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QUALITY OF PALM FATTY ACID DISTILLATE (PFAD) UPON STORAGE: EFFECT OF MILD STEEL

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ABSTRACT

A study to evaluate the effects of interaction between mild steel and palm fatty acid distillates (PFAD) on the quality of PFAD was carried out. PFAD was stored at 65°C in the presence of mild steel strips. Iron content analysis showed that PFAD is a reasonably corrosive material to mild steel and the rate of iron picked up by PFAD was found to be quite rapid at 65°C. This rapid iron pick up resulted in the deterioration of PFAD in terms of its oxidative parameters, due to the known catalytic effect of iron. It is recommended that the avoidance of contact between mild steel and PFAD at high temperatures should be practised, in order to prevent a rapid deterioration of PFAD quality.

Keywords: palm fatty acid distillates, corrosion, mild steel, storage and PFAD quality.

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INTRODUCTION

Palm fatty acid distillate (PFAD) is a by-product produced during the deodorisation step in the physical refining of palm oil. In general, PFAD contains from between 80% to over 90% of free fatty acids together with some unsaponifiable materials, neutral triglycerides, partial glycerides and other high molecular weight substances. PFAD has traditionally been used in animal feed production and has been a source of fatty acid in the oleochemical industry. However, the scope of PFAD usage has been expanded over the last decade and it is now also one of the resources for the production of vitamin E, squalene and phytosterols for pharmaceutical and cosmetic uses. The production and utilisation of PFAD was reviewed by Ab Gapor (2010).

The characteristics of Malaysian PFAD had been surveyed by Hamirin (1983) and Bonnie and Mohtar (2009). The melting points of PFAD are generally higher than those of vegetable oils and temperatures of between 60°C to 70°C are required to keep PFAD in the liquid state. At present, no effective food grade tank coatings which can withstand the high temperatures required for liquefying PFAD (for long periods of time) are available. Thus, PFAD is generally stored in stainless steel tanks and sometimes mild steel tank with or without coatings.

The effect(s) of combined high temperature and the presence of mild steel on the quality of PFAD upon storage and the corrosion characteristics of mild steel by PFAD are reported in this article. The corrosion rate of mild steel by PFAD has been reported earlier by Chong (1986).

MATERIALS AND METHODS

Rectangular mild steel pieces (3 cm x 1 cm x 0.1 cm) conforming to the Japanese standard JIS G3141 (JISC, 1996) for cold roll mild steel were used as the test pieces. For investigating corrosion characteristics, the test pieces were washed and cleaned using Clark's solution, according to ASTM requirements (ASTM, 2004). The experiment design involved two series of samples stored under different conditions. The first series was stored under shaded ambient condition (room temperature), while the second was stored at 65°C in an oven. Each series consisted of 11 1-litre beakers with the test pieces suspended

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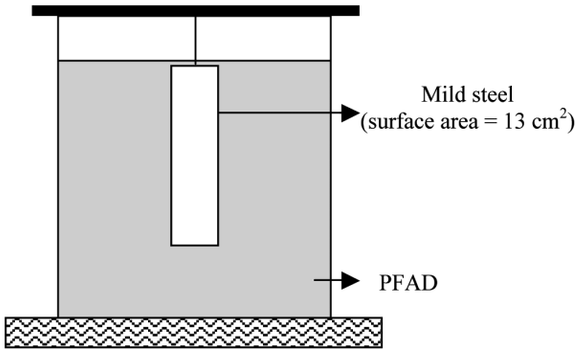

Figure 1. Experimental set-up.

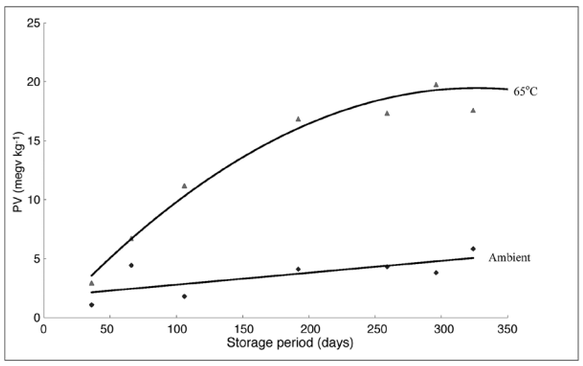

Figure 2. Changes in peroxide value (PV) with time during storage.

in 500 g of PFAD. *Figure 1* shows the experimental set-up for a single beaker. One beaker from each series was removed periodically and the PFAD quality analysed for titre (MPOB c 2.5), moisture (MPOB c 2.2), iodine value (IV) (MPOB c 2.6), trace metals, peroxide value (PV) (MPOB p2.3), free fatty acid (FFA) content (MPOB c2.7) and colour on the Gardner scale. All analyses were carried out according to MPOB test methods (MPOB, 2005), while the trace metals were measured by atomic absorption spectroscopy.

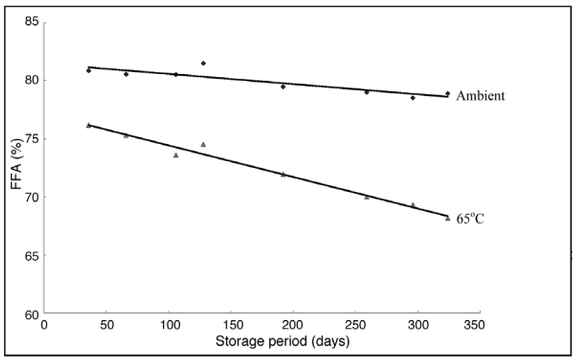

Figure 3. Changes in free fatty acid (FFA) content with time during storage.

RESULTS AND DISCUSSION

Results

The initial quality and identity characteristics of the PFAD used for the experiment are as shown in *Table 1*. *Figures 2*, *3*, *4*, *5* and *Table 2* show the changes for PV, FFA, IV, Fe content and colour with times at different storage conditions of the PFAD samples.

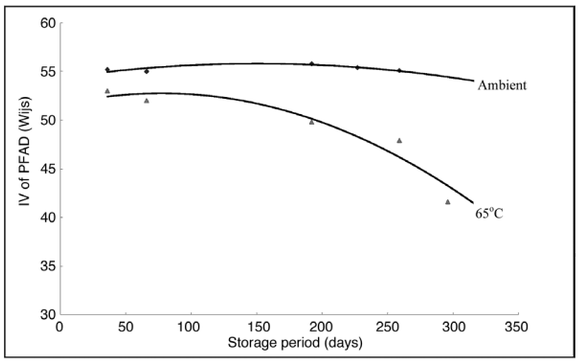

Figure 4. Changes in iodine value (IV) with time during storage.

Observations and Discussion

Ambient sample. From *Figures 2* to *5*, it can be seen that the quality characteristics of the PFAD stored at ambient are hardly affected by the presence of the

TABLE 1. INITIAL CHARACTERISTICS OF PALM FATTY ACID DISTILLATE (PFAD) USED

Parameter	Value
Titre (°C)	44.9
Moisture (%)	0.65
Iodine value (Wijs)	55.2
Colour (Gardner scale)	10+
Copper (ppb)	1.0-2.0
Iron (ppm)	6.0
FFA (%)	80.9
PV (mequiv kg^{-1})	1.1

Note: FFA - free fatty acid.
PV - peroxide value.

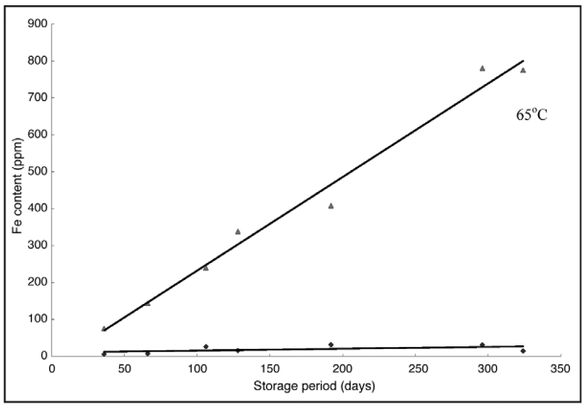

Figure 5. Changes in iron (Fe) content with time during storage.

TABLE 2. CHANGES IN COLOUR WITH TIME DURING STORAGE

Storage period (days)	36	66	106	128	192	227	259	296	324
Ambient	10+	10+	10+	11	11	11	11	11	11
65°C	14+	17+	18+	>18+	>18+	>18+	>18+	>18+	>18+

mild steel pieces except for the period towards the end of the storage period which is about a year. For the first 10 months, there were only minor changes in IV and FFA content from the starting value, while PV and colour (*Table 2*) had only increased marginally. Even iron pick up was minimal. The preservation of all these quality characteristics could be ascribed to the fact that the PFAD at ambient temperatures was solid. In the absence of liquid movements, the deterioration of the PFAD was restricted to only the surface exposed to the atmosphere and the PFAD layer in contact with the mild steel pieces.

Sample stored at 65°C. The most striking result in this set of samples was the rapid rate at which iron was picked up by the PFAD. After only about a month at 65°C, the iron content increased from about 6 mg kg^{-1} to 76 mg kg^{-1}; a twelve-fold increase, and this kept on increasing with the storage time. This indicated the corrosive nature of PFAD and the need to prevent it from coming into contact with bare mild steel surfaces, at high temperatures for long periods of time.

The detrimental effects of soluble iron on vegetable oils and fatty acids are well-known and well documented (Love, 1985). This is reflected in all the oxidative characteristics of the sample. The rapid iron pick up is paralleled by a rapid increase in the PV, a rapid decrease in the IV as the double bonds are oxidised more rapidly in the presence of the iron catalyst and a rapid increase in the colour of the PFAD (*Table 2*). The oxidative deterioration is also reflected in the decreasing of FFA values due to the formation of fatty acid salts, volatile compounds such as aldehydes and ketones, resulting in the decreasing FFA contents.

CONCLUSION

This study shows that the corrosion of mild steel by PFAD at 65°C is quite rapid, resulting in a rapid increment of soluble iron content in PFAD. This leads to a rapid deterioration of the PFAD due to the known catalytic effect of iron, as shown by the lower quality characteristics observed. The quality of the PFAD stored at ambient condition is hardly changed due to the PFAD being a solid at room temperature and deterioration is limited to the PFAD in direct contact with the mild steel plate and that exposed to acid (surface area exposed to acid).

In order to minimise the quality deterioration of PFAD upon storage, transportation and handling, the contact between mild steel and PFAD at high temperatures should be avoided or restricted to a minimum. This could be achieved by using a better inert material than mild steel, such as stainless steel, as the construction material or lining and the use of organic coatings in tanks and pipes.

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