Extraction of Tannin from Oil Palm Empty Fruit Bunch as a Rust Deactivator

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Abstract

The purpose of this research is to investigate the effect of reaction between rust and rust deactivator obtained from oil palm empty fruit bunch (EFB) powder. The extraction of tannin using 65% (v/v), 70% (v/v) and 75% (v/v) acetone gave 4.23%, 4.54% and 4.46% of tannin respectively. From the result of FTIR spectroscopy, the typical absorption peaks of tannin have been observed. In the corrosion tests, two methods were used to certify the reaction between tannin and rust i.e. FTIR method and plate observation technique. The spectrum of FTIR showed that ferric phosphate was formed but ferric tannate had not been formed a week after the mixture of tannin and phosphoric acid was applied to the rusty plate, while in the plate observation method, a thin layer of tannin was found to deactivate the rusting process. The UV-VIS spectroscopy showed that the tannin samples were not pure and contained some impurities due to different spectrum observed from pure tannin sample.

Keywords

tannin, rust deactivator, oil palm empty fruit bunch

Introduction

Malaysia produces an abundant supply of palm-press fibres and oil palm empty fruit bunches (EFB) which are regarded as wastes and have not been utilized satisfactorily [1]. About 7.3 million tones of EFB are generated annually [2]. Studies have shown that the EFB fibre could be used as raw material for papermaking [3].

In the recent study, the optimum acetone concentration for extraction of tannins from EFB was determined. Tannins are generally defined as naturally occurring polyphenolic compound of high enough molecular weight in the range between 500 to 3000 Dalton (Da) and compounds that dissolve in water [2]. Tannin formed complex when reacted with protein, alkaloid, mercury chloride and other heavy metals [4, 5]. Tannins with high molecular weight (eg. 20,000 Da) have ability to form complex with certain polysaccharides [6]. This makes tannin compounds isolated from other polyphenolic groups.

Characterization of the compound using FTIR and UV-VIS was also performed. The tannins were then collected and tested on mild steel plate using two different methods. The study shows that tannins from the oil palm EFB have a potential to be used as an alternative rust deactivator.

Materials and Methods

Materials

The oil palm empty fruit bunch (EFB) in a powder form was obtained from the Sabutek Sdn. Bhd., Teluk Intan, Malaysia. The EFB fibre was dried in a rotating oven with air circulation at 60°C before it was ground to pass a <1.0 mm screen.

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Extraction of tannin

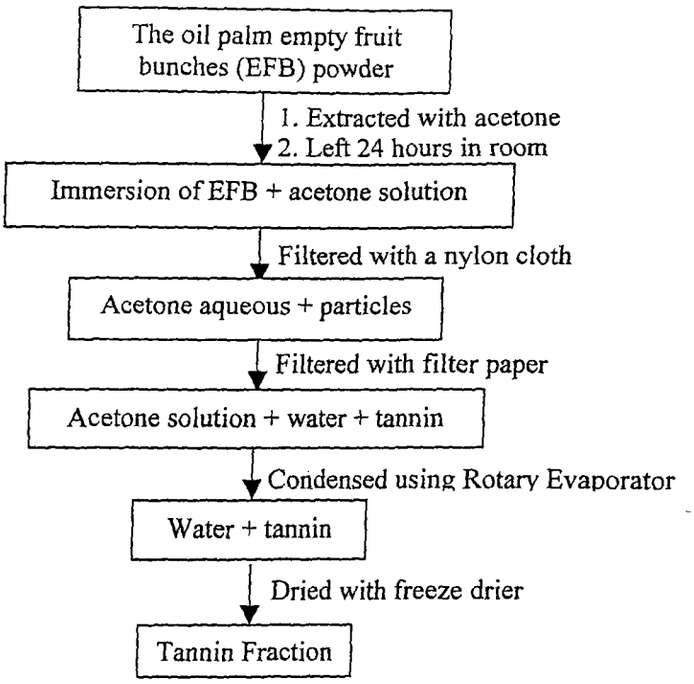

Figure 1- Flow chart of tannin extraction from EFB

The scheme for extraction of tannin from the EFB is shown in Figure 1. The tannins powder collected at the end of the extraction process was analyzed with FTIR and UV-VIS.

Tannin as a rust deactivator

As mentioned earlier, tannin was tested as a rust deactivator by two different methods. The first method is by using mild steel plates that have been rusted by 3% sodium chloride. A solution containing 5% phosphoric acid, 10% tannin aqueous, 0.25% isopropanol was applied on two rusted plates and left for 1 day at room temperature. Any changes that happened on these plates were observed after 1 day and 1 week by FTIR analysis.

The second method was done by applying the solution that containing 5% phosphoric acid, 10% tannin aqueous and 0.25% isopropanol on two different plates. These plates were then left for 1 day to dry before rusted it by 3% sodium chloride and left for 1 day. The changes were observed after 1 day and 1 week. Half of the plates were brushed using sandpaper to discover the affection of the solution on those plates.

Results and Discussion

The extraction using different acetone concentration i.e. 65% (v/v), 70% (v/v) and 75% (v/v) yields 4.23%, 4.54% and 4.46% of tannin respectively. Therefore the optimum acetone concentration is 70% (v/v).

Fourier Transformation Infrared (FTIR) spectrum analysis

In general, FTIR spectrum for all tannin samples that extracted with 65%, 70% and 75% acetone concentration showed similar absorption bands. Some characteristic bands indicate the stretching vibration of certain functional groups in tannin molecule.

According to FTIR analysis of standard tannin sample, the main peaks that recognized are 768 cm^{-1}, 782 cm^{-1}, 7945 cm^{-1}, 822 cm^{-1}, 1062 cm^{-1}, 1110 cm^{-1}, 1202 cm^{-1}, 1250 cm^{-1}, 1284 cm^{-1}, 1350 cm^{-1}, 1450 cm^{-1}, 1520 cm^{-1}, 1620 cm^{-1} and 3423 cm^{-1} [7]. Although the absorption percentage of the spectrums are different from the standard one, most of the main absorption peaks were detected. The collected tannin is not pure since there exist some unfamiliar peaks which could be due to the absorption of foreign particles.

Result of FTIR analysis for tannin and rust reaction

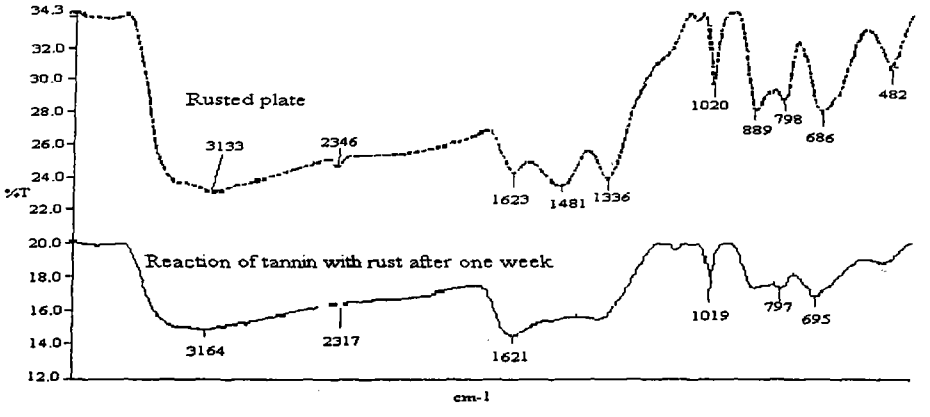

Figure 2- Comparison of FTIR spectrum after one week

Figure 2 showed the comparison of IR spectra of the rust from the rusted plate and of product of tannin with rust after 1 week reaction. The rusted plate spectrum showed the presence of peaks at 1020 cm^{-1} (weak), 889 cm^{-1} (medium), 798 cm^{-1} (medium) and 686 cm^{-1} (broad). Ferric phosphate peaks appeared on the rusted steel spectrum at 1481 cm^{-1} (medium), 1020 cm^{-1} (strong), 686 cm^{-1} (broad) and 482 cm^{-1} (medium) [7]. On the other spectrum however the peaks represent rust (1481 cm^{-1}, 1336 cm^{-1}, 889 cm^{-1} and 686 cm^{-1}) were removed and tremendous reduction of 1020 cm^{-1} peak shows that tannin reacts very well as a rust deactivator.

Anti-corrosion test by plate observation

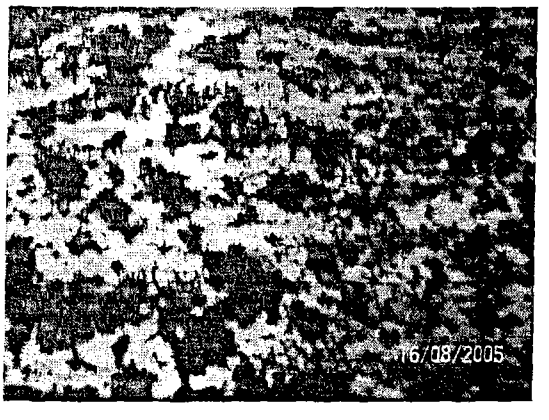

Figure 3- Plate applied with tannin formulation after one day

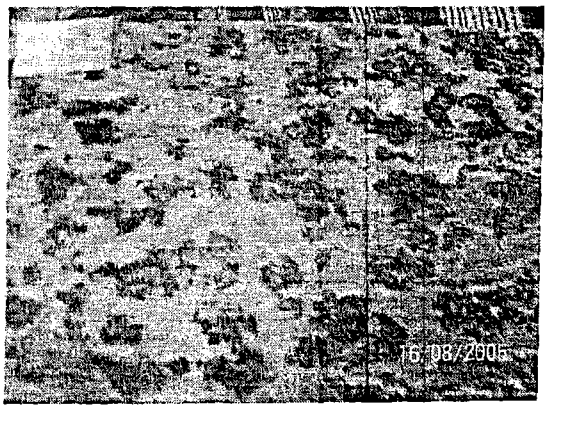

Figure 4- Plate applied with tannin formulation after one week

It can be seen from figures 3 and 4 that the plate covered with tannin formulation showed less black spots after one week compared to the plate surface after one day treated. The rust was cleared without indelible marks when it was cleaned with sandpaper. Again, this indicates that rusting process has been deactivated due to the presence of tannin formulation where it acts as a shield to the plate.

Ultraviolet-visible spectrum analysis

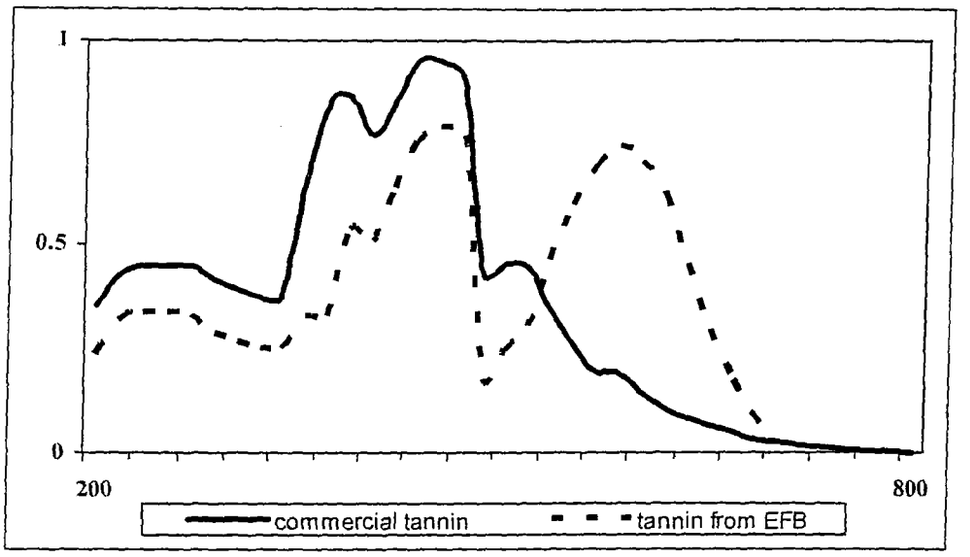

Figure 5- Comparison between UV-VIS spectrums for commercial tannin with tannin that extracted from EFB

The UV spectra of commercial tannin and tannin extracted from EFB are shown in figure 5. The degree of purity of tannin increases as the absorption percentage is higher. Low percentage of absorption may due to the presence of fine raw materials, dirt, etc. From the spectrum in Figure 5, there is an extra peak represents foreign particles that exist in the tannin sample. Although the collected tannin was not pure, it however shows a convincing potential as a rust deactivator.

Acknowledgements

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References

1. Umikalsom M.S., Ariff A.B., Zulkifli H.S., Tong C.C., Hassan M.A. and Karim M.I.A. *Bioresource Technol. 1997; 62: 1-9.*

2. Chua N.S. **Optimal Utilization of energy sources in a palm oil processing complex.** *Proceedings of Seminar on Developments in Palm Oil Milling Technology and Environmental Management, 16-17 May 1991, Genting Highlands, Malaysia.*

3. Sun R.C., Fang J.M., Mott L., Bolton *J. Holzforschung. 1999; 53: 225.*

4. Bate-Smith E.C. and Swain T. Flavonoid Compounds. *In Comparative Biochemistry, Mason H.S. and Forkin M. (eds), Academic Press, New York. 1962; Vol. 3: 705-809.*

5. Hagerman A.E. **Chemistry of tannin-protein complexation. In Chemistry and significance of condensed tannins, Hemingway R.W. and Karchesy J.***J. (eds.), Plenum Press, New York. 1989; 323-333.*

6. Haslam E. **Hydroxybenzoic acids and the enigma of gallic acid. In: The Shikimic Acid Pathways, Recent Advances in Phytochemistry, Conn, E.E. (ed.),** *Plenum Press, London. 1986; 163-200.*

7. Gust *J. Corrosion (NACE). 1991; 47(6): 453-457.*