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EFFECT OF ANTIOXIDANTS AND STORAGE TIME ON THE PHYSICOCHEMICAL PROPERTIES OF RAW PALM OIL

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Abstract: **To determine the effect of antioxidants and storage time on the physicochemical properties of raw palm oil was the main focus of the study. The antioxidants used were ascorbic acid, citric acid and watermelon seed oil. These antioxidants were added to 100ml sample of palm oil in single doses of 50mg, 100mg and 150mg respectively; also the blend(double and triplicate) of the antioxidants were prepared in the ratio of 1:1 to make up the 50mg, 100mg and 150mg of the doses respectively. The results showed that for storage time up to 70 days of palm oil samples treated with different doses of antioxidants; peroxide values decreased with increased in storage time, free fatty acid value did not follow any established trend with increase in the storage time, DOBI values decreased slightly with the increase in storage time of the oil when compared to that of the control sample, melting point and freezing point increased slightly with increase in storage time when compared to that of control sample. With respect to the above findings, antioxidants mostly affect peroxide value as they are substances that inhibit oxidation.**

1. INTRODUCTION

From palm fruit two types of oil are produced. They are the palm oil and the palm kernel oil. The fibrous mesocarp of palm fruit yields 20 – 22% of its oil and the kernel yields about 10% of its oil (Norrizah et al., 2014).

Palm oil (Elaeis guineensis) is one of the edible plant-based oil obtained from the mesocarp of the oil palm fruits (http://scialert.net.abstract/?). It is reddish orange in colour, the colour is attributed to high beta-carotene content. The concentration of carotenoids in palm oil is high when compared to other vegetable oils that are widely consumed (http://scialert.net.abstract/?). The fatty acids content of palm oil depends on the presence and number of double bond(s) or absence of it. They include the following; saturated, unsaturated and poly unsaturated fatty acids. However palm oil contains more of saturated fatty acids by higher proportion (http://scialert.net.abstract/?). Palm oil is among the highly saturated plant-based oil as it contains about 41% saturated fat (https://en.m.wikipedia.org/wiki/pa). At room temperature palm oil is a semi solid substance. Palm oil is one of the plant – based products which contains very little cholesterol.

Palm oil is processed from fresh fruits using different methods which differ in operation mechanism (Tagoe et al., 2012). The operations can be grouped into two namely; local methods and industrial methods. The local methods or the small scale units process little quantity of the fresh fruit bunch while the industrial or the large scale mills process the fresh fruit bunch in large quantity (Tagoe et al., 2012).

Palm oil is used mainly in cooking and frying in Africa. It is also extensively used in the food, cosmetics, pharmaceuticals, and other industries for the manufacture of industrial products such as margarine, soap, body cream, bio diesel etc. It also has properties that prevent friction when used as base stock or additives (Tagoe et al., 2012).

According to Amira et al., (2014), the properties of oils which are determined to know the quality, purity and identification are called physicochemical properties. The two types of physicochemical properties are characteristic properties and variable properties. The characteristics properties are properties that depend on the nature of the oil. The characteristics properties are used to characterize the oil irrespective of location or sources of origin. Examples of these include iodine value and saponification value. The variable properties are those properties that change with location. Examples are free fatty acid value, peroxide value, density, solubility, freezing point, colour, odour and boiling point.

All foods including fats and oils undergo certain undesirable changes during storage which results in spoilage. The major spoilage is rancidity. Rancidity is simply the state where foods that contain fats and oils give remarkable unpleasant taste or smell. Some of the chemical reactions that cause fats and oils to become rancid are hydrolysis and oxidation. These reactions lead to the production of aldehydes and ketones which produce the unpleasant taste and odour. Rancidification can occur in three ways; hydrolytic rancidity, oxidative rancidity and microbial rancidity.

Hydrolytic rancidity is the decomposition of fats and oils by enzymes in the presence of water or the hydrolysis of triglycerides to release free fatty acid.

Oxidative rancidity occurs when peroxides are produced through the addition of oxygen to the double bond of unsaturated fatty acid, thereby releasing volatile aldehydes and ketones.

Microbial rancidity occurs when fats and oil are broken down by enzymes of micro organisms enzymes such as lipase.

The oxidative and the hydrolytic state of any given sample of fats and oils can be determined by estimating the peroxide value which is associated with the oxidation and the free fatty acid which is associated with the hydrolysis.

The peroxide value is used to determine the degree of spoilage of fats and oils (Amira et al., 2014). The standard peroxide value for edible oils which have not undergone rancidity should not be above 10meq/kg (Amira et al., 2014). The free fatty acid value is used as an index to determine the quality of fats and oils (Tagoe et al., 2012).

Palm oil when stored at room conditions for a long time could go rancid and develop awful odour and flavor. This is caused by the development of FFA, aldehyde, ketones and other oxidation products. The use of such oil for edible purposes could be dangerous to health consequently must be processed to eliminate those undesirable components before applies for edible purposes. This implies a lot of cost. However it is possible to prevent the rate of spoilage of the oil.

Oxidation reaction occurs when hydrogen is removed in the presence of oxygen, heat, light, metals etc which acts as catalysts to form lipid radicals which results in oxidative damage of the polyunsaturated fatty acid (Dianzanni & Barrera, 2005).

Antioxidants are substances at low concentration which are capable of preventing or retarding oxidation of oxidizable materials (Frankel & Meyer,2000).

This study aims at monitoring the effect of edible anti-oxidants and storage time on the physicochemical properties of raw palm oil.

2. METHODS

Materials

Palm oil used for the study was purchased from Afor Nnobi Market in Idemili South Local Government Area of Anambra State. Watermelon seed oil was prepared from watermelon fruits purchased from New Market Enugu, and the antioxidants ascorbic acid and citric acid were purchased from Ogbete Market Enugu, Enugu State.

Watermelon Seed Oil Production

Watermelon seeds were obtained from the fruits and were air dried. The seed coats were removed manually and the seed then grounded into powder and the oil was extracted using n-hexane. The miscella was heated to a temperature of 110^{o}C using water bath in order to recover the oil.

Characterization of Palm Oil

100ml of fresh raw palm oil samples were treated with different doses of antioxidants (50mg, 100mg and 150mg) in single, double and triplicates respectively. The double and triplicate doses were blended in the ration of 1: 1.

Physical Characterization

The palm oil treated with various doses of the antioxidants was characterized by the physical properties described below.

Determination of DOBI

The DOBI was determined using the method specified by ISO 17932:2011. Oil solution formed by dissolving about 0.1g of oil in about 25ml(95%) n-hexane was placed in a 1cm cuvette and the absorbance reading was taken at 446nm and 269nm using spectrophotometer of Mark Pharmaspec Model UV – 1700. DOBI is a ratio of absorbance at 446nm to 269nm.

Determination of Freezing Point

The freezing point was determined using a super National (NA 15 RJ) refrigeration as described by Ekumankam et. al, (2014).

Determination of Melting Point

The melting point was determined by monitoring the frozen oil from the refrigerator with the aid of thermometer supported on a retort stand to detect the temperature at which the oil starts to melt.

Chemical Characterization

The palm oil was characterized by the chemical properties described below.

Determination of Free Fatty Acid

The free fatty acid value was determined using the AOCS 2009 method. The method involves titrating known mass of oil neutralized in about 100ml ethanol with 0.1N NaOH solution using phenolphthalein indicator.

Determination of Peroxide Value

The peroxide value was determined using AOCS 2009 method. The method involves titrating chloroform/acetic acid/potassium iodide of the oil solution with solution of sodium thiosulphate using starch as indicator.

3. RESULTS AND DISCUSSION

Effect of antioxidants and storage time on the physical properties of raw palm oil

The effect of different antioxidants and storage time of palm oil on the DOBI is presented in table 1 – 7.

Table 1: The DOBI values and storage time at different doses of citric acid

Storage Time (days)	Freezing point values at different doses of the blend of CA+AA per 100ml of palm oil			Control Sample
	25mg(CA+AA)	50mg(CA+ AA)	75mg(CA+ AA)	
0	18.6	18.6	18.6	18.6
14	18.8	18.4	17.7	20.2
28	19.1	18.6	18.4	22.2
42	20	19.7	19	25.4
56	20.3	19.8	19.4	25.9
70	20.3	20.1	19.6	26.1

From the tables, it could be observed that the DOBI values of samples containing antioxidants slightly decreased compare to blank samples as the storage time of palm oil increased which implies that antioxidants do not affect DOBI significantly. This could be attributed to carotenoid oxidation during storage (Tagoe et al., 2012).

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Table 2: The DOBI values and storage time at different doses of ascorbic acid

Storage Time (days)	DOBI values at different doses of ascorbic acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	3.65	3.65	3.65	3.65
14	3.49	3.59	3.49	3.48
28	3.4	3.4	3.4	3.03
42	3.29	3.31	3.39	2.93
56	2.91	3.06	3.38	2.87
70	2.9	2.99	3.31	2.82

Table 3: The DOBI values and storage time at different doses of WMSO

Storage Time (days)	DOBI values at different doses of WMSO per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	3.65	3.65	3.65	3.65
14	3.48	3.5	3.5	3.48
28	3.05	3.1	3.19	3.03
42	3.01	3.07	3.07	2.93
56	2.89	2.92	2.99	2.87
70	2.87	2.9	2.91	2.82

Table 4: The DOBI values and storage time at different doses of the blend of citric acid and watermelon seed oil

Storage Time (days)	DOBI values at different doses of the blend of CA + WMSO per 100ml of palm oil			Control Sample
	25mg(CA +WMSO)	50mg(CA+ WMSO)	75mg(CA+ WMSO)	
0	3.65	3.65	3.65	3.65
14	3.43	3.55	3.53	3.48
28	3.06	3.14	3.23	3.03
42	3	3.04	3.07	2.93
56	2.92	2.95	3	2.87
70	2.91	2.94	2.95	2.82

Table 5: The DOBI values and storage time at different doses of the blend of ascorbic acid and watermelon seed oil

Storage Time (days)	DOBI values at different doses of the blend of AA + WMSO per 100ml of palm oil			Control Sample
	25mg(AA +WMSO)	50mg(AA+ WMSO)	75mg(AA+ WMSO)	
0	3.65	3.65	3.65	3.65
14	3.49	3.54	3.50	3.48
28	3.22	3.25	3.29	3.03
42	3.15	3.19	3.23	2.93
56	2.90	2.99	3.18	2.87
70	2.89	2.94	3.11	2.82

Table 6: The DOBI values and storage time at different doses of the blend of citric acid and ascorbic acid

Storage Time (days)	DOBI values at different doses of the blend of CA + AA per 100ml of palm oil			Control Sample
	25mg(CA+ AA)	50mg(CA+ AA)	75mg(CA+ AA)	
0	3.65	3.65	3.65	3.65
14	3.43	3.59	3.53	3.48
28	3.24	3.29	3.33	3.03
42	3.14	3.16	3.23	2.93
56	2.93	3.02	3.2	2.87
70	2.93	2.98	3.16	2.82

Table 7: The DOBI values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid

Storage Time (days)	DOBI values at different doses of the blend of AA+CA+WMSO per 100ml of palm oil			Control Sample
	16.6mg(CA+AA+WMSO)	33.3mg(CA+AA+WMSO)	75mg(CA+AA+WMSO)	
0	3.65	3.65	3.65	3.65
14	3.45	3.56	3.52	3.48
28	3.17	3.23	3.28	3.03
42	3.1	3.13	3.18	2.93
56	2.92	2.99	3.13	2.87
70	2.91	2.95	3.07	2.82

The effect of antioxidants and storage time of palm oil on the freezing point of palm oil is presented in tables 8-14. From the tables, it was observed that there is a slight increase in the freezing point of the samples containing antioxidants and that of the control sample as the palm oil storage time increased but the increase in the freezing point of the control sample is more significant which may be linked to the fact that the degree of saturation increases as the oxidation increases which agreed with Frankel (2005), that singlet oxygen interacts with the polyunsaturated fatty acids and that saturated compounds have high freezing point.

Table 8: The Freezing point values and storage time at different doses of citric acid

Storage Time (days)	Freezing point values at different doses of citric acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	18.6	18.6	18.6	18.6
14	19.2	18.6	17.4	20.2
28	19.4	18.8	18.4	22.2
42	20.2	20	19	25.4
56	20.3	20	19.4	25.9
70	20.3	20.1	19.4	26.1

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Table 9: The Freezing point values and storage time at different doses of ascorbic acid

Storage Time (days)	Freezing point values at different doses of ascorbic acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	18.6	18.6	18.6	18.6
14	18.4	18.2	18	20.2
28	18.8	18.4	18.4	22.2
42	19.8	19.4	19	25.4
56	20.2	19.6	19.4	25.9
70	20.3	20.1	19.8	26.1

Table 10: The Freezing point values and storage time at different doses of WMSO

Storage Time (days)	Freezing point values at different doses of WMSO per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	18.6	18.6	18.6	18.6
14	19.0	17.0	17.0	20.2
28	20.6	19.4	18.8	22.2
42	21.6	20.2	19.0	25.4
56	22.3	21.2	20.1	25.9
70	23.0	25.0	22.4	26.1

Table 11: The Freezing point values and storage time at different doses of the blend of citric acid and watermelon seed oil

Storage Time (days)	Freezing point values at different doses of the blend of CA + WMSO per 100ml of palm oil			Control Sample
	25mg(CA +WMSO)	50mg(CA+ WMSO)	75mg(CA+ WMSO)	
0	18.6	18.6	18.6	18.6
14	19.1	17.8	17.2	20.2
28	20	19.1	18.6	22.2
42	20.9	20.1	19	25.4
56	21.3	20.6	19.8	25.9
70	21.7	22.6	20.9	26.1

Table 12: The Freezing point values and storage time at different doses of the blend of ascorbic acid and watermelon seed oil

Storage Time (days)	Freezing point values at different doses of the blend of AA + WMSO per 100ml of palm oil			Control Sample
	25mg(AA +WMSO)	50mg(AA+ WMSO)	75mg(AA+ WMSO)	
0	18.6	18.6	18.6	18.6
14	18.7	17.6	17.5	20.2
28	19.7	18.9	18.6	22.2
42	20.7	19.8	19	25.4
56	21.3	20.4	19.8	25.9
70	21.7	22.6	21.1	26.1

Table 13: The Freezing point values and storage time at different doses of the blend of citric acid and ascorbic acid

Storage Time (days)	Freezing point values at different doses of the blend of CA+AA per 100ml of palm oil			Control Sample
	25mg(CA+AA)	50mg(CA+ AA)	75mg(CA+ AA)	
0	18.6	18.6	18.6	18.6
14	18.8	18.4	17.7	20.2
28	19.1	18.6	18.4	22.2
42	20	19.7	19	25.4
56	20.3	19.8	19.4	25.9
70	20.3	20.1	19.6	26.1

Table 14: The Freezing point values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid.

Storage Time (days)	Freezing point values at different doses of the blend of AA+CA+WMSO per 100ml of palm oil			Control Sample
	16.6mg(CA+AA+WMSO)	33.3mg(CA+AA+WMSO)	75mg(CA+AA+WMSO)	
0	18.6	18.6	18.6	18.6
14	18.9	17.9	17.5	20.2
28	19.6	18.9	18.5	22.2
42	20.5	19.9	19	25.4
56	20.9	20.3	19.6	25.9
70	21.2	21.7	20.5	26.1

The effect of antioxidants and palm oil storage time on melting point of palm oil is presented in tables 15 – 21. From the tables, it was found that the melting point of samples containing antioxidants and that of the control samples increase as the palm oil storage time increase. The increase is more pronounced in the control sample. This is as a result of increase in oxidation which results in saturated fatty acid leading to high melting point (Frankel, 2005).

Table 15: The Melting point values and storage time at different doses of citric acid

Storage Time (days)	Melting point values at different doses of citric acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	24.8	24.8	24.8	24.8
14	23.8	22.9	22.6	26.8
28	25.4	25.1	24.4	27.0
42	27.8	26.8	26.1	29.4
56	27.9	27.0	26.2	29.6
70	28.0	27.1	26.2	29.6

Table 16: The Melting point values and storage time at different doses of ascorbic acid

Storage Time (days)	Melting point values at different doses of ascorbic acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	24.8	24.8	24.8	24.8
14	23.2	22.8	22.6	26.8
28	25.4	251	25	27
42	27.8	27.2	26.5	29.4
56	28.1	28	27.4	29.6
70	28.3	28.2	27.9	29.6

Table 17: The Melting point values and storage time at different doses of WMSO

Storage Time (days)	Melting point values at different doses of WMSO per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	24.8	24.8	24.8	24.8
14	25.4	24	23.6	26.8
28	25.4	25.2	25.2	27
42	27	27	26	29.4
56	27.8	27.1	26.8	29.6
70	28.5	27.8	27	29.6

Table 18: The Melting point values and storage time at different doses of the blend of citric acid and watermelon seed oil

Storage Time (days)	Melting point values at different doses of the blend of CA + WMSO per 100ml of palm oil			Control Sample
	25mg(CA +WMSO)	50mg(CA+ WMSO)	75mg(CA+ WMSO)	
0	24.8	24.8	24.8	24.8
14	24.6	23.5	23.1	26.8
28	25.4	25.2	24.8	27
42	27.4	26.9	26.1	29.4
56	27.9	27.1	26.5	29.6
70	28.3	27.5	26.6	29.6

Table 19: The Melting point values and storage time at different doses of the blend of ascorbic acid and watermelon seed oil

Storage Time (days)	Melting point values at different doses of the blend of AA + WMSO per 100ml of palm oil			Control Sample
	25mg(AA +WMSO)	50mg(AA+ WMSO)	75mg(AA+ WMSO)	
0	24.8	24.8	24.8	24.8
14	24.3	23.4	23.1	26.8
28	25.4	25.2	25.1	27
42	27.4	27.1	26.3	29.4
56	28	27.6	27.1	29.6
70	28.4	28	27.5	29.6

Table 20: The Melting point values and storage time at different doses of the blend of citric acid and ascorbic acid

Storage Time (days)	Melting point values at different doses of the blend of CA+AA per 100ml of palm oil			Control Sample
	25mg(CA+AA)	50mg(CA+ AA)	75mg(CA+ AA)	
0	24.8	24.8	24.8	24.8
14	23.5	22.85	22.6	26.8
28	25.4	25.1	24.7	27
42	27.8	27	26.3	29.4
56	28	27.5	26.8	29.6
70	28.15	27.65	27.05	29.6

Table 21: The Melting point values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid

Storage Time (days)	Melting point values at different doses of the blend of AA+CA+WMSO per 100ml of palm oil			Control Sample
	16.6mg(CA+AA+WMSO)	33.3mg(CA+AA+WMSO)	75mg(CA+AA+WMSO)	
0	24.8	24.8	24.8	24.8
14	24.1	23.2	22.9	26.8
28	25.4	25.1	24.9	27
42	27.5	27	26.2	29.4
56	27.9	27.4	26.8	29.6
70	28.3	27.7	27	29.6

Effect of antioxidants and storage time on the chemical properties of raw palm oil

The effect of different antioxidants and storage time of palm oil on the free fatty acid is presented in table 22- 28. From the tables, it can be seen that free fatty acid did not follow any established trend which could be attributed to the fact that antioxidants prevents oxidation Brewer (2011) and not hydrolysis which free fatty acid helps to measure.

Table 22: The free fatty acid values and storage time at different doses of citric acid

Storage Time (days)	Free fatty acid values (FFA) at different doses of citric acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	37	37	37	37
14	29	23	37	25
28	32	35	42	33
42	24	33	26	35
56	32	32	33	32
70	25	30	32	30

Table 23: The free fatty acid values and storage time at different doses of ascorbic acid

Storage Time (days)	Free fatty acid values (FFA) at different doses of ascorbic acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	37	37	37	37
14	42	38	26	25
28	37	41	45	33
42	30	21	22	35
56	28	27	29	32
70	33	37	29	30

Table 24: The free fatty acid values and storage time at different doses of watermelon seed oil (WMSO)

Storage Time (days)	Free fatty acid values (FFA) at different doses of WMSO per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	37	37	37	37
14	31	39	34	25
28	38	44	41	33
42	19	26	28	35
56	32	29	32	32
70	27	30	25	30

Table 25: The free fatty acid values and storage time at different doses of the blend of citric acid and watermelon seed oil

Storage Time (days)	Free fatty acid values (FFA) at different doses of the blend of CA + WMSO per 100ml of palm oil			Control Sample
	25mg(CA + WMSO)	50mg(CA + WMSO)	75mg(CA + WMSO)	
0	37	37	37	37
14	31	28	24	25
28	49	36	32	33
42	36	27	33	35
56	29	32	35	32
70	30	38	34	30

Table 26: The free fatty acid values and storage time at different doses of the blend of ascorbic acid (AA) and watermelon seed oil (WMSO)

Storage Time (days)	Free fatty acid values (FFA) at different doses of the blend of AA + WMSO per 100ml of palm oil			Control Sample
	25mg (AA + WMSO)	50mg (AA + WMSO)	75mg(AA + WMSO)	
0	37	37	37	37
14	25	24	28	25
28	36	32	25	33
42	21	28	22	35
56	31	30	31	32
70	33	28	34	30

Table 27: The free fatty acid values and storage time at different doses of the blend of citric acid (CA) and ascorbic acid (AA)

Storage Time (days)	Free fatty acid values (FFA) at different doses of the blend of CA + AA per 100ml of palm oil			Control Sample
	25mg(CA + AA)	50mg(CA + AA)	75mg(CA + AA)	
0	37	37	37	37
14	29	26	25	25
28	29	20	26	33
42	35	23	27	35
56	32	28	48	32
70	28	35	30	30

Table 28: The free fatty acid values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid

Storage Time (days)	Free fatty acid values (FFA) at different doses of the blend of AA+CA+WMSO per 100ml of palm oil			Control Sample
	16.6mg(CA+AA+WMSO)	33.3mg(CA+AA+WMSO)	75mg(CA+AA+WMSO)	
0	37	37	37	37
14	24	28	28	25
28	25	30	28	33
42	34	24	27	35
56	30	34	34	32
70	27	32	29	30

The effect of antioxidants and palm oil storage time on the peroxide values of raw palm oil is presented in tables 29 – 35 and figures 1 - 7. From the tables, it was generally observed that in samples containing antioxidants that their peroxide values decreased with as the palm oil storage time increased while that of the control sample increased as the palm oil storage time increased. The decrease in the peroxide value is agreement with Frankel (2005) that antioxidants prevent oxidation and decrease in peroxide value shows oxidation inhibition while increase in peroxide value shows increase in oxidation. Also from tables, it was observed that peroxide values of samples containing ascorbic acid tend to zero which shows that ascorbic acid is one of the strongest antioxidant though it is insoluble in fats but Erich & Gart-Wolfhard (2008) affirmed that though water soluble antioxidants do not prevent oxidation in fats they have the ability to intercept free radicals that travel through the aqueous parts of the food.

Table 29: The peroxide values and storage time at different doses of citric acid

Storage Time (days)	Peroxide values (meq/Kg) at different doses of citric acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	4.995	4.995	4.995	4.995
14	4.495	4.398	4.096	6.996
28	4.298	4.199	3.497	7.99
42	4.198	3.896	3.449	9.999
56	3.796	3.398	3.097	10.987
70	3.797	3.145	2.876	11.237

Table 30: The peroxide values and storage time at different doses of Ascorbic acid

Storage Time (days)	Peroxide values (meq/Kg) at different doses of Ascorbic acid per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	4.995	4.995	4.995	4.995
14	0	0	0	6.996
28	0	0	0	7.99
42	0	0	0	9.999
56	0	0	0	10.987
70	0	0	0	11.237

Table 31: The peroxide values and storage time at different doses of watermelon seed oil

Storage Time (days)	Peroxide values (meq/Kg) at different doses of watermelon seed oil per 100ml of palm oil			Control Sample
	50mg	100mg	150mg	
0	4.995	4.995	4.995	4.995
14	4.696	4.397	4.300	6.996
28	4.498	4.299	4.094	7.990
42	4.098	3.696	3.598	9.999
56	3.896	3.697	3.497	10.987
70	3.900	3.612	3.245	11.237

Table 32: The peroxide values and storage time at different doses of the blend of citric acid and watermelon seed oil

Storage Time (days)	Peroxide values (meq/Kg) at different doses of the blend of CA + WMSO per 100ml of palm oil			Control Sample
	25mg(CA + WMSO)	50mg(CA + WMSO)	75mg(CA + WMSO)	
0	4.995	4.995	4.995	4.995
14	4.497	4.299	4.098	6.996
28	4.096	3.895	3.596	7.99
42	3.697	3.696	3.498	9.999
56	3.297	3.099	2.897	10.987
70	3.098	2.784	2.613	11.237

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Table 33: The peroxide values and storage time at different doses of the blend of ascorbic acid and watermelon seed oil

Storage Time (days)	Peroxide values (meq/Kg) at different doses of the blend of AA + WMSO per 100ml of palm oil			Control Sample
	25mg(AA + WMSO)	50mg(AA + WMSO)	75mg(AA + WMSO)	
0	4.995	4.995	4.995	4.995
14	4.098	3.7	3.598	6.996
28	3.499	3.298	3.097	7.99
42	0	0	0	9.999
56	0	0	0	10.987
70	0	0	0	11.237

Table 34: The peroxide values and storage time at different doses of the blend of ascorbic acid and citric acid

Storage Time (days)	Peroxide values (meq/Kg) at different doses of the blend of CA + AA per 100ml of palm oil			Control Sample
	25mg(CA+AA)	50mg(CA+AA)	75mg(CA+AA)	
0	4.995	4.995	4.995	4.995
14	3.596	3.199	3.299	6.996
28	3.196	2.899	0.000	7.990
42	0.000	0.000	0.000	9.999
56	0.000	0.000	0.000	10.987
70	0.000	0.000	0.000	11.237

Table 35: The peroxide values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid

Storage Time (days)	Peroxide values (meq/Kg) at different doses of the blend of AA+CA+WMSO per 100ml of palm oil			Control Sample
	16.6mg(CA+AA+WMSO)	33.3mg(CA+AA+WMSO)	75mg(CA+AA+WMSO)	
0	4.995	4.995	4.995	4.995
14	4.093	3.099	0	6.996
28	3.898	2.899	0	7.99
42	3.797	2.698	0	9.999
56	3.297	2.497	0	10.987
70	2.841	2.299	0	11.237

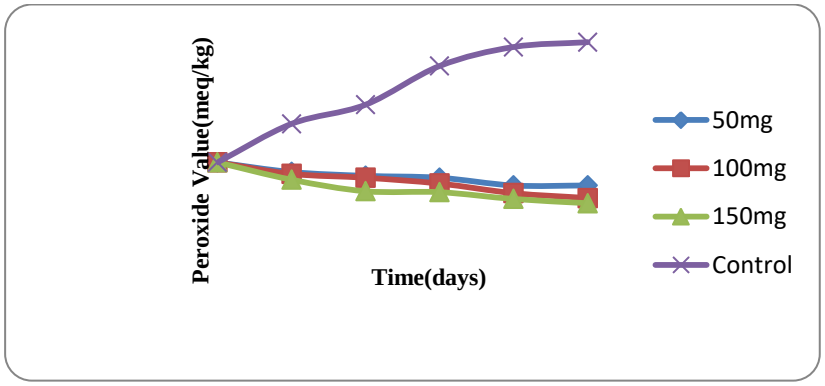

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Fig.1: Plot of peroxide values (meq/Kg)and storage time at different doses of citric acid per 100ml of raw palm oil

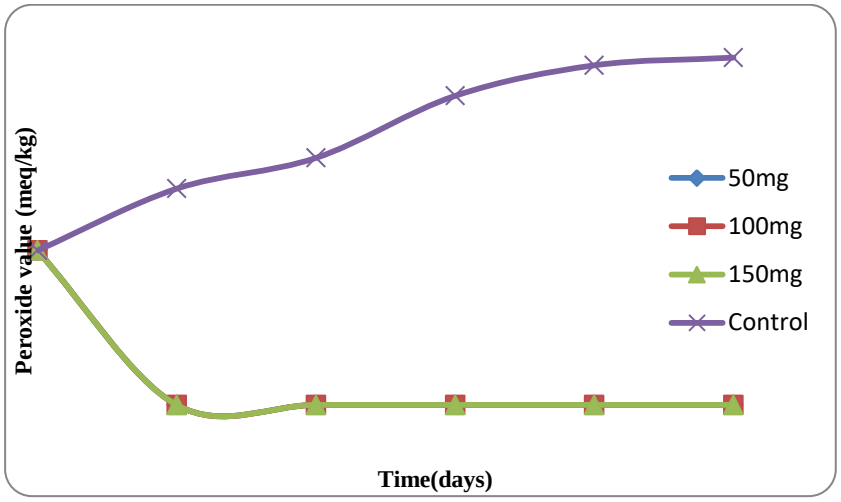

Fig.2: Plot of peroxide values (meq/Kg) and storage time at different doses of ascorbic acid per 100ml of raw palm oil

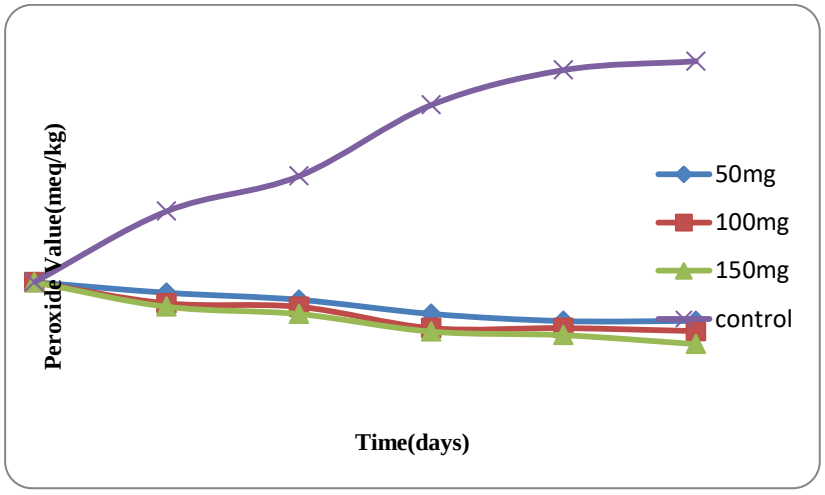

Fig. 3: Plot of peroxide values and storage time at different doses of watermelon seed oil

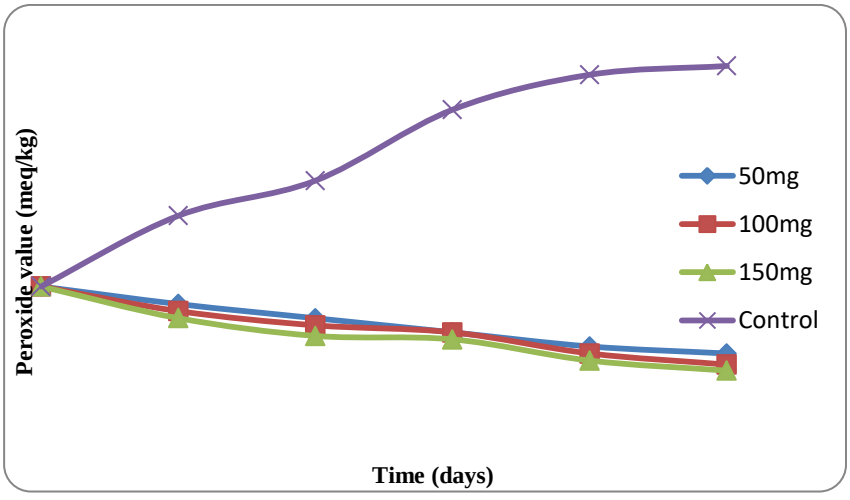

Fig. 4: Plot of peroxide values and storage time at different doses of the blend of citric acid and watermelon seed oil

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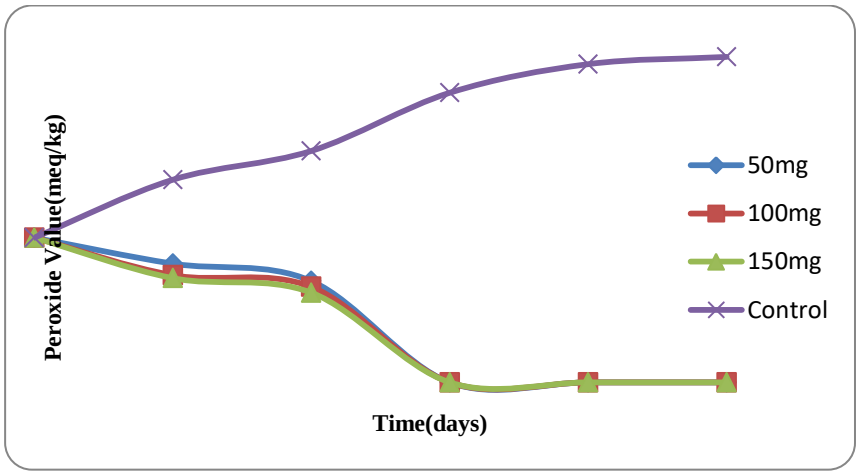

Fig. 5: Plot of peroxide values and storage time at different doses of the blend of ascorbic acid and watermelon seed oil

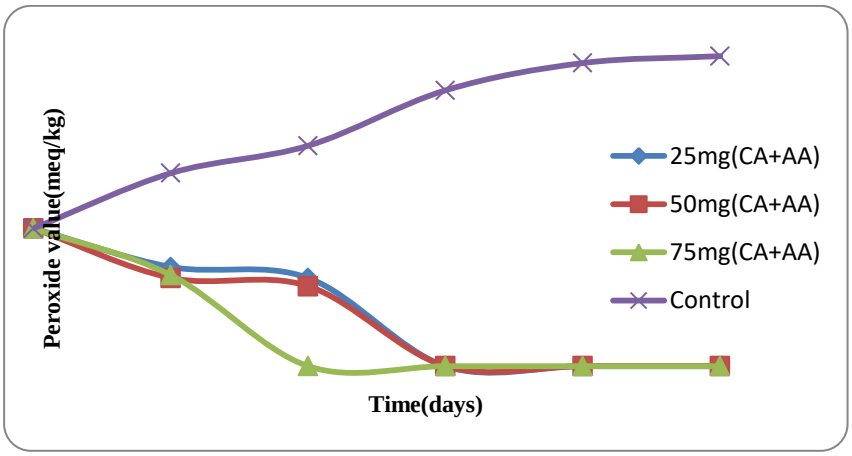

Fig.6: Plot of peroxide values and storage time at different doses of the blend of ascorbic acid and citric acid

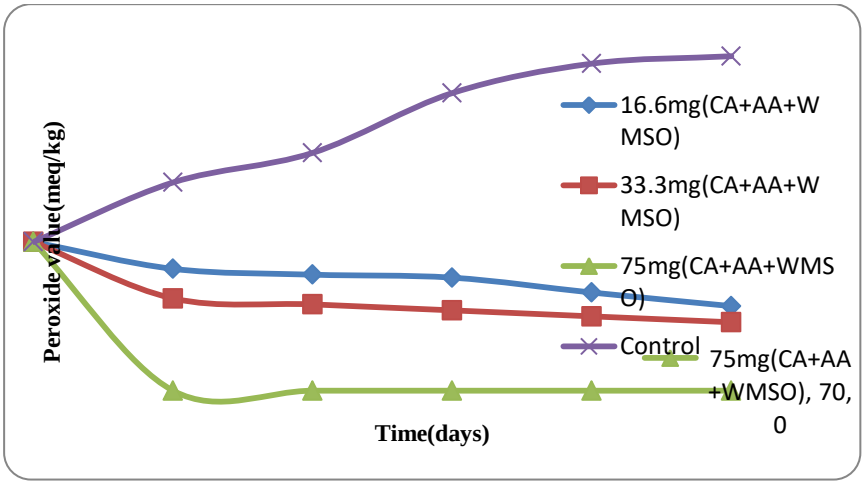

Fig. 7: Plot of peroxide values and storage time at different doses of the blend of watermelon seed oil, ascorbic acid and citric acid

4. CONCLUSION

The study investigated the effect of antioxidants and palm oil storage time on the physicochemical properties of crude palm oil. From the study on the physical properties, it was concluded that antioxidants slightly affect the DOBI values which slightly decreased with increase in palm oil storage time. Also the freezing point and the melting point were slightly affected as there was slight increase with increase in palm oil storage time.

Considering the effect on the chemical properties, it was concluded that antioxidants do not have any effect on the free fatty acid which did not follow any established trend as the palm oil storage time increased.

On the other hand, it was concluded that antioxidants affected the peroxide value which is an indicator of oxidation in that the peroxide values decreased as palm oil storage time increased. Also it was concluded that ascorbic acid is one of the strongest antioxidants as there was a mop up of the peroxide values in the sample containing ascorbic acid showing there is no oxidation.

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