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Storage Properties of Oils of Two Nigerian Oil Seeds *Jatropha curcas* (Physic Nut) and *Helianthus annuus* (Sunflower)

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Abstract: Oils of *Jatropha curcas* and *Helianthus annuus* stored at ambient conditions for four months in four different containers (polythene, glass, metal and plastic bottles) were sampled at one month interval for physico-chemical properties. Increases were noted in all the containers as follows: Free fatty acid (0.72-1.02 and 0.6-1.14%), peroxide value (0.2-1.86 and 0.23-0.44 mEq kg^{-1}), iodine value (1.40-11.50 and 6.20-14.20), acid value (13.00-50.00 and 36.00-59.00 mg KOH g^{-1}) for *Jatropha curcas* and *Helianthus annuus*, respectively. No container effect on the color, dirt/sediment, specific gravity and reflective index of the oils was apparent. All parameters were closed in the limits for oils edited by Codex Alimentary Commission.

Key words: Physico-chemical properties, container, storage, *J. curcas*, *Helianthus annuus*

INTRODUCTION

Oil crops and their products are about the second most valuable commodity in the world trade (Ibanga and Okon, 2004) and are regarded as a vital part of the world's food supply. Most oils are liquid at 20°C and are normally obtained from seeds, kernels and nuts either by mechanical pressure or by solvent extraction. Components such as moisture, Free Fatty Acid (FFA), color matter, resins and gums and sometimes vitamins, affect color, flavor, clarity and are removed during refining (degumming, neutralizing, washing and drying, bleaching and decolorizing) (Abulude *et al*., 2005). They are used in cooking, food manufacture, as lubricant, in animals feed, soap manufacturing, tin plating and in cosmetic, in pharmaceutical applications, paints, leather making, cloth, insecticide and printing ink.

The storing of large volume of oil for long period under diverse conditions is not an easy task, since many of its characteristics (color, flavor and clarity), which are necessary to be maintained, deteriorate (Abulude *et al*., 2004). In order to maintain stability of oil for long periods for consumption and individual usage, without loss of quality and quantity, a good storage method need to be developed.

Research works have been carried out on oil seeds of *Jatropha curcas* and *Helianthus annuus* (Quadrado, 1994), but there is death of information on the storage properties of these oil seeds. This study was, therefore carried out to determine the effect of storage on the physico-chemical properties of oils from *Jatropha curcas* and *Helianthus annuus* seeds produced in Akure, Ondo State, Nigeria.

MATERIALS AND METHODS

The seeds of *Jatropha curcas* and *Helianthus annuus* were obtained within the vicinity of Federal College of Agriculture, Akure in October, 2005, dehulled, sun dried for 24 h, ground in a

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Kenwood blender, sieved (40 mesh sieve) and stored in a screw-cap bottle, till required for analysis. The oils were obtained by exhaustive extraction of the materials with petroleum ether (b.pt 40-60°C) using soxhlet extractor. The oils were left opened for 1 h to allow any trace of petroleum vapors to escape before storage in containers.

The analytical studies (physico-chemical properties) were carried out between October 2005 and February, 2006. The storage containers (polythene, glass, plastic and metal bottles) were purchased from a local market in Akure. These were washed with detergent, rinsed in distilled water and dried. One liter of each oil was stored in each of the containers for four months. The analytical values determined before the commencement of storage were used as the reference values. Two determinations on each oil were carried out on the properties at one month interval. Iodine Value (IV), Free Fatty Acid (FFA), Peroxide Value (PV), Acid Value (AV) and Saponification Value (SV) were determined by the methods described by Pearson (1981). The refractive index (R_f) of the oils was measured on acetone cleaned surface of prisms through the telescope, the Specific gravity (Sg) of the oils was determined using specific gravity bottle, dirt and sediments were determined using filtration method (Odetokun, 1998). Sensory evaluations were done by panel of nine judges, who evaluated the samples in terms of color and odor using a nine point hedonic scale (9 = super good, downwards to 1 = super bad). The relative humidity (%) and temperature (°C) were recorded daily (Amoo and Moza, 1999).

The mean, standard deviation, coefficient of variation in percent (CV%) and test of significance were performed using SPSS 10.0 for Windows.

RESULTS AND DISCUSSION

Records for the average ambient temperature (°C) and relative humidity (%) during the storage period, by month are depicted in Table 1. The temperature ranged between 29.2-32.0°C, whereas humidity ranged between 80-85% during the period.

The results of the quality assessment of the oils during storage in the different containers are shown in Table 2-5. The initial FFA content was 0.46 (*J. curcas*) and 0.40% (*H. annuus*). Odetokun (1998) reported FFA content of 1.87 and 5.30% for *M. glaziovil* seed oil and palm oil, respectively. Amoo and Mosza (1999) reported 0.06% for *Bauhinia racemosa* oil and Abulude *et al*. (2005) gave between 0.65-0.95% for palm oil stored in different containers. The PV content was between 5.42 and 7.28 mEq kg^{-1} (*J. curcas*), 6.77 and 7.20 mEq kg^{-1} (*H. annuus*) and the IV content was between 28.60 and 40.10 (*J. curcas*), 17.90 and 32.10 (*H. annuus*). These levels of IV were in line with mean values of 15.95 and 13.52, respectively reported by Abulude *et al*. (2004) and Amoo and Moza (1999). The average content of PV was 3.50 (*J. curcas*), 2.20 (*H. annuus*) with SV of 289 (*J. curcas*) and 274 (*H. annuus*) at the onset of the experiment.

The FFA, AV, IV, SV and PV increased for all replicates from the 1 st month to the 4th month of storage. The reasons for these increases may be attributed to the absorption of moisture from the surroundings, oxidation, heat, light and metal. When these occur there is the likelihood of microorganisms affecting the oils, which in turn may lead to spoilage. The low FFA values suggest that the samples are good edible oils. High acid values are usually indicative of damage or high moisture which enables the enzyme lipase to convert the triglycerides to free fatty acids. The values obtained

Table 1: Ambient temperature and humidity of the environment during storage periods

Period of storage	Temp. (°C)	Humidity (%)
Commencement (October)	29.2	80
November (1st month)	30.1	85
December (2nd month)	30.9	85
January (3rd month)	31.3	84
February (4th month)	32.0	85

Table 2: Quality assessment of oil samples during storage in polythene bag at ambient conditions

Oil sample	Period of storage	FFA (%)	PV (mEq kg^{-1})	IV	Odor	Color	Sediment/ dirt (g)	R_f	Sg (g)	SV (mg KOH g^{-1})	AV
J. Curcas	Commencement										
	(October)	0.46	5.42	28.60	8.8	Yellow	Nil	1.46	0.93	28.90	3.50
	November	0.69	5.42	29.65	8.8	Yellow	Nil	1.46	0.93	28.90	4.21
	December	1.10	5.42	30.00	8.6	Yellow	Nil	1.46	0.93	29.30	5.62
	January	1.20	5.42	30.12	8.4	Yellow	Nil	1.46	0.93	29.90	6.44
	February	1.48	5.60	30.14	8.1	Yellow	Nil	1.46	0.93	30.20	8.94
	Mean	0.99	5.46	29.76	8.54	-	-	1.46	0.95	29.44	5.74
	Standard deviation	0.41	0.08	0.70	0.30	-	-	0.0	0.00	5.90	2.13
	CV (%)	41.4	1.48	2.37	3.47	-	-	0.0	0.00	2.00	37.05
H. annuus	Commencement										
	(October)	0.40	6.77	28.60	8.9	Yellow	Nil	1.42	0.95	27.40	2.20
	November	0.76	6.79	29.65	8.9	Yellow	Nil	1.41	0.95	28.80	2.40
	December	1.05	7.00	30.00	8.9	Yellow	Nil	1.41	0.95	29.90	4.51
	January	1.32	7.00	30.12	8.7	Yellow	Nil	1.42	0.95	30.30	6.10
	February	1.54	7.00	30.42	8.7	Yellow	Nil	1.42	0.95	31.00	7.01
	Mean	1.01	6.91	21.72	8.82	-	-	1.42	0.95	294.80	4.87
	Standard deviation	0.45	0.42	2.82	0.11	-	-	0.01	0.95	14.10	2.19
	CV (%)	44.4	1.75	13.00	1.24	-	-	0.39	0.95	4.78	45.00

FFA- Free Fatty Acid, PV- Peroxide Value, IV- Iodine Value, R_f- Refractive Index, Sg- Specific Gravity, SV- Saponification Value, AV- Acid Value

Table 3: Quality assessment of oil samples during storage in glass bottle at ambient conditions

Oil samples	Period of storage	FFA (%)	PV (mEq kg^{-1})	IV	Odor	Color	Sediment/ dirt (g)	R_f	Sg (g)	SV (mg KOH g^{-1})	AV
J. curcas	Commencement										
	(October)	0.46	5.42	28.60	8.8	Yellow	Nil	1.46	0.93	289.00	3.51
	November	0.98	5.42	28.60	8.8	Yellow	Nil	1.45	0.93	299.00	4.00
	December	1.09	5.55	29.44	8.7	Yellow	Nil	1.46	0.93	310.00	4.25
	January	1.28	5.69	29.70	8.6	Yellow	Nil	1.46	0.93	316.00	5.77
	February	1.32	6.00	30.00	8.3	Yellow	Nil	1.46	0.93	325.00	6.74
	Mean	1.03	5.62	29.27	8.64	-	-	1.43	0.93	307.80	4.85
	Standard deviation	0.35	0.24	0.64	0.21	-	-	0.01	0.0	14.13	1.35
	CV (%)	33.68	4.31	2.19	2.40	-	-	0.58	0.0	4.57	27.83
H. annuus	Commencement										
	(October)	0.40	6.77	17.90	8.9	Yellow	Nil	1.42	0.95	274.00	2.20
	November	0.56	6.87	19.00	8.7	Yellow	Nil	1.43	0.95	282.00	3.42
	December	0.80	6.87	20.12	8.7	Yellow	Nil	1.43	0.95	299.00	4.52
	January	1.10	7.10	21.44	8.7	Yellow	Nil	1.44	0.95	302.00	6.00
	February	1.25	7.20	24.10	8.7	Yellow	Nil	1.44	0.95	311.00	6.84
	Mean	0.82	6.96	20.51	8.74	-	-	1.43	0.95	293.60	4.60
	Standard deviation	0.32	0.18	2.40	0.09	-	-	0.01	0.00	15.18	1.88
	CV (%)	43.34	2.58	11.69	1.02	-	-	0.58	0.00	5.17	40.86

*See footnote Table 2

at the commencement period fell below the maximum acceptable value of 4 mg KOH g^{-1} oil as recommended by Codex Alimentarius Commission (1989). The higher levels obtained there after indicated deterioration. The IV is often the most useful figure for identifying oil or placing it into a particular group. It is an index of unsaturation which shows the molecular weight for their fatty acids in the two investigated oils to be mainly non-drying.

The PV, which was also low, is a measure of the peroxide oxygen present and is the value used in assessing the extent of oil spoilage. The highest levels of PV were found in the metal container. However, the obtained values were within the acceptable value of 10 m Eq kg^{-1} (Abayeh *et al*., 1998). The low PV indicated that the oils had low susceptibities to oxidative rancidity and are suitable to be kept for sometime in different containers without appreciable deterioration. The higher the IV, the greater is the liability of the oils to go rancid by oxidation. It then suggests that the oils stored in the

Table 4: Quality assessment of oil samples during storage in metal container at ambient conditions*

Oil samples	Period of storage	FFA (%)	PV (mEq kg^{-1})	IV	Odor	Color	Sediment/ dirt (g)	R_f	Sg (g)	SV	AV
J curcas	Commencement (October)	0.46	5.42	28.60	8.8	Yellow	Nil	1.46	0.93	289.00	3.50
	November	0.88	6.00	30.20	8.6	Yellow	Nil	1.46	0.93	292.00	4.45
	December	1.05	6.35	33.17	8.6	Yellow	Nil	1.46	0.93	305.00	6.26
	January	1.25	6.88	37.22	8.2	Yellow	Nil	1.46	0.93	318.00	8.77
	February	1.36	7.28	40.10	8.0	Yellow	Nil	1.48	0.93	339.00	10.84
	Mean	1.00	6.39	33.86	8.44	-	-	1.47	-	308.6	6.76
	Standard deviation	0.35	0.73	4.79	0.33	-	-	0.01	-	20.53	3.04
	CV (%)	35.38	1.42	14.15	3.89	-	-	0.61	-	6.65	44.90
H annuus	Commencement (October)	0.40	6.77	17.90	8.90	Yellow	Nil	1.42	0.95	274.00	2.20
	November	0.40	6.91	20.17	8.90	Yellow	Nil	1.42	0.95	289.00	4.66
	December	0.52	6.95	23.82	8.90	Yellow	Nil	1.42	0.95	312.00	6.84
	January	0.54	7.10	28.11	8.90	Yellow	Nil	1.44	0.95	324.00	7.99
	February	1.00	7.21	32.10	8.90	Yellow	Nil	1.44	0.95	333.00	9.25
	Mean	0.57	6.99	24.42	8.90	-	-	1.43	0.95	306.40	6.19
	Standard deviation	0.25	0.17	5.78	0.0	-	-	0.01	0.0	24.50	2.80
	CV (%)	43.36	2.45	23.66	0.0	-	-	0.77	0.0	8.00	45.20

*See footnote Table 2

Table 5: Quality assessment of oil samples during storage in plastic bottle at ambient conditions

Oil samples	Period of storage	FFA (%)	PV (m Eq kg^{-1})	IV	Odor	Color	Sediment /dirt (g)	R_f	Sg (g)	SV	AV (mgKOHg^{-1})
J. Curcas	Commencement (October)	0.46	5.42	28.60	8.8	Yellow	Nil	1.46	0.93	289.00	3.50
	November	0.69	5.82	30.00	8.6	Yellow	Nil	1.46	0.93	294.00	4.25
	December	0.92	5.89	30.89	8.6	Yellow	Nil	1.46	0.93	303.00	4.89
	January	0.96	6.55	31.10	8.6	Yellow	Nil	1.46	0.93	310.00	5.21
	February	1.18	6.88	32.05	8.4	Yellow	Nil	1.46	0.93	318.00	6.72
	Mean	0.84	6.11	30.53	8.60	-	-	1.46	0.93	302.80	4.91
	Standard deviation	0.28	0.59	1.30	0.14	-	-	1.46	0.0	11.74	1.20
	CV (%)	2.70	9.66	9.26	1.64	-	-	0.0	0.0	3.88	24.48
H. annuus	Commencement (October)	0.40	6.77	17.90	8.9	Yellow	Nil	1.42	0.95	274.00	2.20
	November	0.52	6.77	21.45	8.9	Yellow	Nil	1.43	0.95	286.00	3.52
	December	0.74	6.95	24.20	8.8	Yellow	Nil	1.44	0.95	298.00	4.72
	January	0.76	6.95	26.10	8.8	Yellow	Nil	1.44	0.95	301.00	5.65
	February	1.24	7.10	27.22	8.8	Yellow	Nil	1.44	0.95	311.00	6.81
	Mean	0.73	6.91	23.37	8.84	-	-	1.43	0.95	294.00	458.00
	Standard deviation	0.32	0.14	3.76	0.06	-	-	0.01	0.00	14.30	1.80
	CV (%)	43.95	2.03	16.09	0.62	-	-	0.62	0.00	4.86	34.25

*See footnote Table 2

metal container may go rancid quickly if there was further increase in the period of storage. The SV is inversely related to the average molecular weight of the fatty acids in the oils fractions. According to Entanan (1989), a SV of 200 mg KOH kg^{-1} indicates a preponderance of fatty acids with low molecular weight. It therefore follows that the oils can be categorized to have low molecular weight.

A prominent rancid odor was perceived in all the containers after the 3rd month for *J. curcas* and 2nd month for *H. annuus* by the panelists. This could be attributed to an increase in the FFA contents of the oils. The oils that were stored in the metal and polythene containers had musty odors normally associated with products stored for a long time. During the months of storage there was no dirt nor sediments recorded for the two oils. The results obtained here showed that the containers were appropriate for storage within these periods. No significant effects were obtained for the specific gravities of the two oils. This effect could be due to non availability of sediments which would have normally increased the weights of the oils.

Table 6: Chemical properties of oils stored for four months in different containers

Parameter	f-value	Test of significance
Saponification value	1.01	ns
Acid value	0.34	ns
Peroxide value	0.31	ns
Iodine value	0.28	ns
Free fatty acid	0.53	ns

ns- No Significant difference (p = 0.05)

Statistical result depicts that CV (%) among the parameters with FFA being the highest, while R_f showed the lowest variation. The FFA contents of the samples were not similarly distributed. On the other hand the low CV (%) was an indication of similar values of the parameters in the samples. As shown in Table 6 the analytical observations of the commencement of storage for FFA, PV, IV, SV and AV were much different as compared with the results of samples stored in different containers. It was observed however, that there were no significant differences (p = 0.05) in the parameters when compared with the variations between the replicates throughout the period of storage in the four containers.

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