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Oxidative Stability and Antioxidant Activity of Some Non-Conventional Vegetable Oils

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Abstract: Light induced oxidation of the oils of five non-conventional oil sources namely: *I. gabonensis* (Wild Mango or Dica nut) Seed, *D. edulis* (African native pear) seed, *D. edulis* flesh, *P. americana* (Avocado pear) flesh and *T. catappa* (Almond) seed were monitored under light of different intensities (Dark, fluorescent light, daylight and direct sunlight). G. Max (Soya bean) oil was used as reference sample for this comparative study. *I. gabonensis* has the highest stability under the tested conditions. Peroxidation process was accelerated in all the tested oils under direct sunlight. G. *max* oil recorded the highest peroxide value. All the tested oil samples except *I. gabonesis* exhibited higher percentage antioxidant activity than the conventional oil from *G. max* . The strongest effect was obtained for *D. edulis* flesh oil.

Keywords: Oxidative stability, vegetable oils, antioxidant, peroxide,

Introduction

The large oil content of some non-conventional oil seeds has made them a good complement, if not substitute to some conventional oils. Earlier work on the samples investigated in this study revealed that they are good sources of oil. For examples, *Irvingia gabonensis* seeds (Dica nut) 70% (Okoye and Okonkwo, 1999), , *Dacryodes edulis* flesh (African pear) 49 – 59% (Mbofung, et al., 2002), *Persea americana* flesh (Acocado) 15 - 30%, (Werman and Neeman, 1986). These values show that these non-conventional vegetable oils could compete favourably with the conventional ones such as groundnut (35-32%), soybean (17-20%), oil palm (20 – 22%) and cotton seed oils (28 – 32%), (Mbofung, et al., 2002).

In view of the economic importance of oils for domestic and industrial applications, we set out to investigate the ability of oils to withstand deterioration due to environmental conditions which may affect their quality and nutritional values over a period of time. This is of paramount importance when some non conventional oils are being introduced into the food industry and the world market (Mbofung, et al., 2002, Werman and Neeman, 1986 and Awowo, et al., 2002). Some of these environmental factors are light, air ,water e.t.c. (Harry, 1995). Effect of these factors on oils is oxidative deterioration leading to reduction in food value, off flavours and odours (Harry, 1995).

The oxidative deterioration of oils and fats is a complex process leading to varying degrees of decomposition products common in oils and fats containing unsaturated fatty acids. P. Americana (Avocado) oil is unsaturated and the predominant fatty acid is oleic (Werman and Neeman, 1986). *D. edulis* flesh oil contained 22.2% linoleic, 28.5% oleic, 45% palmitic acids while its seeds contained 36.9% Linoleic acid (Kinkela and Bezard, 1993). *I. gabonensis* is rich in saturated fatty acids: myristic 50.6%and lauric 38.8% (Leakey and Tchoundjeu, 2001). Thus these oils will be expected to have varying degrees of stability. Determination of their peroxide values over a period of time will provide information on the stability of the oils to oxidative deterioration.

It has also been reported that vegetable oils contain trace amount of natural antioxidants such as vitamin E and carotenoids, (Wang, et al. 2002). These contribute to the stability of the oils against development of undesirable flavours and odours. Natural antioxidants have been established to promote health by acting against oxidative stress related diseases such as cancer and coronary heart diseases (Tutour, 1990).

In this study the stability of these non-conventional oils was investigated and compared with *Glycine max* (soybean) oil under light of different intensities. Also, the antioxidant activity of the oils was evaluated using 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radicals spectrophotometric assay.

Materials and Methods

Materials: P. americana fruit and T. catappa seeds were harvested from Obafemi Awolowo University Campus. D. edulis fruits, I. *gabonensis* and *G. max* seeds were obtained from the local market in Ile-Ife. The samples were air-dried, pulverized and the oils extracted by soxhlet extraction using n-hexane as solvent.

Determination of the peroxide value of the oils: The peroxide value of the oils was determined as previously described (Werman and Neeman, 1986), with a slight modification. Oil sample (10mL) was placed in transparent glass bottles and the bottles were loosely capped to enable contact with atmospheric air. The oil samples were

Table 1a: Effect of Light Intensity on the Oxidative Stability of Oils (Peroxide values in meq/kg)

	Terminalia catappa				Dacryodes edulis seed				Glycine max			
Days	In the dark	Fluore. scent	Day light	Direct sunlight	In the dark	Fluore. scent	Day light	Direct sunlight	In the dark	Fluore. scent	Day light	Direct sunlight
0	0.50	0.50	0.50	0.50	5.60	5.60	5.60	5.60	3.60	3.60	3.60	3.60
14	0.50	6.00	3.00	11.00	10.00	14.00	12.00	71.00	4.40	16.00	21.40	56.00
28	1.00	33.00	8.00	68.00	27.00	88.00	124.00	200.00	5.00	21.00	29.00	120.00
42	1.00	44.00	26.00	118.00	29.00	168.00	130.00	236.00	7.00	33.00	40.00	160.00
56	2.17	48.36	32.82	120.79	33.00	170.79	178.07	129.77	14.40	67.40	72.52	180.79
70	3.90	52.24	33.93	131.89	32.00	187.38	186.00	137.52	17.70	78.63	109.34	316.31
84	4.34	61.75	38.46	134.38	31.00	155.45	130.69	225.93	18.30	40.60	47.30	360.78

(b)

	Persea americana flesh				Irvingia gabonensis				Dacryodes edulis flesh			
Days	In the dark	Fluores. cent. light	Day light	Direct sunlight	In the dark	Fluores. cent light	Day light	Direct sunlight	In the dark	Fluores cent light	.Day Light	Direct sunlight
0	3.00	3.00	3.00	3.00	0.81	0.81	0.81	0.81	6.00	6.00	6.00	6.00
14	16.20	72.00	92.00	110.00	1.30	7.00	2.13	9.20	11.00	12.60	11.80	35.00
28	20.00	176.00	175.00	203.00	2.00	17.00	10.00	37.00	14.00	110.00	108.00	178.00
42	22.00	140.00	120.00	174.00	2.20	21.00	14.00	62.00	30.00	58.00	48.00	114.00
56	24.51	131.69	130.43	173.74	2.89	27.82	23.69	32.24	33.40	142.57	179.00	132.01
70	18.78	94.05	171.21	177.22	3.00	29.67	25.54	27.06	37.75	166.99	84.47	155.77
84	24.20	93.89	126.63	166.09	4.05	30.22	30.02	20.08	55.99	171.88	119.37	177.86

separately exposed to four oxidative conditions at room temperature (28.5 $\pm$ 1.0^0 C) i.e. darkness, daylight on the shelf for 12hrs per day; direct sunlight for average of 8 hrs per day; and 100cm beneath 40W fluorescent lamp for 24 hrs per day. Each experiment was carried out in duplicate.

Sample Analysis: Peroxide values were determined every two weeks using the AOAC official method of analysis (AOAC, 1990).

Evaluation of antioxidant activity: The determination of the radical scavenging activity of each of the oils was carried out using the DPPH (1,1-diphenyl-2-picrylhydrazyl) assay as described by Mensor et al. 2001, with a slight modification. The test sample (2.0mL) of the varying concentrations (100, 50 and 25μg/mL) was added to 1.0mL of DPPH (0.2mM) in ethanol. The mixture was incubated in a dark chamber for 30minutes and absorbance was taken at 518nm on a spectrophotometer (Pharmacie Biotech, Novaspec II). The mean absorbance from three

replicate assays was then converted into the percentage antioxidant activity (AA%) using the formula :

$AA\% = 100 - \{[(Abs_{sample} - Abs_{blank}) \times 100] / Abs_{control}\}$

α-Tocopherol was used as positive control.

Results and Discussion

Oxidative Stability: The change in peroxide value of the oil samples against light intensity is presented in Table 1. The peroxide formation curves are presented in Figures 1 – 4. All the oils investigated showed varying peroxide values and induction periods under the studied conditions. In the dark, *I. gabonensis* had the least peroxide value. It changed from 0.81 to 4.05 meq/kg after 84 days. *T. catappa* oil exhibited similar changes (0.50 – 4.34 meq/kg) under this condition. *G. max* values ranges between 3.60 – 18.30 and the highest peroxide value of 55.99 meq/kg was obtained for *D. edulis* flesh oil with an initial value of 6.00.

Under fluorescent light, all the tested oils were photosensitive. Within the period of 70days oil samples obtained from seeds showed consistent increase in their peroxide values which ranges between 29.67 – 187.38 meq/kg .The least value was obtained for I. gabonensis while the most sensitive oil was *D. edulis* oil seed. *P. americana* and *D. edulis* flesh oil attained highest values of 176.00 and 110.00meq/kg respectively within 28days. However, while *P. americana* flesh oil showed consistent drop in its peroxide value which could be due to the formation of secondary oxidation products. It is interesting to note that the peroxide value of *D. edulis* flesh oil stated to increase again after 56days. This could be due to generation of additional free radicals during the formation of secondary oxidation products which caused the reinitiation of the peroxidation. Similar peroxidation trend was

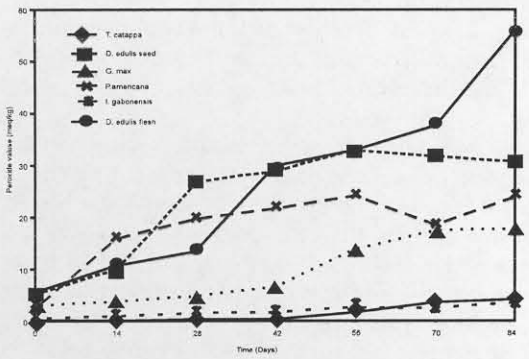

Fig. 1: Proxide formation in crude oil during storage at room temperature in the dark.

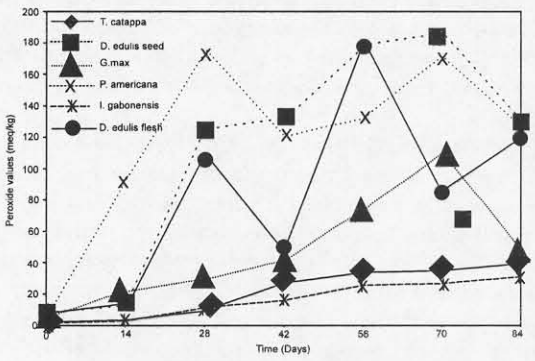

Fig. 3: Peroxide formation in crude oil during storage at room tempereture (exposure to daylight)

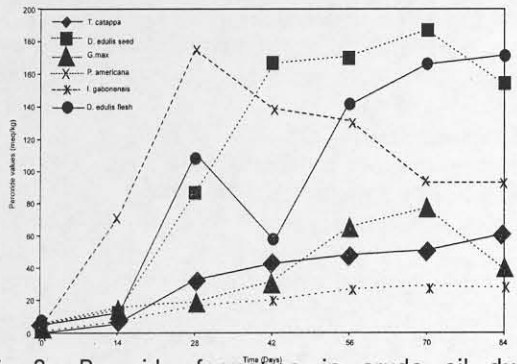

Fig. 2: Peroxide formation in crude oil during storage at room temperature (exposure to flourescent light)

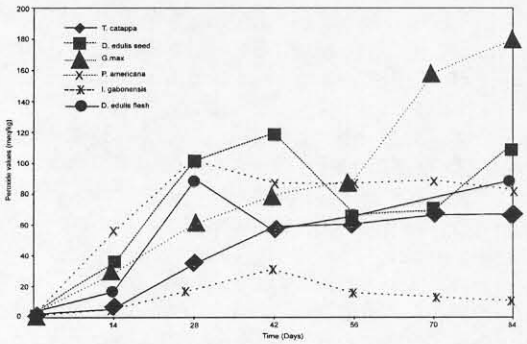

Fig. 4: Peroxide formation in crude oil during storage at room temperature (exposure todirect sunlight.

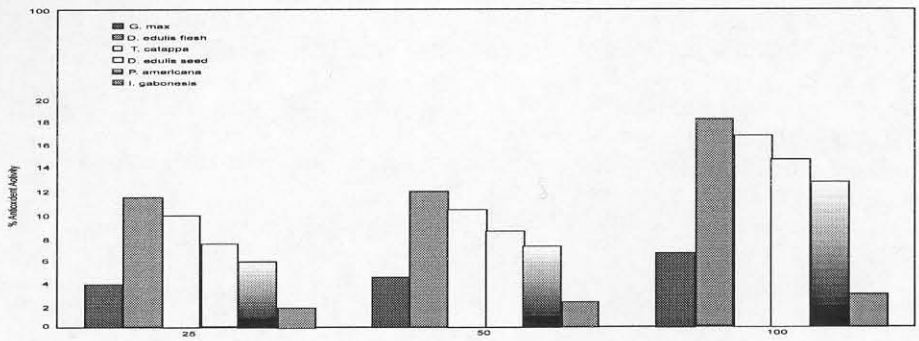

Fig. 5:Antioxident activity of the oil samples.

observed for the oils exposed to daylight. It has been demonstrated that exposure to daylight and artificial light caused significant peroxidation of unsaturated oil (Werman and Neeman, 1986). *I. gabonensis* was the least affected, this could be due to its high level of saturated fatty acids, which has been reported to be about 90% (Leakey and Tchoundjeu, 2001) .

Peroxidation process was accelerated under direct sunlight for all the oil samples; this may be due to the loss of natural antioxidants present in the oils resulting from exposure to intensive light of sunlight. *G. max* oil was the most affected and had the highest value of 360.78meq/kg with an initial value of 3.60meq/kg. This observation was in agreement with the earlier report on the *G. max* oil (Werman and Neeman, 1986). The trend observed when samples were exposed to sunlight was similar to that observed under other conditions.

Under all the tested oxidative conditions, I. gabonensis demonstrated the highest stability, this may be due to the presence of high level of saturated fatty acids in the oil, which are known to be resistant to oxidation. Under

direct sunlight all the oil samples were more stable than the conventional *G. max oil*. This was in agreement with the percentage antioxidant activity obtained for the oil samples (Fig. 5). Deterioration of the oils obtained from the flesh were rapid, probably due to extraction of additional components such as pigments and dyes (Pheophytin, porphyrins e.t.c.) which absorbed strongly in the visible or near UV light ((Werman and Neeman, 1986).

Antioxidant Activity: The variation of the antioxidant activity of the oil samples with concentration is shown in Fig 5. The result indicates a consistent increase in antioxidant activity with increase in concentration. α-tocopherol used as standard exhibited 23.9 percentage antioxidant activity at the concentration of 2.5μg/mL. All the tested oil samples except *I. gabonensis* exhibited higher percentage antioxidant activity than the conventional *G. max* oil (3.8 – 6.5%). The strongest effect was measured for *D. edulis* flesh oil (11.3 – 18.2%), the activity could be as a result of additional minor components (polyphenols) that are responsible for the flavour and taste of the fruit extracted into the oil. The natural antioxidants are probably destroyed on exposure to light of different intensities, which aided its peroxidation (Arieh, et al. 1986). All the tested oil samples except *I. gabonensis* may serve as better dietary sources of natural antioxidants.

References

AOAC, 1990. Official Methods of analysis of the Assoc. of Official Analytical Chemists. Pg. 956.

Awowo, A., O. Ndoye, K. Schreekenberg, H. Tabuna, F. Isseri and L. Temple, 2002.Production and marketing of Safou (Dacyodes edulis) in Cameroon and internationally: market development issues. Forests, Tress and Livelihoods, 12: 125 – 147.

Kampf, A., S. Grinberg and A. Galun, 1986. Oxidative Stability of Jojoba Wax.JAOCS, 2: 246-248

Kinkela, T. and Bezard, 1993. Fat content and fatty acid composition of some food products from Congo. Original title: Les lipides de quelques produits alimentaires Congolais. Sci. des aliments, 13: 567-575.

Lawson, H. 1995. Food Oils and Fats. Technol., Utilization, and Nutrition. Chapman & Hall Publ. Comp. New York. Pg 8 18 – 21.

Leakey, R. R. B., and Z. Tchoundjeu, 2001. Diversification of Tree crops: Domestication of Companion Crops For Poverty Reduction and Environmental serv., Experimental Agri., 37:279 – 296.

Mbofung, C. M. F, T. Silou, and I. Mouragadja 2002. Chem. characterization of Safou (Dacryodes edulis) and evalu. of its poten. as an ingredient in nutritious biscuits. .Forests, Trees and Livelihoods, 12: 105 – 117

Mensor, L. L. , F. S. Menezes, G. G. Leitao, A. S. Reis, T. C. Santos, C. S. Coube and S. G. Leitao, 2001. Screening of Brazilian Plant Extracts for Antioxidant Activity by the use of DPPH Free Radical Method, Phytother. Res., 15: 127 – 130.

Okoye, W. E. and E. U. Okonkwo, 1999. Extraction and characterization of oils from nine lesser-known Nigerian oil seeds., 2: 231 – 2.

Tutour, B. L., 1990. Anti-oxidative activities of algal extracts. Synergistic effect with vitamin E. Phytochem. 29: 3759-3765

Werman, M. J. and I. Neeman, 1986. Oxidative Stability of Avocado Oil. Jour. of The American Oil Chemists' Society, 63: 355 – 360

Wang, T., K. B. Hicks and R. Moreau, 2002. Antioxidant activity of Phytosterols, Oryzanol and Phytosterol conjugates. J. Am. Oil Chem. Soc., 79: 1201 – 1206.