For good control, the cycle in the measurement signal should steadily decay, and end with the measurement returned to the setpoint. Simultaneously, the cycle in the controller output should also steadily decay, and end with the output at the new value. This re-establishes balance among the load variables and the manipulated variable.

In fact, this oscillation respresents the trial-and-error search for the new solution to the control problem. The controller is not aware of the load variables. Hence, when it sees the measurement begin to change, it tries new output values until in narrows in on the one value that returns the measurement to the setpoint.

If the controller in a particular loop responds to an upset with an oscillation in which each successive peak is one-fourth as large as the preceding one, the loop is said to have quarter-wave damping*(i.e.* B/A = 1/4 in *Figure 3c)* Depending on the period, a loop having quarter-wave damping stabilizes fairly quickly following an upset. Often, this is taken as an indication of good control. Determining proper controller adjustments is somewhat more complicated than achieving this one objective. Nevertheless, quarter-wave damping may be used for a rough evaluation of controller performance.

(Foxboro (M) Sdn. Bhd.)

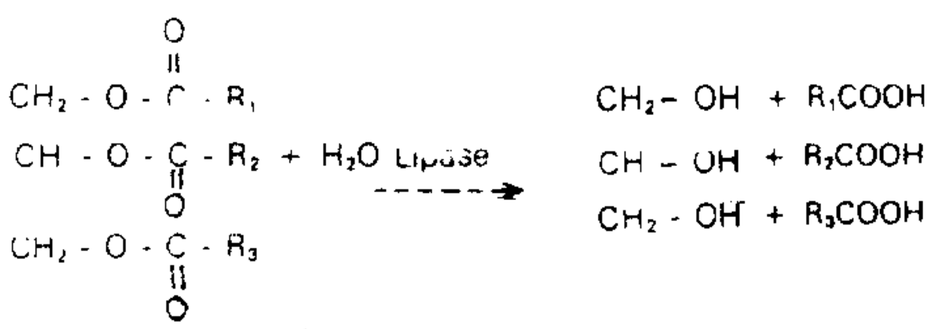
● QUALITY PARAMETERS

FREE FATTY ACID

This is the first article in a new series covering important quality parameters for palm oil products. We shall start with the most commonly applied quality parameter, i.e. *free fatty acid.*

General

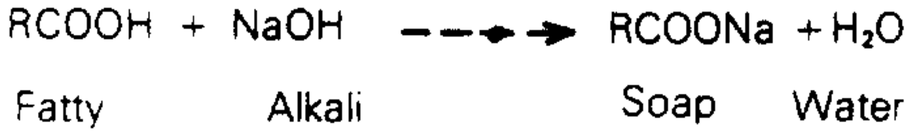
The free fatty acid (FFA) content of an oil is a measure of the extent of hydrolysis of triglycerides. The mechanism of hydrolysis can be expressed as follows:



Triglycerides Water Glycerol Fatty acids

The higher the FFA, the poorer is the oil quality

FFA is normally determined by titrating a mixture of a known weight of oil and a suitable solvent *(e.g.* 95% ethanol) against a standard sodium hydroxide solution using phenolphthalein as an indicator.



The FFA content is given by the formula:

$$\text{FFA content} = \frac{(V)\ (N)\ (MW)}{10\ (W)}$$

Where
- V = Volume of alkali used
- N = Normality of alkali
- W = Mass of oil used
- MW = Molecular weight of fatty acid (M = 256 for palm oil, 200 for palm kernel and coconut oil)

Undesirable Effects of High FFA

Crude Palm Oil

- Indicative of poor quality, either due to long storage, adulteration or inadequate quality control.
- Solubilization of trace metals (as soaps)
- High refining losses through acid oil or fatty acid distillate.

Refined, Bleached and Deodorised Palm Oil

- FFA, above 0.1% is out of specification, any may result in payment of penalty or rejection of parcel.
- Re-refining of oil may be necessary and this incurs additional cost.

How to Prevent High FFA in Palm Oil

Harvesting, Milling and Storage

- Avoid over-ripening of fruits as bruising of these fruits liberates enzymes which promote hydrolysis of the oil.
- Care must taken to avoid bruising of fruit bunches during transport.
- Sterilization should be carried out promptly as delay promotes hydrolysis.

- Milling conditions (temperature retention time) should be optimized
- Do not adulterate good oil with bad oil
- During storage or shipment, precautions must be taken to avoid contamination with water and steam and keep oil at low temperatures (not more than 10 °C above melting point) to minimize autocatalytic hydrolysis.

Refining

- Sufficient neutralization (caustic refining) or deacidification (physical refining) is necessary to obtain low FFA RBD oil. It has been observed that RBD oil with FFA of less than 0.05% is more stable against hydrolytic deterioration
- Avoid contamination with soap traces spent bleaching clay, phosphatides or phosphoric acid as these contaminants can cause FFA instability

(T.S. Tang)

• NUTRITION

CURRENT KNOWLEDGE ON THE STATUS OF PALM OIL IN RELATION TO HEART DISEASE AND CANCER

In Issue No. 7 we provided a general review on the role of oils and fats and their relationship to heart disease and cancer. We will now continue with the current understanding of the relationship between palm oil and these diseases.

Anti-Thrombotic and the Lack of Atherosclerotic Effects of Palm Oil

In a series of elegantly executed experiments on rats, Dr. Hornstra from the Netherlands demonstrated that the blood of rats fed on a palm oil diet has a lesser tendency to clot than saturated fats and oils. In fact, this antithrombotic effect of palm oil is comparable with, or better than, several polyunsaturated oils such as linseed, rapeseed and sunflowerseed oils which are known for their antithrombotic effects.

Dr. Hornstra also conducted palm oil feeding experiments on rabbits and found that after 18 months of feeding, the palm oil diet produced the lowest degree of fatty deposits in the arteries (atherosclerosis), compared to olive, sunflowerseed and linseed oils.

It is known that the balance of two very important chemical substances that influence the bleeding and the blood coagulation process is affected by a palm oil diet. These substances with the generic name of prostaglandins of which one is known as thromboxane and the other prostacyclin have the following activities

- Thromboxane, by its very name is thrombotic or has a tendency to promote the clumping of blood platelets thereby blood clotting.
- Prostacyclin has the opposite effect it relaxes the blood vessel wall and is anti-thrombotic.

Hornstra showed that feeding animals a diet containing palm oil reduced the levels of thromboxane and at the same time increased the levels of prostacyclin. The nett effect was that palm oil feeding favourably altered the balance of prostacyclin to thromboxane leading to a reduced tendency to thrombosis, thereby reducing the risk of a heart attack.

Effects of Palm Oil Feeding in Humans

In an experiment on Benedictine nuns reported in France not so long ago, it was found that a palm oil diet actually lowered the level of blood cholesterol compared to peanut oil and milk-fat feeding periods.

In addition, the subjects who were fed the palm oil diet showed a more favourable ratio of the "protective" high density lipoproteins in relation to the "bad" or atherogenic low density lipoproteins compared to the diets containing peanut oil or milk fat.

Looking over the literature, it is possible to trace back to several oil feeding experiments on humans in which palm oil was used as one of the test fats. In all these experiments it was found that during the palm oil feeding period, the level of blood cholesterol was in fact lower than the period before the experiments began.

More human feeding experiments that are being funded by PORIM are now underway in many parts of the world including Malaysia to confirm and extend the above studies. Meanwhile feeding experiments on rabbits conducted in PORIM's own laboratories, have confirmed palm oil's ability to lower the levels of the atherogenic low density lipoproteins and raise the levels of "protective" high density lipoproteins.