous shaking until the first pink colour appeared which persisted for 30 seconds.

Assay of acid value (AC) of the TPO

5 g of TPO was weighed into a conical flask and heated on a hot plate preset at 40ºC. 50 ml of neutralized Iso-propanol was added to the palm oil and the temperature of the hot plate was raised to 60ºC. While warm, 1ml of phenolphthalein indicator in isopropanol was added. The sample was shaken gently while titrating against standard sodium hydroxide until a permanent pink colour was observed. A blank in the same manner as the sample was determined.

Bleaching of the TPO

30 ml of the TPO was measured with a measuring cylinder into a beaker and heated to 70ºC. 1.2 g of the activated plantain stem was added and stirred continually, and then the temperature was raised to 80ºC for 30 min. At the end, the mixture was filtered to remove the plant sample form the bleached oil. This procedure was repeated for the other samples.

Evaluation of the bleaching performance of the samples

The percentage colour reduction of the TPO was monitored refractometrically and spectrometrically. The evaluation of the bleaching performance of each sample as carried out by determining the β-carotene content in the unbleached and bleached oil sample using a UV-visible spectrophotometer. Absorption wavelength of 474 nm was used with n-hexane used as the solvent. This method of evaluation was recommended by British Standards Institution (BSI, 1971). The percentage colour removal is expressed as the amount of β-carotene removed in the bleaching process given as:

$$\beta\text{-carotene (mg/kg)} = \frac{383 \times A}{I \times C} \quad \ldots\ldots\ldots\ldots \quad (1)$$

Where: A = absorbance of a given mass of oil; C = mass of the oil in grammes dissolved in 100 cm^3 of the solvent; I= path length of cell used

Evaluation of the β-carotene in the bleached and unbleached oil samples

β-carotene in the bleached and unbleached oil samples were measured by dissolving 9 ml of the oil in 100 ml of n-hexane. A portion of the n-hexane was poured into the cavette and placed into the cuvette holder of the UV-visible spectorophotometer. This was done to zero the equipment, little portion of the oil bearing solution was poured into the already clean cuvette and the absorbance of the sample was determined at an absorption wavelength of 474 nm. This procedure was repeated for all the samples. The percentage colour removal as calculated as % colour removal =

$$\frac{\beta\ carotene\ in\ unbleached\ oil - \beta - carotene\ in\ bleached\ oil \times 100/1}{\beta - carotene\ in\ unbleached\ oil} \quad (2)$$

Determination of the refractive index (RI)

The RI is the ratio of the sine of the angle of incidence of a ray of light in the surface separating two media to the sine of its angle refraction. The ray passing from a dense to a denser medium is bent towards the normal. Expressed mathematically,

$$\frac{Sin\ i}{Sin\ r} = n = \text{index of refraction} \quad (3)$$

Where i = angle of incidence; r = angle of refraction

The Abbe 600 model refractometer was used. A glass rod was used to place a drop of the oil sample on the ground surface of the prism and the prism box was closed the arm of the telescope was adjusted using the prism control knob. The value of the RI was displayed on the digital screen of the instrument. The procedure was repeated for all the samples.

Calculation using the Lorentz-Lorentz linear equation

Lorentz-Lorentz linear equation was used to determine the bleaching reaction of the unbleached and the bleached oil. The equation is expressed thus:

$$r = \frac{(n^2 - 1)1}{(n^2 - 2)\,d} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where r = specific refractivity; n = refractive index; d = density

Results and Discussion

The FFA and AV of the TPO were determined. The FFA and AV are used to ascertain the level of exposure of oil to spoil (Abdul, 2000). The result obtained for FFA (3.8%) and AV (4.82 mg/l) falls within the acceptable range 5% maximum or FFA and 5 mg/l of AV (Noor, 1995). Figs. 1 – 7 show the spectrograms of standard β-carotene unbleached and bleached oil using sample X/5M at sample to oil ratios of 0.04, 0.08, 0.012, 0.16, and 0.20, respectively. Whereas, Anozie *et al*. (1993) obtained the wavelength of maximum absorbance at 444 nm, the wavelength of maximum absorbance obtained in this work is 474 nm. This might be due to the more advanced and computerized instrument use for the study. The maximum absorbance ranges from 0.575 to 0.762 for the β-carotene, unbleached and bleached oil samples. This indicates an increase in percentage colour removal in the sample. The methods recommended by the BSI (1971) and Anozie *et al*. (1993) were adopted to ascertain the percentage colour removal of the TPO. The values obtained for β-carotene in CPO was 543.072 mg/kg. The β-carotene content in the bleached oils was lower than in the unbleached oil.

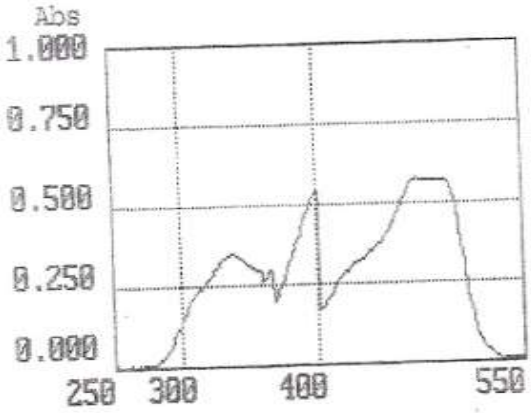

Fig. 1: The spectrogram of β-carotene

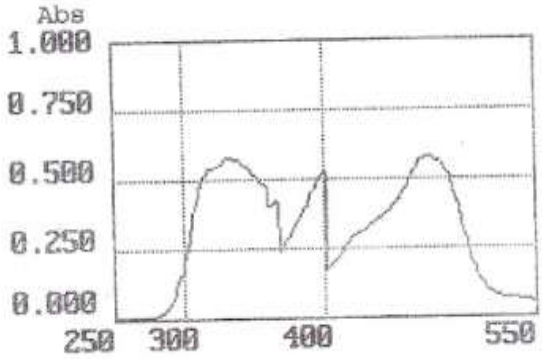

Fig. 2: The spectrogram of unbleached palm oil

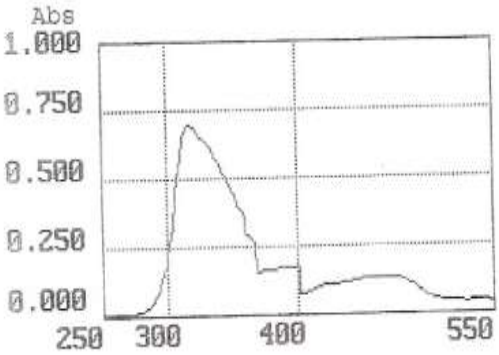

Fig. 3: The spectrogram of TPO bleached with X_1/5.0M HCl at sample to oil ratio of 0.04

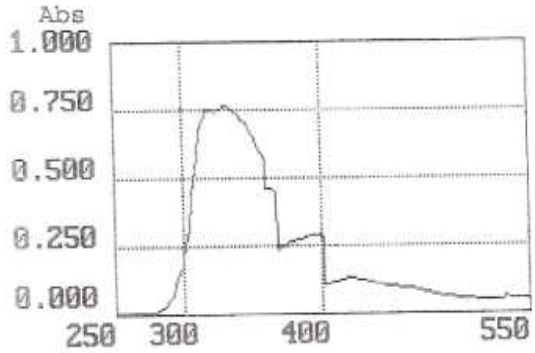

Fig. 4: The spectrogram of TPO bleached with X_1/5.0M HCl at sample to oil ratio of 0.08

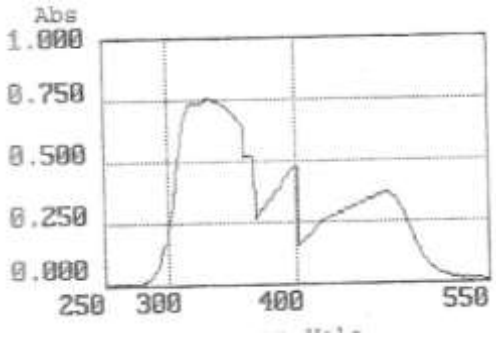

Fig. 5: The spectrogram of TPO bleached X_1/5.0M HCl at sample to oil ratio of 0.12

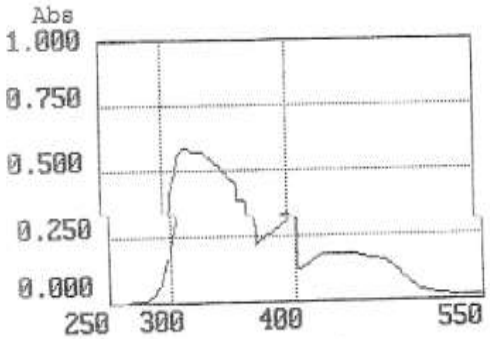

Fig. 6: The spectrogram of TPO bleached with X_1/5.0M HCl at sample to oil ratio of 0.16

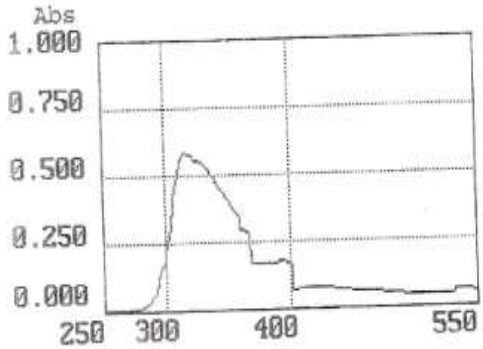

Fig. 7: The spectrogram of TPO oil bleached with X_1/5.0M HCl at sample to oil ratio of 0.20

Table 1 shows the spectrophotometric evaluation on the bleaching parameters of the activated plantain (X_1) and banana (X_2) stem. Generally, it was observed that the β-carotene content reduces with increase in sample to oil ratios. 80-100^{o}C temperature range was chosen for this study because at temperature greater than 150^{o}C; Patterson (1992) revealed that structural changes such as isomerization of the esters in oil become highly probable. In addition, the tendency for heat bleaching to occur along side with absorption bleaching is also probable. Comparative examinations of the results obtained show that the pulverized plantain stems at (X_1/0.50M) with a sample to oil ratio of 0.20 gave the highest bleaching performance of 97.05% at 80^{o}C for 30 min bleaching period. Similarly, the pulverized stem at (X_1/1.00M) with a sample to oil ratio of 0.04 gave the least bleaching performance of 0.88% at 100^{o}C for 30 min. The refractive evaluation of the bleaching performance of the activated banana and plantain stem is shown in Table 2.

Table 1: Spectrometric evaluation on the bleaching parameters of the activated plantain and banana stems

Samples at concentration of HCl	Samples to oil ratio	β – carotene standard (mg/kg)	β – carotene in unbleached oil (mg/kg)	β – carotene in bleached oil (mg/kg)	% colour removal	Bleaching conditions
X_1/5.00 M	0.04	530.965	534.072	40.853	92.510	Time
	0.08	530.965	534.072	158.356	70.347	30 min
	0.12	530.965	534.072	440.876	17.449	80°C
	0.16	530.965	534.072	207.674	61.115	
	0.20	530.965	534.072	60.854	88.606	
X_1/1.00 M	0.04	530.965	534.072	268.526	44.720	Time 30 min
	0.08	530.965	534.072	151.497	71.635	80°C
	0.12	530.965	534.072	444.706	16.737	
	0.16	530.965	534.072	362.513	32.112	
	0.20	530.965	534.072	270.227	45.402	
X_1/0.75M	0.04	530.965	534.072	54.046	89.880	Time 30 min
	0.08	530.965	534.072	473.217	11.394	80°C
	0.12	530.965	534.072	439.599	18.627	
	0.16	530.965	534.072	50.215	90.597	
	0.20	530.965	534.072	58.301	85.084	
X_1/0.50M	0.04	530.965	534.072	525.750	1.513	Time 30 min
	0.08	530.965	534.072	478.787	10.358	80°C
	0.12	530.965	534.072	421.599	21.627	
	0.16	530.965	534.072	69.791	86.932	
	0.20	530.965	534.072	15.746	97.055	
X_1/5.00M	0.04	530.965	534.072	508.964	4.701	Time
	0.08	530.965	534.072	520.475	3.191	30 mins
	0.12	530.965	534.072	517.029	2.595	90°C
	0.16	530.965	534.072	359.169	32.749	
	0.20	530.965	534.072	212.778	60.159	
X_1/1.00M	0,04	530.965	534.072	515.348	3.505	Time 30 min
	0.08	530.965	534.072	403.852	24.383	90ºC
	0.12	530.965	534.072	307.677	40.389	
	0.16	530.965	534.072	245.546	42.384	
	0.20	530.965	534.072	177.031	66.853	
X_1/0.75 M	0.04	530.965	534.072	480.452	10.039	Time 30 min
	0.08	530.965	534.072	141.284	73.547	90°C
	0.12	530.965	534.072	79.153	85.179	
	0.16	530.965	534.072	31.066	94.182	
	0.20	530.965	534.072	20.427	96.175	
X_1/0.50 M	0.04	530.965	534.072	456.621	14.502	Time
	0.08	530.965	534.072	339.168	36.493	30 min
	0.12	530.965	534.072	335.338	37.212	90ºC
	0.16	530.965	534.072	122.560	77.052	
	0.20	530.965	534.072	104.687	80.398	
X_1/5.00 M	0.04	530.965	534.072	519.603	2.709	Time
	0.08	530.965	534.072	506.836	5.099	30 min
	0.12	530.965	534.072	451.089	15.537	100°C
	0.16	530.965	534.072	221.714	58.487	
	0.20	530.965	534.072	147.242	72.431	
X_1/1.00 M	0.04	530.965	534.072	529.391	0.876	Time
	0.08	530.965	534.072	518.752	2.869	30 min
	0.12	530.965	534.072	496.623	7.012	100°C
	0.16	530.965	534.072	133,624	74.981	
	0.20	530.965	534.072	48.939	90.836	
X_1/0.75 M	0.04	530.965	534.072	264.270	50.518	Time
	0.08	530.965	534.072	188.096	64.782	30 min
	0.12	530.965	534.072	175.329	67.171	100°C
	0.16	530.965	534.072	146.817	72.509	
	0.20	530.965	534.072	244.695	54.184	

X_1/0.50 M	0.04	530.965	534.072	502.156	5.949	Time
	0.08	530.965	534.072	500.879	6.215	30 min
	0.12	530.965	534.072	491.091	15.048	100°C
	0.16	530.965	534.072	415.341	22.231	
	0.20	530.965	534.072	134.476	74.819	
X_2/5.00 M	0.04	530.965	534.072	508.539	4.780	Time
	0.08	530.965	534.072	371.936	30.357	30 min
	0.12	530.965	534.072	202.921	62.044	80°C
	0.16	530.965	534.072	114.139	72.151	
	0.20	530.965	534.072	40.428	92.429	
X_2/1.00 M	0.04	530.965	534.072	470.239	11.952	Time
	0.08	530.965	534.072	403.427	24.461	30 min
	0.12	530.965	534.072	76.600	85.556	80°C
	0.16	530.965	534.072	29.938	74.581	
	0.20	530.965	534.072	10.639	98.007	
X_2/0.75 M	0.04	530.965	534.072	522.157	5.230	Time
	0.08	530.965	534.072	514.497	3.665	30 min
	0.12	530.965	534.072	356.190	33.306	80°C
	0.16	530.965	534.072	420.029	42.629	
	0.20	530.965	534.072	146.817	72.509	
X_2/0.50 M	0.04	530.965	534.072	493.644	17.569	Time
	0.08	530.965	534.072	355.764	33.389	30 min
	0.12	530.965	534.072	349.807	34.501	80°C
	0.16	530.965	534.072	415.341	23.231	
	0.20	530.965	534.072	152.349	71.474	
X_2/5.00 M	0.04	530.965	534.072	479.601	10.199	Time
	0.08	530.965	534.072	449.387	15.974	30 min
	0.12	530.965	534.072	407.257	23.744	90°C
	0.16	530.965	534.072	397.043	25.658	
	0.20	530.965	534.072	426.832	20.079	
X_2/1.00 M	0.04	530.965	534.072	423.002	20.797	Time
	0.08	530.965	534.072	379.595	25.180	30 mins
	0.12	530.965	534.072	278.313	47.889	90°C
	0.16	530.965	534.072	133.624	74.981	
	0.20	530.965	534.072	48.939	90.836	
X_2/0.75 M	0.04	530.965	534.072	511.943	4.143	Time
	0.08	530.965	534.072	471.516	11.712	30 min
	0.12	530.965	534.072	403.492	30.645	90°C
	0.16	530.965	534.072	323.848	39.362	
	0.20	530.965	534.072	244.695	54.184	
X_2/5.00 M	0.04	530.965	534.072	509.390	4.620	Time
	0.08	530.965	534.072	495.347	7.251	30 min
	0.12	530.965	534.072	79.153	85.179	100°C
	0.16	530.965	534.072	35.321	93.387	
	0.20	530.965	534.072	16.596	76.894	
X_2/1.00 M	0.04	530.965	534.072	487.687	86.869	Time
	0.08	530.965	534.072	404.730	25.055	30 min
	0.12	530.965	534.072	375.132	30.908	100°C
	0.16	530.965	534.072	343.849	35.617	
	0.20	530.965	534.072	265.547	50.278	
X_2/0.75 M	0.04	530.965	534.072	488.538	8.526	Time
	0.08	530.965	534.072	403.852	24.383	30 min
	0.12	530.965	534.072	376.191	29.562	100°C
	0.16	530.965	534.072	254.905	54.759	
	0.20	530.965	534.072	213.203	60.079	
X_2/0.50 M	0.04	530.965	534.072	478.324	10.439	Time
	0.08	530.965	534.072	448.536	16.015	30 min
	0.12	530.965	534.072	372.361	30.279	100°C
	0.16	530.965	534.072	332.359	37.768	
	0.20	530.965	534.072	260.440	51.235	

X_1= Plantain stem; X_2= Banana stem; CPO =Crude palm oil; Min = Minutes

Table 2: Refractometric evaluation of the bleaching performances of activated banana and plantain stem samples

Samples at concentration of HCl	Samples to oil ratio	Refractive indices of samples				
		β-carotene standard	CPO	Degummed unbleached CPO	Bleached oil	Bleaching condition
X_1/5.00 M	0.04	1.3633	1.4522	1.3724	1.3510	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3569	80°C
	0.12	1.3633	1 .4522	1.3724	1.3567	
	0.16	1.3633	1.4522	1.3724	1.3535	
	0.20	1.3633	1.4522	1.3724	1.3536	
X_1/1.00M	0.04	1 .3633	1.4522	1.3724	1.3380	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3374	80°C
	0.12	1.3633	1.4522	1.3724	1.3362	
	0.16	1.3633	1.4522	1.3724	1.3346	
	0.20	1.3633	1.4522	1.3724	1.3341	
X_1/0.75 M	0.04	1.3633	1.4522	1.3724	1.3633	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3630	80°C
	0.12	1.3633	1.4522	1.3724	1.3632	
	0.16	1.3633	1.4522	1.3724	1.3636	
	0.20	1.3633	1.4522	1.3724	1.3635	
X_1/0.50 M	0.04	1 .3633	1.4522	1.3724	1.3633	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3630	80°C
	0.12	1.3633	1.4522	1 .3724	1.3632	
	0.16	1.3633	1 .4522	1.3724	1.3636	
	0.20	1.3633	1.4522	1.3724	1.3635	
X_1/5.00m	0.04	1.3633	1.4522	1.3724	1.3643	Time 30 min
	0.08	1.3633	1 .4522	1.3724	1.3631	90°C
	0.12	1.3633	1.4522	1.3724	1.3633	
	0.16	1.3633	1 .4522	1.3724	1.3641	
	0.20	1.3633	1.4522	1.3724	1.3624	
X_1/1.00M	0.04	1 .3633	1 .4522	1.3724	1.3626	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3624	90°C
	0.12	1.3633	1.4522	1.3724	1.3615	
	0.16	1.3633	1.4522	1.3724	1.3612	
	0.20	1.3633	1.4522	1.3724	1.3610	
X_1/0.75 M	0.04	1.3633	1.4522	1.3724	1.3638	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3635	90°C
	0.12	1.3633	1.4522	1.3724	1.3622	
	0.16	1.3633	1.4522	1.3724	1.3621	
	0.20	1.3633	1 .4522	1.3724	1.3620	
X_1/0.50 M	0.04	1.3633	1 .4522	1.3724	1.3614	Time 30 min
	0.08	1.3633	1 .4522	1.3724	1.3610	90°C
	0.12	1.3633	1.4522	1.3724	1.3621	
	0.16	1.3633	1.4522	1.3724	1.3629	
	0.20	1.3633	1.4522	1.3724	1.3612	
X_1/5.00 M	0.04	1.3633	1.4522	1.3724	1.3622	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3613	90°C
	0.12	1.3633	1.4522	1.3724	1.3627	
	0.16	1.3633	1.4522	1.3724	1.3625	
	0.20	1.3633	1.4522	1.3724	1.3622	
X_2/0.50m	0.04	1.3633	1.4522	1.3724	1.3612	Time 30 min
	0.08	1.3633	1 .4522	1.3724	1.3610	90°C
	0.12	1.3633	1.4522	1 .3724	1.3624	
	0.16	1.3633	1.4522	1.3724	1.3628	
	0.20	1.3633	1.4522	1.3724	1.3628	
X_2/5.00 M	0.04	1.3633	1.4522	1.3724	1.3630	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3637	100°C
	0.12	1.3633	1.4522	1,3724	1.3633	
	0.16	1.3633	1.4522	1.3724	1.3629	
	0.20	1.3633	1.4522	1 .3724	1.3625	
X_2/1.00M	0.04	1.3633	1.4522	1.3724	1.3654	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3652	100°C
	0.12	1.3633	1 .4522	1.3724	1.3648	
	0.16	1.3633	1.4522	1.3724	1.3643	
	0.20	1.3633	1.4522	1.3724	1.3637	
X_2/0.75 M	0.04	1.3633	1.4522	1.3724	1.3717	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3712	100°C
	0.12	1.3633	1.4522	1.3724	1.3710	
	0.16	1.3633	1.4522	1 .3724	1.3707	
	0.20	1.3633	1 .4522	1.3724	1.3701	
X_2/0.50 M	0.04	1.3633	1.4522	1.3724	1.3985	Time 30 min
	0.08	1.3633	1.4522	1.3724	1.3983	100°C
	0.12	1.3633	1.4522	1.3724	1.3980	
	0.16	1.3633	1.4522	1.3724	1.3979	
	0.20	1.3633	1.4522	1 .3724	1.3975	

X_1= Plantain stem; X_2= Banana stem; CPO= Crude palm oil; Min =Minutes

Effect of methanol leaf extracts of Phyllantusamarus on bodyweight

The body weight for the induced not treated group reduced gradually compared to the normal control group throughout the 4 weeks while that of the treated groups reduced initially after the administration of alloxan but later gained slight weight (Fig. 2). From the study, the decrease in the bodyweight of the diabetic not treated rats is due to insulin deficiency which prevents the absorption of glucose to cells where they are required and in the process the body alternatively sources for energy from protein and lipid catabolism (Mhya *et al*., 2019). The rats treated with extracts showed a slight weight gained as that of the standard drug. The extract may have helped to stop or reduce the protein breakdown. This result agreed with the findings of Almalki *et al*. (2019).

Conclusion

The results of this study suggested that *Phyllantusamarus* possess hypoglycaemic properties which may be due to the phyto-constituents of the plant extract. It may be used in drug development if further investigated.

Conflict of Interest

Authors have declared that there is no conflict of interest in this study.

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