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Chemical characteristics of palm oil biodeterioration

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Abstract

Examination of the palm oil from *dura* and *tenera* varieties of the oil palm (*Elaeis guineensis*) Jacquin for growth of microorganisms (fungi and bacteria), revealed that *tenera* was more stable to bacteria and fungal deterioration while *dura* was less biostable. Determination of the chemical composition of the palm oil types revealed that crude protein contents of the fresh oil samples which ranged from 0.037 to 0.066% were lower than those kept under different conditions. A *tenera* oil sample (80S, sample 8) had the highest free fatty acid (14.76%) while a *dura* oil sample (10 OJ, sample 10) had the lowest (4.46%). The peroxide values (PV) of the fresh oil sample were low (0.00 – 10.40mEq/kg). The iodine values of the fresh oil samples were lower (23.57 – 48.95) than those kept under different conditions (40.32 – 70.43). Palm oils should not be stored for a long time because of deterioration.

Keywords: Palm oils, chemical characteristics, biodeterioration

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INTRODUCTION

Biodeterioration covers a wide range of biological activities where the effect is to "make things worse" and thus adversely affect man's economy[1]. Microorganisms are known to cause chemical characteristics that lead to deterioration in quality of vegetable oils derived from the seeds or fruits pulps of plants. The keeping quality of the oils is basically dependent on their chemical compositions, for instance, the percentages of the degree of unsaturation[2].

Some slight deterioration at least is to expected in any commercial oil-bearing material and is, in fact, inherent in the process by which fat is formed. In the living plants and animals, fats, carbohydrates and proteins are synthesized in a complicated series of steps with the aid of certain enzymes. These enzymes are capable of assisting the reverse as well as the forward reactions and hence under proper conditions may promote the degradation of the very substances that, they have previously been instrumental in synthesizing[3].

Oils in general are known to be susceptible to microbial attack. The composition of the various oils determines the extent and type of organisms likely to thrive in them[4].

Palm oil is known to support the growth of fungi and bacteria especially when it contains moisture[5]. Their lipolytic enzymes are so active that even under unfavorable conditions palm oil is seldom produced with a free fatty acid content (FFA) of less than 2% and under favorable conditions of processing, the free fatty acid content of this oil reaches 20%and higher. When the fruit is bruised, lipolytic action occurs and a near maximum FFA (8-10%) is reached within 40 minutes. The FFA of unbruised fruits may increase only 0.2% or less in the course of 4 days[3].

This study is aimed at examining the biodeteriogenic effects of microorganisms contaminating the oils from *tenera* and *dura* varieties of the oil palm (*Elaeis guineensis*) Jacquin and the chemical components of the oils.

MATERIALS AND METHODS

Collection of samples

The palm fruits used in this work were obtained from *Elaeis guineensis dura* (Ojukwu) and *Elaeis guineensis tenera* (Osukwu) varieties. Each sample of *dura* and *tenera* varieties was obtained from 5 locations in Abia State. Namely: Nvosi (1,3), Ikputu (2,4), Ndume (5,6), Ubakala (7,8) and Amawom (9,10).

Extraction of palm oil from mesocarp oil palm varieties

A modification of the method of Anochili[6] was used. The freshly harvested ripe oil palm fruits were separated from the bunch and boiled in a large container for about 4 hours. The mass of pulp was produced by pounding the boiled fruits in a special pit. The initial stages were carried out in the pit, the sides of which are coated with cement. The whole mass was immersed in water, stirred and the crude oil, which rose to the surface, was skimmed off into another pot. The fibres were then sifted out of the water manually and finally the nuts were collected and separated from the remaining fibres. The crude oil thus obtained was boiled in smaller vessels where any fibre still present sank to the bottom. The oil was again skimmed to further remove traces of water[6].

Isolation of fungi

Sabouraud dextrose agar (temperature 45 – 50^0C) in 9ml amounts was used as blank for diluting the oil samples kept under different conditions. Sterile streptomycin (50µg/ml) was added to the Sabouraud dextrose agar to suppress bacterial growth. The agar medium was autoclaved at 121^0C for 15minutes and 1.05kg/cm^2 (15Ib/in^2). Oil samples were serially diluted in molten agar in test tubes, before pouring into sterile petri plates, one mililitre of 10^{-3}, 10^{-4} and 10^{-5} dilutions were used. The agar medium was allowed to cool and solidify before the plates were incubated

at room temperature (30± 20^0C) for 72 –120 hours. Fungal counts were taken from the oil sample kept under different conditions after incubation to represent the fungal load of the samples. A portion of each fungal colony which developed was picked using a sterile inoculating needle and aseptically subcultured on to fresh Sabouraud dextrose agar plates. The plates were kept as stock cultures for identification tests.

Isolation of bacteria

Molten nutrient agar (temperature 45-50^0C) in 9ml amounts was used as blank for diluting the oil samples kept under different conditions and 50µg/ml nystatin was added to suppress fungal growth. The agar medium was autoclaved at 121^0C for 15 minutes and 1.05kg/cm^2 (15Ib/in^2). The oil sample was treated as previously described for fungal growth. Viable aerobic bacterial counts were taken from the oil samples kept under different conditions after incubation to represent the bacterial load of the samples. Colonies were picked from the plates and streaked on fresh nutrient agar plates to purify. Pure cultures of the isolates were put on nutrient agar slants and stored in the refrigerator (4^0C) as stock cultures for identification tests.

Determination of free fatty acid content

The free fatty acid content of a fat/oil is the number of milligrammes of KOH required to neutralize lg of FFA present in fat/oil sample. The free fatty acid contents of the palm oil types/samples were determined according to the method described by Coursey[7]. The acid value is the number of mg of KOH necessary to neutralize the free acid in lg of sample. The acid value is given by T – B x 5.61/W

0.1M KOH contains 5.6mg/ml or 5.6g/l where T=Titre value of the sample; B=Titre value of a blank. The blank was provided as a control by titrating 2.5ml of the neutral alcohol without sample. The free fatty acid (FFA) is normally determined as oleic acid where by the acid value = 2 x FFA.

NaOH may be used and a generalized formula may be used (for palm oil and fractions): 25.6 x MNaoH x V/W where V= Volume of NaOH solution used in ml; W=Weight of sample

Determination of iodine value

Iodine number or value is a quantitative measure of the degree of unsaturation in a lipid. The principle of the assessment is based on the fact that halogens add to the double bonds of unsaturated fatty acids. The iodine value was determined by the PORIM Test Method[8]. Iodine value was calculated as 12.69N ($V_2 – V_1$)/W where N=Normality of Na_2 S_2 O_3 used; W=the Volume in millilitres of $Na_2S_2O_3$ used (Blank); V_1=the Volume in millilitres of $Na_2S_2O_3$ solution used for the determination (test sample).

Determination of peroxide value

The peroxide value was determined by the method described by Pearson[7] as the mg weight of iodine, which is formed by 1kg of fat/oil sample. When potassium iodine was subjected to the oxidation effect of peroxide forming iodine at room temperature, the iodine, which was liberated, was titrated against standard sodium thiosulphate solution (0.02N $Na_2S_2O_3$). The peroxide value was reported as the volume of 0.02N $Na_2S_2O_3$ used in the titration[7].

Determination of crude protein

The Kjeldahl procedure described by Pearson[7] was used for the determination of nitrogen and crude protein contents of the oil samples. This method involved the determination of total nitrogen which was converted to protein.

RESULTS AND DISCUSSION

The viable counts of microbial organisms (fungi and bacteria) in the oil samples are shown in Tables 1 and 2. Low counts of fungal species were recorded in the fresh oil samples; oil kept in the laboratory (room temperature) for three months and refrigerated oils. Fairly high counts were recorded for oils kept in ambient temperature for 3 months and stale oils (stored under ambient temperature and room temperature). Although low counts of fungal

Table 1: Fungal counts in the oil samples

Oil Samples	Fresh	Kept at room temperature for 3 months (30 ± 2^0C)	Stored for one year	Kept in ambient temperature for 3 months ($28 - 32^0$C)	Refrigerated (4^0C)
1 OS	40 ± 0.00	50 ± 0.24	$1.90 \pm 0.89 \times 10^3$	$5.00 \pm 0.73 \times 10^2$	45 ± 2.49
2 OS	50 ± 0.24	50 ± 0.00	$1.68 \pm 0.28 \times 10^3$	$7.60 \pm 0.29 \times 10^2$	57 ± 4.02
3 OJ	60 ± 0.24	80 ± 0.43	$2.08 \pm 0.71 \times 10^3$	$1.80 \pm 0.14 \times 10^2$	63 ± 5.16
4 OJ	40 ± 0.43	80 ± 0.50	$1.12 \pm 0.79 \times 10^3$	$2.06 \pm 0.44 \times 10^3$	60 ± 9.04
5 OS	40 ± 0.00	50 ± 0.00	$3.80 \pm 0.19 \times 10^2$	$4.00 \pm 0.00 \times 10^2$	50 ± 7.08
6 OJ	40 ± 0.24	50 ± 0.24	$4.40 \pm 0.35 \times 10^2$	$1.88 \pm 0.29 \times 10^3$	40 ± 4.30
7 OJ	60 ± 0.24	80 ± 0.43	$1.28 \pm 0.71 \times 10^3$	$7.80 \pm 0.14 \times 10^2$	63 ± 6.24
8 OS	30 ± 0.00	50 ± 0.24	$1.90 \pm 0.89 \times 10^3$	$1.70 \pm 0.73 \times 10^3$	40 ± 5.04
9 OS	40 ± 0.24	60 ± 0.00	$1.76 \pm 0.14 \times 10^3$	$2.36 \pm 0.29 \times 10^3$	40 ± 4.30
10 OS	60 ± 0.24	80 ± 0.24	$2.20 \pm 0.17 \times 10^3$	$4.60 \pm 0.44 \times 10^2$	70 ± 2.49

OS = Osukwu; OJ = Ojukwu
The counts are means of three replicates ± standard deviation.

Table 2: Total viable counts of aerobic heterotrophic bacteria in the oil samples

Oil Samples	Fresh	Kept at room temperature for 3 months (30 ± 2^0C)	Stored for one year	Kept in ambient temperature for 3 months ($28 - 32^0$C)	Refrigerated (4^0C)
1 OS	$2.70 \pm 0.57 \times 10^3$	$2.00 \pm 0.60 \times 10^2$	$3.70 \pm 0.24 \times 10^3$	$2.1. \pm 0.86 \times 10^3$	$3.30 \pm 0.89 \times 10^3$
2 OS	$3.33 \pm 0.33 \times 10^3$	$1.94 \pm 0.97 \times 10^2$	$3.70 \pm 0.00 \times 10^3$	$1.94 \pm 0.53 \times 10^3$	$3.70 \pm 0.24 \times 10^3$
3 OJ	$2.60 \pm 0.42 \times 10^3$	$3.10 \pm 0.29 \times 10^2$	$8.00 \pm 0.24 \times 10^3$	$1.63 \pm 0.42 \times 10^3$	$3.70 \pm 0.24 \times 10^3$
4 OJ	$3.00 \pm 0.11 \times 10^3$	$1.60 \pm 0.14 \times 10^2$	$7.80 \pm 0.24 \times 10^3$	$1.56 \pm 0.43 \times 10^3$	$3.50 \pm 0.71 \times 10^3$
5 OS	$3.01 \pm 0.05 \times 10^3$	$1.90 \pm 0.49 \times 10^2$	$5.80 \pm 0.24 \times 10^2$	$1.29 \pm 0.30 \times 10^3$	$3.70 \pm 0.65 \times 10^3$
6 OJ	$3.67 \pm 0.35 \times 10^3$	$1.60 \pm 0.14 \times 10^2$	$5.90 \pm 0.24 \times 10^2$	$1.61 \pm 0.42 \times 10^3$	$3.80 \pm 0.24 \times 10^3$
7 OJ	$3.67 \pm 0.03 \times 10^3$	$8.00 \pm 0.81 \times 10^1$	$8.20 \pm 0.24 \times 10^3$	$1.11 \pm 0.27 \times 10^3$	$3.60 \pm 0.00 \times 10^3$
8 OS	$3.12 \pm 0.11 \times 10^3$	$2.30 \pm 0.13 \times 10^2$	$5.60 \pm 0.49 \times 10^3$	$7.80 \pm 0.21 \times 10^2$	$3.70 \pm 0.00 \times 10^3$
9 OS	$3.67 \pm 0.24 \times 10^3$	$3.20 \pm 0.27 \times 10^2$	$6.80 \pm 0.00 \times 10^3$	$3.86 \pm 0.10 \times 10^2$	$3.90 \pm 0.00 \times 10^3$
10 OS	$3.73 \pm 0.37 \times 10^3$	$1.00 \pm 0.12 \times 10^2$	$7.80 \pm 0.24 \times 10^3$	$4.53 \pm 0.99 \times 10^2$	$3.90 \pm 0.24 \times 10^3$

OS = Osukwu; OJ = Ojukwu
The counts are means of three replicates ± standard deviation.

species were recorded (Table 1), spores were present in the oils. The proliferation of these fungi can therefore occur if there is accidental wetting or careless handling as the oils absorb moisture from the atmosphere. Most of the fungi isolated from the oil samples are known to be actively lipolytic (9; 10) and so are capable of eventually lipolysing the oils especially if storage is prolonged. In fresh oil samples, the fungal count of *tenera* is lower than that of *dura*. This suggests that tenera oil is more stable to fungal deterioration while *dura* oil is less biostable. A similar fungal count was exhibited for oils kept in the laboratory for 3 months and refrigerated oils. A similar fungal count was also exhibited for stale oils except oil sample 60J (*dura* oil sample 6). A similar fungal count was also exhibited for oils kept in ambient temperature for 3 months except 30J (*dura* oil sample 3).

High counts of aerobic heterotrophic bacteria species were recorded in all the oil samples under different conditions except the oils kept in the laboratory (room temperature) for 3 months. In the stale oils, higher bacterial counts were recorded in *dura* oil samples than in the *tenera* samples. This suggests that *tenera* oil is more stable to bacterial deterioration while *dura* oil is less biostable. However, the highest bacterial counts were recorded for the stale oils. The results indicate the levels of deterioration of the oils during processing and handling as well as the survival of bacterial cells in the oils under room temperature, ambient temperature and refrigeration.

Table 3: Chemical compositions of the oil types

a. Fresh oils

Samples	Proteins %	FFA %	PV (mEq/kg)	IV
1 OS	0.056	9.98	2.80	45.95
2 OS	0.053	8.33	4.80	48.96
3 OJ	0.040	7.33	5.20	43.51
4 OJ	0.049	8.60	4.60	40.25
5 OS	0.037	6.02	0.00	45.32
6 OJ	0.053	6.11	1.40	33.37
7 OS	0.047	4.23	10.40	23.57
8 OS	0.054	14.76	6.40	48.95
9 OS	0.066	10.81	0.00	40.61
10 OJ	0.066	4.46	0.00	44.81

The crude protein free fatty acid (FFA), peroxide value and iodine values (IV) of the oil samples are presented in Table 3. The crude protein content of the fresh oil samples was lower than the level in oil samples kept under room temperature, variable conditions, ambient temperature and refrigeration. The protein content increased in the oils kept in the laboratory for 3 months.

b. Oils kept in the laboratory (room temperature) for 3 months

Samples	Proteins %	FFA %	PV (mEq/kg)	IV
1 OS	0.219	13.06	1.90	57.10
2 OS	0.219	10.45	2.40	70.43
3 OJ	0.219	9.57	3.40	59.77
4 OJ	0.263	15.67	2.20	53.30
5 OS	0.238	8.19	0.80	67.38
6 OJ	0.131	11.84	3.20	68.15
7 OJ	0.219	7.34	1.80	60.91
8 OS	0.131	21.93	1.00	64.72
9 OS	0.176	7.93	0.60	66.62
10 OJ	0.131	5.51	6.80	61.29

c. Stale oils (stored under variables conditions for 1 year)

Samples	Proteins %	FFA %	PV (mEq/kg)	IV
1 OS	0.219	7.90	0.20	62.66
2 OS	0.219	17.60	6.60	43.44
3 OJ	0.219	7.06	20.00	59.59
4 OJ	0.219	8.70	9.60	57.67
5 OS	0.219	7.90	2.80	56.13
6 OJ	0.431	8.33	5.80	57.07
7 OJ	0.219	7.90	2.80	56.13
8 OS	0.219	16.60	8.20	58.80
9 OS	0.219	15.00	1.40	56.50
10 OJ	0.431	5.82	3.70	57.00

d. Oils kept in ambient temperature 3 months

Samples	Proteins %	FFA %	PV (mEq/kg)	IV
1 OS	0.200	12.19	0.33	49.58
2 OS	0.175	10.45	8.33	67.24
3 OJ	0.175	9.93	5.00	54.47
4 OJ	0.175	8.19	0.57	47.33
5 OS	0.156	8.19	0.00	32.68
6 OJ	0.219	11.49	0.63	37.19
7 OJ	0.175	8.01	5.46	46.200
8 OS	0.219	24.02	0.57	50.10
9 OS	0.219	18.46	0.33	51.52
10 OJ	0.175	4.53	6.30	30.80

e. Refrigerator Oils

Samples	Proteins %	FFA %	PV (mEq/kg)	IV
1 OS	0.096	12.60	8.90	56.97
2 OS	0.101	8.60	6.20	56.53
3 OJ	0.176	8.00	22.00	45.14
4 OJ	0.146	8.80	14.00	62.67
5 OS	0.218	7.90	4.10	40.32
6 OJ	0.113	8.90	3.00	60.04
7 OJ	0.131	6.00	11.43	63.02
8 OS	0.219	19.20	7.33	62.67
9 OS	0.175	15.00	4.10	56.97
10 OJ	0.219	4.90	4.10	59.16

OS = Osukwu; OJ = Ojukwu

In the stale oil samples, only 60J (*dura* oil samples 6) and 100J (*dura* oil sample 10) had the highest protein contents. For oils kepts in ambient temperature for 3 months there was a decrease in the protein contents of the oil samples except 80S (*tenera* oil sample 8) and 90S (*tenera* oil sample 9). For the refrigerated oils only 80S (*tenera* oil sample 8) and 100S (*tenera* oil sample 10) had the highest protein contents. The crude protein contents in fresh oil samples were low but increased under room temperature, ambient temperature and refrigeration. Moreover, Akpanabiatu *et al*[11] reported that the *tenera* variety is richer in fat, ash and organic matter than the *dura* while the *dura* is richer in crude protein and fiber.

Deterioration of a fat leads to the liberation of free fatty acids (FFA) from triglycerides. The amount of free fatty acid (FFA) in a fat or oil is indicative of its level of spoilage. In the fresh oil samples, 80S (tenera oil sample 8) showed the highest amount of FFA. The highest level of FFA was recorded for 80S (*tenera* oil sample 8) for the samples kept in the laboratory. For the stale oils, the highest amount of FFA was recorded for 10S (*tenera* oil sample 1) followed by 80S (*tenera* oil sample 8). The result indicated that 80S (*tenera* oil sample 8) had the highest level of spoilage and 100J (*dura* oil sample 10) had the lowest level of spoilage. These results are similar to those of Egan *et al*[12] who reported that FFA/acid value is a measure of the extent to which the glycerides in the oil have been decomped by lipase or other action and that decomposition is accelerated by heat and light. The results of FFA determination in Table 3 is in agreement with those of Ekpa and Ekpe[13] who reported that oil samples exposed to normal room conditions (room temperature, 28^0C) were observed to have higher FFA values than the corresponding unexposed samples. However, Ekpa *et al*[14] reported that *dura* variety, in general, exhibited higher values of FFA than the *tenera* variety. Another report by Ekpa *et al*[15] showed that there were significant ($P<0.05$) variations in the major constituent fatty acids among the varieties.

Palm oil from red *tenera* had a mean palmitic acid content of 460. $7gkg^{-1}$ compared with 404.1gkg-1 for red *dura* oil (RDPO) while their oleic acid contents were 348.5 and 416.4gkg-1 respectively. They also reported that there were significant differences observed between palm oils from the red and yellow fruits of the same variety. Other reports[15,16] also showed that the mean total fatty acids calculated for the oil samples showed that the *dura* is richer in unsaturated fatty acids in all locations than the *tenera* varieties. The high level of unsaturation in the *dura* makes it preferable and more adequate nutritionally than the *tenera*. Since the level of unsaturation is affected by the environment where the oil palm is grown, a careful selection of planting location is necessary, if high unsaturation to saturation ratio is desired. In addition, Ekpa and Ekpe[13] reported significant differences ($P<0.05$) in free fatty acid contents for palm oils from the red and yellow *dura* and *tenera* fruits. The FFA was higher in the DRPO (2.90%) than the corresponding TRPO (2.20%) while essentially equal amounts were recorded for the yellow fruits of the two varieties (TYRO, 1.38% and DYPO, 1.30%)[15].

The peroxide value (PV) of the fresh oil samples showed no values for 50S (*tenera* oil sample 5), 90S (*tenera* oil sample 9) and 100S (*dura* oil sample 10). This might be as a result of the freshness of the oil values

except 70J (*dura* oil sample 7). The peroxide value of the oils kept in the laboratory for 3 months were low. For the stale oils, the highest peroxide value was observed for 3 OJ (*dura* oil samples 3). The PV of oils kept in ambient temperature for 3 months were low and 50S (*tenera* oil sample 5) had no value. Higher peroxide values were observed for the refrigerated oils and the highest was recorded for 3 OJ (*dura* oil sample 3). The spoilage of fats and oils during storage is called rancidity and is associated with the production of foul odours[17]. The result recorded for the PV of oil samples is similar to those of Egan *et al*[12] who reported fresh oils usually have peroxide values well below 10mEq/kg. A rancid taste often begins to be noticeable when the peroxide value is between 20 and 40mEq/kg. Ekpa and Ekpe[13] reported that palm oil samples obtained from red and yellow fruits of the *dura* variety (DRPO and DYPO) had higher peroxide values (1.51 and 1.32 respectively) than the values for palm oils from the corresponding *tenera* variety (0.70 for TRPO and 0.80 for TYPO).

Metallic impurities particularly, iron and copper are pro-oxidants and are undesirable. They accelerate the rate of peroxide formation in the oil[18], while the presence of natural antioxidants for example tocopherols, or synthetic anti-oxidants inhibit the formation of peroxides[12]. Peroxide value determines the degree of oxidation of the oil. The peroxide value alone is unreliable because it cannot measure products of secondary oxidation. Anisidine value and carbonyl value are commonly in use[18]. Palm oil oxidation has been the subject of much research. The two main parameters, peroxide value (PV) and P-anisidine value (AV) are regularly used as criteria of the oxidation state of the oil. Total oxidation (TOTOX) is taken as 2xPV+AV [19]. Very little information is available on the degree of oxidation of traditionally produced palm oils[19]. A comparison[20] of traditional palm oils produced in West Africa based on the work of Ata[21], showed these oils had low peroxide values comparable in range to those found in Malaysian crude palm oil. By itself, however peroxide is not very useful as a guide because it is readily destroyed by heat. Peroxide must be measured in conjunction with P-anisidine value, the latter increases when peroxides decompose[19]. The report[19] is in accordance with the PV results recorded for oils kept in ambient temperature for 3 months, unlike the refrigerated oils.

Oil samples 50S (*tenera* oil sample 5) and 90S (*tenera* oil sample 9) were observed to solidify at room temperature. This is in accordance with Egan *et al*[12] who reported that for natural oils and fats the less unsaturated fats with low iodine values are solid at room temperature or conversely, oils that are more highly unsaturated are liquids (showing there is a relationship between melting points and iodine values (IV)). This suggests that 50S (*tenera* oil sample 5) and 90S (*tenera* oil sample 9) with iodine values of 67.38 and 66.62 respectively, were less unsaturated and the other oil samples highly unsaturated. In general, the greater the degree of unsaturation (high IV), the more readily the oil or fat becomes rancid. The lowest iodine value (IV) was recorded for 70J (*dura* oil sample 7) for fresh samples. For oils kept in the laboratory for 3 months, the highest IV was recorded for 20S (*tenera* oil sample 2). The IV recorded for the stale oils were high. The lowest IV was recorded for oil samples kept in ambient temperature for 3 months.

The IV recorded for the refrigerated oils were high. The iodine value is a useful index to detect adulteration of palm oil with any other vegetable or animal fat. Most vegetable oils are predominantly unsaturated and have high iodine value whereas animal fats tend to be predominantly saturated and show low iodine values[18]. The differences in the FFA and melting point (MP) profiles of *dura* and *tenera* oils were explained in terms of differences in the level of chain packing of the constituent fatty acids of the individual oils[14,16]. In accordance with the report of Egan *et al*[12], the oils kept in the

laboratory for 3 months and stale oils were more liable to become rancid.

In conclusion, the viable counts of microbial numbers (fungi and bacteria) contaminating the oils from *tenera* and *dura* varieties of the oil palm (*Elaeis guineensis*) Jacquin kept under different conditions were determined. The chemical components of the oils kept under different conditions were also determined. The oil merchants are therefore advised not to store palm oils for a long time, be it under ambient temperature or variable conditions.

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