

**UNIVERSITI TEKNOLOGI MARA**

**PRODUCTION AND  
CHARACTERIZATION OF  
CARBOXYMETHYLCELLULOSE  
FROM OIL PALM EMPTY FRUIT  
BUNCH FIBRES**

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## ABSTRACT

Oil palm empty fruit bunch (EFB) is abundantly generated in the palm oil mill every year. The utilization of this oil residue as value-added products such as carboxymethylcellulose (CMC) could minimize the wastage and simultaneously provides additional income. Attempts to synthesize CMC from isolated cellulose of EFB were carried out. The EFB was first characterized and the findings showed that EFB constitutes of various components namely, the cellulose (39.5%), holocellulose (65.7%), oil (0.02%), extractive-free fibres (75.6%), extractives (6.9%), lignin (16.0%), ash (3.4%) and finally moisture (10.0%). Methods to isolate cellulose from the fibres were developed by adopting ASTM procedures that involved two major steps namely, delignifying of lignin and dissolution of hemicellulose. Trace amount of lignin (0.002%) were detected in cellulose that reflected the efficacy of the method developed and the cellulose was of high quality. The thermal behavior of cellulose analyzed by Perkin Elmer Pyris series – TGA 6 showed that it has the best heat resistance compared to EFB fibres and thus, reflected the crystalline feature of cellulose. The FTIR spectrum of cellulose analyzed by Perkin Elmer - FTIR Spectrum One Spectrophotometer was identical to the commercial cellulose. Method to produce CMC had been developed that involved manipulation of three variable parameters namely, temperature of reaction (55, 60 and 70°C), time of reaction (4, 6, 8, 16, 18 and 20 h) and concentration of sodium hydroxide (2.6 moles and 3.4 moles per mole of monochloroacetic acid). Thirty-six grades of CMC produced were characterized and the findings showed that the percent yield of CMC, moisture content, DS, purity, viscosity and ash content were in the range of 49.76 – 58.62%, 7.3 – 8.8%, 0.74 – 0.95, 85.5 – 99.5%, 116 – 2217 cps and 15.2 – 20.2%, respectively. Overall judgment on the selection of the best processing condition was preferably of 55°C, 2.6 moles NaOH and 4 h reaction time. The thermal profile of CMC showed the thermal stabilization of cellulose and the amorphous behavior of CMC. The FTIR spectra of CMC and commercial CMC exhibited similar pattern with the presence of peaks at the fingerprint region between 1300 – 1580  $\text{cm}^{-1}$  due to the presence of carboxymethyl group. This clearly indicated that cellulose had been successfully converted to CMC.

# CHAPTER 1

## INTRODUCTION

This chapter introduces the problem identification as well as the rationale of the study. It also highlights the objectives and the significance of the study in terms of producing carboxymethylcellulose from oil palm empty fruit bunch fibres as a value added product.

### 1.1 Problem Identification

Waste management is one of the major problems faced especially by the under-developed and developing countries including Malaysia. Sectors like agriculture, housing and industry all contribute to the various types of wastes. The Malaysian palm oil industry is no exception. With the rapid expansion of this industry, wastes generated in large quantity yearly, such as palm oil mill effluent, empty fruit bunches (EFB), fronds and palm kernel shells contribute to waste management problems. In addition to this, the oil palm industry is also confronting with other challenging issues that need to be overcome. Main issues are the under-utilization of abundant production of biomass for commercial purpose (Husin *et al.*, 1995; Jalani, 1998; Jalani *et al.*, 1999; Tinker, 2000); how to gain and enhance economic sustainability and the impact of biomass on the environment. All these issues act as the turning points that trigger the development of research ideas in this study.

With respect to these issues, the strategy of the oil palm industry in the past was to expand palm oil production and establish ways of handling the commodity. However, in future there would be less emphasis on expansion; instead, the focus would be on the competitiveness of the industry. This changing scenario was due