HYDROLYTIC STABILITY TEST

FOR REFINED PALM OIL PRODUCTS

Keywords: Rate of hydrolysis, phosphorus, palm oil, palm olein, palm stearin, free fatty acids, hydrolytic stability

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The rates of hydrolysis of refined palm oil products were investigated under different conditions of storage and found to be correlated with different quality parameters. Strong correlations were observed between rates of hydrolysis and the phosphorus content of palm oil and palm olein. Multiple regression equations were derived defining the relationship between the phosphorus levels and the hydrolytic stability of refined palm oil and palm olein.

INTRODUCTION

Rancidity is detectable by the subjective organoleptic appraisal of off-flavour in oils or fats: two types of rancidity are recognized namely oxidative and hydrolytic. Oxidative rancidity is caused by oxygen attack on unsaturated fatty acids with subsequent release of off-flavours, while hydrolytic rancidity is caused by hydrolysis of triglycerides in the presence of moisture, with the liberation of fatty acids. Another off-quality parameter for oils is colour instability, which is generally not so well-defined.

The measurement of rancidity is a necessity at all levels of the trade in oils and fats. At the refinery, a quality control measure is required to assess an oil before it leaves the factory, while the food manufacturer needs to know the shelf life and stability of foods using the oil.

Oxidative rancidity, being a complex subject, has been studied in some detail. It is clearly caused by the oxidation of a fat, resulting in the formation of hydroperoxides and eventually aldehydes and ketones. As the first product formed by oxidation is the hydroperoxide, the most common method used for meas-

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urement is peroxide value (PV). Anisidine value (AV) is another parameter commonly used in evaluation of secondary oxidative products. In this study, the ultraviolet absorption of the conjugated dienes and trienes was also measured. For measuring resistance to oxidation, the well-known Rancimat (Läubli and Bruttel, 1986) and Swift tests (Wheeler, 1932) were employed.

Hydrolytic rancidity and the measurement of an oil's resistance to hydrolysis are less well studied. Most of the work carried out has been on raw materials such as in cereals, seeds or the palm fruit. The studies of Loncin and Jacobsberg (1963) and Chong *et al.* (1984) relate to hydrolysis of crude palm oils during storage. In these studies, the rates of hydrolysis of refined palm oil products under different conditions of storage were studied. Factors affecting the hydrolysis of the oils were also identified.

EXPERIMENTAL

Fifteen samples each of refined palm oil, olein and stearin were collected from local refineries for analysis. The tests included were :-

a) All quality parameters – free fatty acids (FFA) moisture, impurities, $E^{1\%}_{233}$, peroxide value (PV), anisidine value (AV), phosphorus (P), iron (Fe), Copper (Cu) and colour – were measured on the fresh oils. The above tests were carried out as described in *PORIM Test Methods.*

b) Oven stability tests at 60°C and the determination of free fatty acids (FFA) were carried out weekly for 8 weeks for the oils kept at 60°C. The oils (1000 ml) were contained in open 2-litre beakers.

c) 90°C FFA stability test.
Water (equivalent to 1% of the mass of the oil) was added to refined oils (1000 ml). The oils were stored at 90°C in open 2-litre beakers for three days. The level of free fatty acids in the oils was measured daily.

d) Ambient Storage Tests.
Ambient Storage Tests at 30°C were carried out in sealed 500 ml cans for six months. The oils were analysed for FFA content after the storage period.

e) Modified Swift Test.
The oils (100g) were heated to 130°C in round-bottomed flasks fitted with an air inlet and outlet. Air was bubbled into the sample at 500 ml/min for 4 hours. At the end of the period, the oil was analysed for peroxide value. The coefficient of variation of the analyses was 5%.

f) Rancimat Test
Oils (2.5g) were heated at 100°C in a Rancimat 679 apparatus. Air was bubbled in at 20L/h and passed through a conductivity flask filled with distilled water. The induction periods of the samples were recorded. The coefficient of variation for repeated analysis of a sample with a 19.6 hr induction period was 1.3%.

RESULTS AND DISCUSSION

Quality Characteristics of the Refined Oil Products

Tables 1, 2 and *3* show the quality characteristics of refined palm oil, palm olein and palm stearin obtained from refineries. The mean moisture level of the oil products (palm oil, olein and stearin) was 0.04 - 0.05%, while the free fatty acid content was 0.07%. The oxidation characteristics of the oil products were generally similar, as shown by their peroxide values, anisidine values, $E^{1\%}_{233}$ and $E^{1\%}_{269}$. Iron content was more variable, being higher in the stearin. Phosphorus levels were also variable, ranging from 0.40 ppm to 14.15 ppm. Another variable characteristic was the Rancimat value, which ranged from as low as 23 hours to 60 hours, with the exception of a value of 100 hours for a sample with synthetic antioxidant added. The colour of the refined oils was generally below 3R in a 5 1/4 inch Lovibond cell. A few samples were above 3R: this was suspected to be due to colour reversion.

TABLE 1. QUALITY CHARACTERISTICS OF REFINED PALM OIL (rPO)

Sample rPO	Moisture %	FFA %	PV meq/kg	$E^{1\%}_{233}$	$E^{1\%}_{269}$	AV	Fe (ppm)	Cu (ppm)	P (ppm)	Rancimat (hrs)	Colour (5 1/4" cell)	
											Red	Yellow
03	0.07	0.06	0.00	2.09	0.63	1.45	0.40	0.002	1.23	54.00	2.3	23
05	0.06	0.05	0.00	1.79	0.46	1.21	0.80	0.002	3.23	45.60	2.3	23
06	0.05	0.07	0.00	1.68	0.43	1.53	1.10	0.003	6.77	46.10	2.2	22
12	0.07	0.05	0.77	1.95	0.60	2.15	0.40	0.001	1.92	43.50	2.5	25
14	0.04	0.09	0.77	2.24	0.60	1.55	0.80	0.003	8.85	47.80	2.8	28
18	0.03	0.08	0.58	1.55	0.58	1.57	0.40	0.002	2.54	48.70	2.5	25
24	0.04	0.07	0.40	1.58	0.52	0.99	0.30	0.002	0.85	48.78	2.4	24
27	0.06	0.09	0.30	1.86	0.59	1.11	0.50	0.004	6.31	60.05	3.3	33
29	0.03	0.09	1.96	1.76	0.21	1.96	0.30	0.002	1.00	50.75	2.1	21
33	0.02	0.04	0.50	1.90	0.29	0.98	0.50	0.003	3.40	51.00	1.9	20
36	0.04	0.03	0.99	1.86	0.74	4.29	0.20	0.000	0.40	50.00	1.5	30
44	0.01	0.06	0.50	1.52	0.45	0.93	0.40	0.002	1.80	58.00	2.0	21
47	0.03	0.07	0.39	1.82	0.50	1.22	0.50	0.003	6.70	60.00	2.4	24
51	0.03	0.09	0.40	1.58	0.60	1.89	0.30	0.002	1.85	51.00	2.8	28
54[a]	0.03	0.06	0.89	1.73	0.25	0.71	0.50	0.002	4.08	100.00	2.1	21
55	0.04	0.06	0.30	1.64	0.49	0.97	0.40	0.003	7.46	60.00	2.3	23
Min	0.01	0.03	0.00	1.52	0.21	0.71	0.20	0.000	0.40	43.50	1.5	20
Max	0.07	0.09	1.96	2.24	0.74	4.29	1.10	0.004	8.85	100.00	3.3	33
Mean	0.04	0.07	0.55	1.78	0.50	1.53	0.49	0.002	3.65	54.71	2.34	23.8
s.d.	0.02	0.02	0.48	0.20	0.15	0.84	0.23	0.009	2.71	13.20	0.41	3.47

[a]Antioxidant added.

TABLE 2. QUALITY CHARACTERISTICS OF REFINED PALM OLEIN(rPOo)

Sample rPOo	Moisture %	FFA %	PV meq/kg	$E^{1\%}_{233}$	$E^{1\%}_{269}$	AV	Fe (ppm)	Cu (ppm)	P (ppm)	Rancimat (hrs)	Colour (5 1/4" cell)	
											Red	Yellow
02	0.08	0.09	0.00	1.87	0.82	1.21	0.30	0.003	2.62	52.30	2.7	27
07	0.05	0.06	0.77	2.17	0.42	0.78	0.40	0.004	5.85	41.30	2.3	23
10	0.07	0.05	3.84	2.43	0.61	2.66	0.30	0.001	0.77	31.60	3.0	30
15	0.04	0.09	0.38	2.37	0.66	1.94	0.40	0.003	3.31	38.60	2.7	27
20	0.04	0.08	0.38	2.05	0.80	1.81	0.30	0.004	5.69	45.60	3.1	30
22	0.04	0.07	0.50	1.94	0.54	0.99	0.30	0.003	1.15	41.60	2.4	24
25	0.02	0.07	1.29	1.89	0.54	1.26	0.50	0.060	1.00	23.58	3.5	35
30	0.05	0.09	4.06	1.91	0.20	2.77	0.30	0.003	1.00	44.15	2.6	26
34	0.05	0.07	0.79	1.73	0.36	1.00	0.20	0.003	3.40	52.00	2.2	22
37	0.03	0.05	0.67	1.98	0.28	1.08	0.20	0.002	4.00	49.98	2.4	24
40	0.03	0.06	0.86	1.61	0.51	1.87	0.30	0.002	1.30	49.15	2.2	22
42	0.02	0.07	0.29	1.86	0.70	1.11	0.30	0.002	1.10	47.00	2.2	22
46	0.03	0.09	0.40	1.89	0.52	1.04	0.30	0.003	6.70	55.00	2.6	26
53	0.05	0.10	0.69	1.58	0.47	1.29	0.30	0.003	2.08	52.00	2.6	26
52	0.04	0.04	0.69	2.02	0.52	5.06	0.20	0.001	0.77	47.00	2.3	23
Min	0.02	0.04	0.00	1.58	0.20	0.78	0.20	0.001	0.77	23.58	2.2	22
Max	0.08	0.10	4.06	2.43	0.82	5.06	0.50	0.060	6.70	55.00	3.5	35
Mean	0.04	0.07	1.04	1.95	0.53	1.72	0.31	0.007	2.72	44.72	2.6	25.8
s.d.	0.02	0.02	1.22	0.24	0.17	1.10	0.08	0.02	2.03	8.47	0.38	3.67

TABLE 3. QUALITY CHARACTERISTICS OF REFINED PALM STEARIN(rPOs)

Sample (rPOs)	Moisture %	FFA %	PV meq/kg	$E^{1\%}_{233}$	$E^{1\%}_{269}$	AV	Fe (ppm)	Cu (ppm)	P (ppm)	Rancimat (hrs)	Colour (5 1/4" cell)	
											Red	Yellow
08	0.04	0.06	0.77	2.08	0.40	0.95	1.00	0.004	5.92	55.10	2.2	22
11	0.06	0.05	0.96	1.74	0.87	1.95	1.00	0.002	3.77	59.10	2.3	23
16	0.05	0.08	0.77	1.95	0.59	1.30	2.50	0.003	14.15	59.70	2.3	23
31	0.06	0.05	1.19	1.48	0.32	1.28	1.50	0.002	1.54	74.20	1.6	16
35	0.03	0.05	2.08	1.72	0.31	0.74	1.50	0.002	4.20	55.00	2.2	22
38	0.03	0.05	0.29	1.84	0.21	0.46	1.50	0.002	4.00	61.05	2.0	21
41	0.21	0.06	0.57	1.38	0.49	1.50	1.50	0.002	2.80	59.98	1.8	18
48	0.02	0.06	0.50	1.57	0.44	0.92	1.00	0.002	5.50	82.00	1.9	19
50	0.04	0.06	0.50	1.63	0.41	1.08	1.50	0.001	4.85	72.00	2.2	22
57	0.06	0.12	4.12	1.95	0.51	1.15	2.00	0.002	3.38	33.60	2.8	28
59	0.04	0.09	0.59	1.58	0.47	1.37	1.50	0.001	2.15	36.00	2.3	23
68	0.04	0.09	0.59	1.42	0.54	1.63	2.00	0.002	2.00	32.00	2.8	28
69	0.01	0.09	0.59	1.40	0.53	1.47	2.00	0.002	1.77	34.00	2.8	28
70	0.01	0.07	0.78	1.33	0.61	2.63	2.50	0.003	0.92	70.00	3.1	31
71	0.04	0.07	1.18	1.29	0.58	1.59	2.50	0.003	0.90	54.00	3.1	31
Min	0.01	0.05	0.29	1.29	0.21	0.46	1.00	0.001	0.90	32.00	1.6	16
Max	0.21	0.12	4.12	2.08	0.87	2.63	2.50	0.004	14.15	82.0	3.1	31
Mean	0.05	0.07	1.03	1.62	0.49	1.33	1.7	0.002	3.86	55.81	2.4	23.67
s.d.	0.05	0.02	0.96	0.25	0.16	0.52	0.53	0.0008	3.26	15.85	0.46	4.58

Hydrolytic Stability

The hydrolytic stability of the oils was measured by the FFA test at 90°C, at 60°C and at ambient temperature. The rate of change of FFA at 90°C was calculated using an exponential curve based on:-

$$FFA_t = A(1 + r)^t$$

where t is storage period in days
r is rate of change
$A = FFA_o$ when $t = o$

Thus

$$\ln FFA_t = \ln A + t \ln (1 + r)$$

$$\ln (1 + r) = b' = \frac{\Sigma (t - \bar{t})(\ln FFA_t - \ln FFA)}{\Sigma (t - \bar{t})^2}$$

$$1 + r = e^{b'}$$

$$r = 1 - e^{b'}$$

r was computed for palm oil, olein and stearin *(Table 4)*.

This rate was found to be higher for palm oil and palm olein (averaging 45.0 and 41.2 respectively) than for palm stearin (33.1) *(Table 4)*, indicating that stearin was more resistant to hydrolysis than palm oil and palm olein.

A simple multiple step regression analysis was performed on the data correlating the compound rate at 90°C with various parameters of quality of the refined oil. The phosphorus content of the oil showed a significant correlation with the rate of hydrolysis. The rate of hydrolysis at 90°C *(Table 5)* could then be expressed by the following equations, derived from the multiple step regression analysis where P = phosphorus(ppm), Fe = Iron(ppm) and H_2O = moisture(%) :-

Palm oil $R_1 = 7.56\ P + 16.04$

Palm olein $R_2 = 9.76\ P + 14.68$

Palm stearin $R_3 = 75.27 - 20.9\ Fe - 119.7\ H_2O$

All products R_g (general) $= 31.3 + 4.9\ P - 10.2\ Fe$.

Strong correlations were observed between the rate of hydrolysis at 90°C and the phosphorus content of the oil *(Table 6)*. No such observation was made with the stearins, where the rates of hydrolysis appeared to be more affected by the level of iron in the oil. The correlation between hydrolysis and phosphorus content in refined palm oil had been observed earlier in oils during shipment. The rapid hydrolysis was due to the catalytic action of the polyphosphoric acids which were formed during deodorization by dehydration of residual phosphoric acids present in the oil (Siew,1987).

On the other hand, the rate of hydrolysis of palm stearins was negatively correlated with the iron and moisture content and this is not easily explained. Because of the observed strong correlation, the two equations based on phosphorus (R_1 and R_2) could be used to define the hydrolytic stability of palm oil and palm olein respectively. A plot of the calculated rate of hydrolysis based on these two equations, versus the free fatty acid obtained after storage of the oil for 4 weeks at 60°C is shown in *Figure 1*.

An arbitrary critical value of R_1 or $R_2 = 40$ was chosen to define oils stable to hydrolysis. From *Figure 1*, it can be seen that samples with R_1 or $R_2 < 40$ had FFA below 0.15% after storage for one month at 60°C, while samples with R_1 or $R_2 > 40$ had FFA values above 0.15%. This criterion was applicable to oils with starting FFA of below 0.08%. There were a few exceptions, especially in cases where the starting FFA values of the oils were close to 0.08% or higher, although phosphorus content might be low.

On the basis of the equations for palm oil and palm olein the maximum phosphorus contents of refined palm oil and palm olein for R_1 and R_2 to be not more than 40 are calculated to be 3.2 and 2.6 ppm respectively. From the results obtained *(Table 5)* it was also noted that samples Nos. 03, 36, 70, 40, and 52 with FFA < 0.06% and phosphorus < 1.3ppm had hydrolytic rates R of below 27, and the FFA levels were below 0.1% after one month of storage at 60°C. This was in contrast to samples Nos. 54 and 55 with FFA of 0.06% but phosphorus contents of 4.1 and 7.5 ppm respectively where the FFA levels

TABLE 4. RESULTS OF FFA STABILITY TEST AT 90°C

No.	Samples	FFA				Compound Rate
		0 day	1 day	2 days	3 days	
1	05 rPO[a]	0.05	0.06	0.10	0.15	46.33
2	12 rPO	0.05	0.07	0.10	0.12	34.76
3	03 rPO	0.06	0.08	0.09	0.10	17.94
4	44 rPO	0.06	0.07	0.11	0.20	28.81
5	54 rPO	0.06	0.12	0.20	0.20	51.02
6	55 rPO	0.06	0.28	0.40	0.44	88.40
7	14 rPO	0.09	0.16	0.24	0.31	50.92
8	27 rPO	0.09	0.40	0.40	0.49	64.52
9	51 rPO	0.09	0.10	0.14	0.15	20.55
10	06 rPO	0.07	0.11	0.23	0.33	71.42
11	18 rPO	0.08	0.11	0.18	0.20	38.28
12	24 rPO	0.07	0.09	0.10	0.12	18.80
13	33 rPO	0.04	0.09	0.11	0.15	51.68
14	36 nPO	0.03	0.03	0.04	0.04	12.20
15	47 rPO	0.07	0.21	0.35	0.42	80.15
16	10 rPOo[b]	0.05	0.06	0.07	0.09	21.14
17	37 rPOo	0.05	0.11	0.18	0.24	68.17
18	07 rPOo	0.06	0.11	0.20	0.31	73.75
19	40 rPOo	0.06	0.07	0.10	0.12	27.59
20	46 rPOo	0.09	0.21	0.36	0.39	63.85
21	53 rPOo	0.10	0.17	0.24	0.26	37.87
22	30 rPOo	0.09	0.11	0.14	0.17	23.98
23	02 rPOo	0.09	0.11	0.18	0.29	49.22
24	15 rPOo	0.08	0.19	0.33	0.41	62.22
25	20 rPOo	0.09	0.16	0.23	0.40	72.54
26	22 rPOo	0.07	0.09	0.11	0.15	28.24
27	25 rPOo	0.07	0.09	0.09	0.10	11.29
28	34 rPOo	0.07	0.10	0.12	0.19	37.41
29	42 rPOo	0.07	0.11	0.15	0.17	34.61
30	52 nPOo[c]	0.04	0.05	0.05	0.05	06.92
31	11 rPOs[d]	0.05	0.07	0.10	0.12	34.76
32	31 rPOs	0.05	0.07	0.10	0.12	21.14
33	35 rPOs	0.05	0.07	0.10	0.11	31.29
34	08 rPOs	0.06	0.09	0.16	0.25	62.23
35	41 rPOs	0.06	0.10	0.11	0.11	21.09
36	48 rPOs	0.06	0.15	0.22	0.28	64.94
37	50 rPOs	0.06	0.10	0.17	0.17	44.12
38	69 rPOs	0.09	0.14	0.15	0.15	17.27
39	68 rPOs	0.09	0.14	0.15	0.15	17.27
40	59 rPOs	0.09	0.16	0.21	0.21	32.50
41	16 rPOs	0.08	0.11	0.12	0.14	19.31
42	38 rPOs	0.05	0.11	0.16	0.17	49.87
43	57 rPOs	0.12	0.21	0.27	0.30	34.99
44	70 rPOs	0.07	0.16	0.16	0.16	28.15
45	71 rPOs	0.07	0.09	0.11	0.11	16.84

[a]rPO : refined palm oil
[b]rPOo : refined palm olein
[c]nPOo : alkali refined palm olein
[d]rPOs : refined palm stearin

TABLE 5. CALCULATED RATES FOR HYDROLYSIS
(from multiple step-regression analysis)

Samples	P(ppm)	Fe(ppm)	R_g[a]	$R_1/R_2/R_3$[a]	FFA/4 wks at 60°C
rPOo02	2.6	0.3	40.98	40.05	0.23
rPOo07	5.9	0.4	56.13	72.26	0.24
rPOo10	0.8	0.3	32.16	22.48	0.10
rPOo15	3.3	0.4	43.39	46.88	0.10
rPOo20	5.7	0.3	56.17	70.31	0.27
rPOo20	1.1	0.3	33.63	22.41	0.36
rPOo25	1.0	0.5	31.10	24.44	0.12
rPO030	1.0	0.3	33.14	24.44	0.14
rPOo37	4.0	0.2	48.86	53.72	0.14
rPOo40	1.3	0.3	34.61	27.36	0.09
rPOo42	1.1	0.3	33.63	25.41	0.11
rPOo46	6.7	0.3	61.07	80.07	0.26
rPOo52	0.8	0.2	33.18	22.48	0.06
rPOo53	2.1	0.3	38.53	35.17	0.18
rPOs08	5.9	1.0	50.01	49.58	0.16
rPOs11	3.8	1.0	39.72	47.19	0.10
rPOs16	14.2	2.5	75.38	17.03	0.14
rPOs31	1.5	1.5	23.35	36.74	0.07
rPOs35	2.5	1.5	28.25	40.33	0.07
rPOs38	4.0	1.5	35.60	43.92	0.09
rPOs41	2.8	1.5	29.72	18.79	0.07
rPOs48	5.5	1.0	48.05	51.98	0.15
rPOs50	4.0	1.5	35.60	39.14	0.12
rPOs57	3.4	2.0	27.56	26.29	0.14
rPOs59	1.5	2.2	16.21	24.50	0.11
rPOs68	2.0	2.0	20.70	28.68	0.10
rPOs69	2.0	1.8	22.74	36.45	0.11
rPOs70	0.9	2.5	10.21	21.83	0.10
rPOs71	0.9	2.5	10.21	18.24	0.07
rPO03	1.2	0.4	33.10	25.11	0.10
rPO05	3.2	0.4	42.90	40.23	0.23
rPO06	6.8	1.1	53.40	67.44	0.23
rPO12	1.9	0.4	36.53	30.40	0.10
rPO14	8.9	0.8	66.75	83.32	0.23
rPO18	2.5	0.4	39.47	34.94	0.17
rPO24	0.9	0.3	32.65	22.84	0.10
rPO27	0.5	0.5	28.65	19.82	0.27
rPO33	3.4	0.5	42.88	41.74	0.09
rPO36	0.4	0.2	31.22	19.06	0.04
rPO44	1.8	0.4	36.04	29.64	0.07
rPO47	6.7	0.5	59.03	66.69	0.21
rPO51	1.9	0.3	37.55	30.40	0.21
rPO54	4.1	0.5	46.29	47.03	0.16
rPO55	7.5	0.4	63.97	72.74	0.30

[a]For R_1, R_2, R_3 and R_g, see page 213.

TABLE 6. CORRELATION BETWEEN RATE OF HYDROLYSIS AT 90°C AND OTHER PARAMETERS

		Palm Oil	Palm Olein	Palm Stearin
Rate of hydrolysis with	P	0.8710	0.89212	0.18531
	Fe	0.54136	0.01921	-0.65707
	FFA	0.19813	0.28781	-0.30410
	Moisture	0.07526	-0.05708	-0.25331
	Colour	0.23110	-0.07700	-0.28490
	PV	-0.26175	-0.42875	-0.08838
	AV	-0.46235	-0.52680	-0.50176
	Cu	0.73026	0.19560	0.07805
	$E^{1\%}_{233}$	0.00898	0.21210	0.53803
	$E^{1\%}_{269}$	-0.42341	0.12762	-0.33552
	Rancimat	0.22379	0.36364	0.06460

Number of samples : 15

TABLE 7. HYDROLYTIC STABILITY OF REFINED OILS ON STORAGE AT AMBIENT TEMPERATURE

	Palm oil	Palm olein	Palm stearin
Average % FFA Change/month	18.7	29.2	15.1
s.d.	12.5	16.9	11.8
Min	3.7	5.5	4.2
Max	55.3	61.1	44.4
Number of Samples	16	18	16

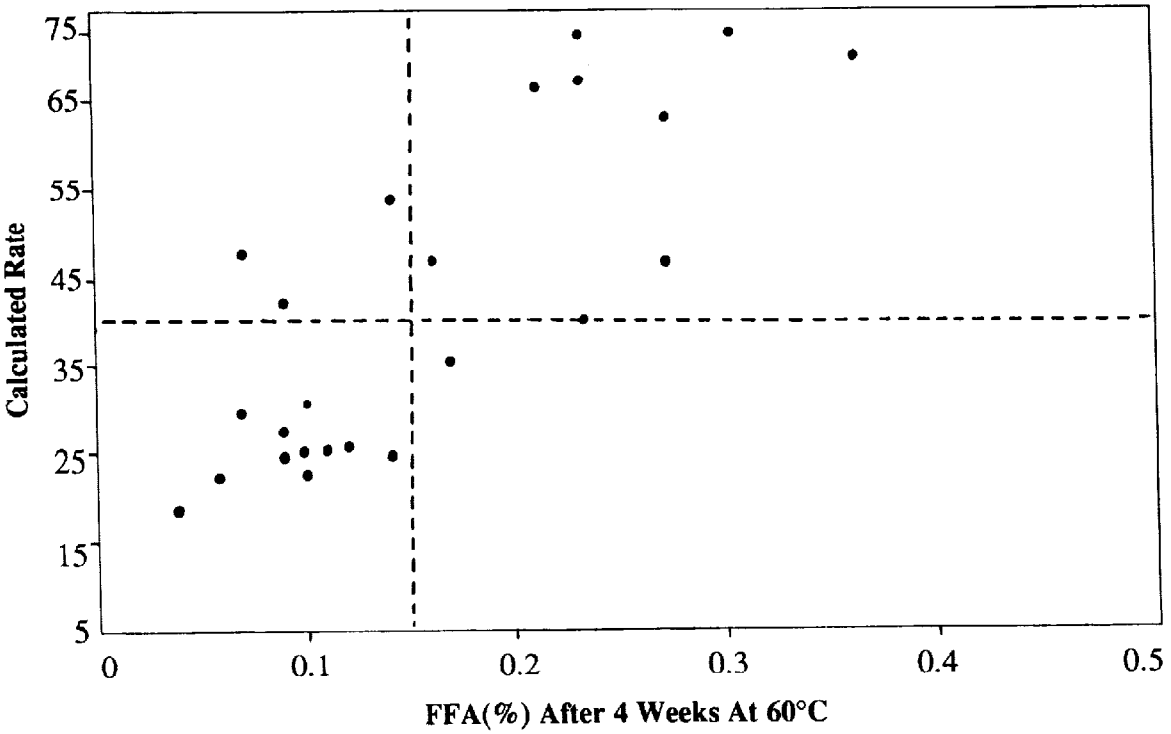

Figure 1. Hydrolysis Rate Versus FFA

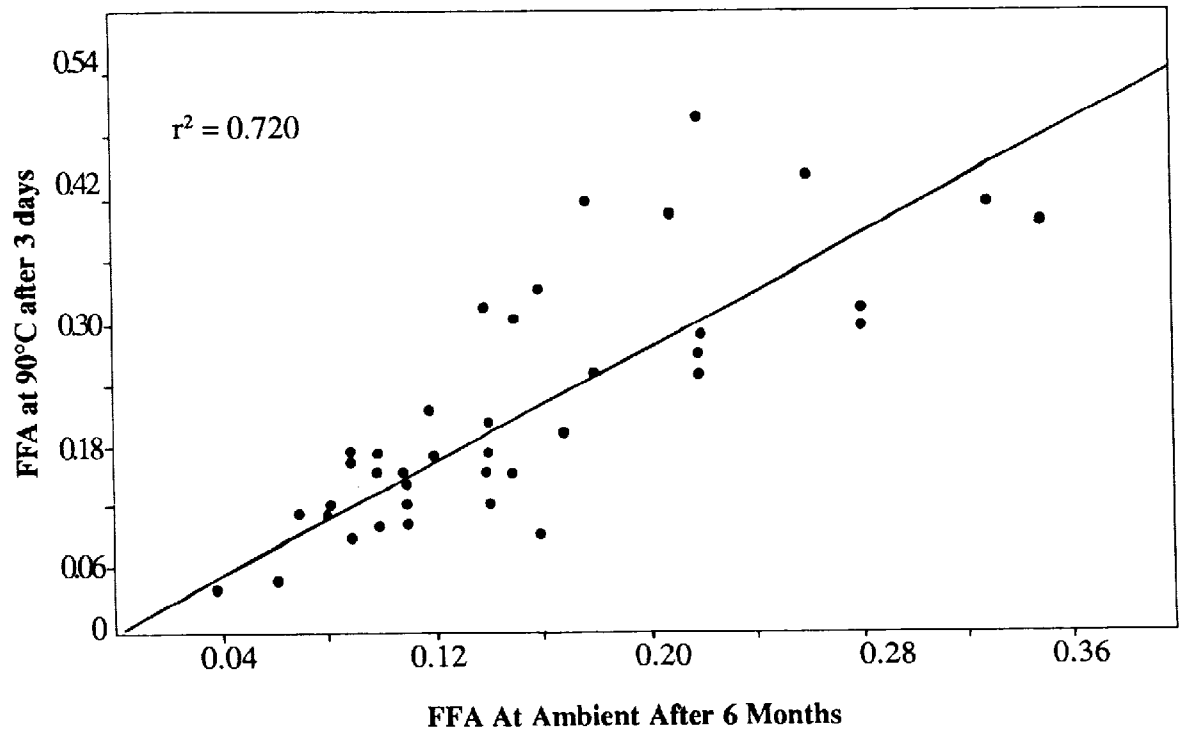

Figure 2. Rate of FFA Formation at 90°C Versus Rate at Ambient Temperature $Y=1.4151X^{1.0363}$

on storage were high, at 0.16 and 0.3% respectively.

A good correlation was also obtained between the FFA value after three days at 90°C and the FFA value at ambient temperature after 6 months *(Figure 2)*, confirming that the test at 90°C could give a good indication of the hydrolytic stability of the oil. This figure may be useful for predicting the shelf life of cooking oils (RBD palm olein) in areas where local authorities specify FFA content in Food Laws.

The average rates of FFA change per month for the oils, calculated from storage experiments at ambient temperature *(Table 7)*, were 18.7, 29.2 and 15.1% for palm oil, olein and stearin respectively, indicating a tendency for hydrolysis to occur faster with refined olein and palm oil than with palm stearin.

CONCLUSIONS

The hydrolytic stability of refined palm oil and palm olein is dependent on the phosphorus levels in the oils. The factors determining the hydrolytic stability of refined palm stearin are less well defined, but it appears to be affected by the iron and water content.

The hydrolytic stability of refined palm oil and palm olein may be defined by equations relating to the phosphorus levels as well as by an accelerated stability test. The results of the stability test, carried out at 90°C on oils containing 1% water, show good correlations with those of tests carried out at 60°C and at ambient temperature. For palm oil and olein to have relatively good hydrolytic stability, they should contain not more than 0.08% moisture and preferably below 0.08% FFA, and should have phosphorus levels below 3.2 ppm and 2.6 ppm respectively.

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