CHAPTER I

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I.1 Background

Activated carbons are the most versatile and commonly used adsorbent because of their extremely high surface area and micropore volume [1], large adsorption capacity, fast adsorption kinetics, and relative ease of regeneration [2]. They are produced from a variety of carbonaceous source materials. The choice of precursor is largely dependent on its availability, cost, and purity, but the manufacturing process and intended application of the product are also important considerations [3].

Precursors to activated carbons are organic materials that are rich in carbon, such as coal, lignite, and wood. Although coal is the most commonly used precursor, agricultural waste in certain condition is a better choice [1]. Activated charcoal produced from residues would reduce the pressure on forests since wood is also commonly used for this purpose [4]. Many agricultural byproducts such as walnut shell, coconut shell, cherry stone, apricot stone, nuts, grape seeds, eucalyptus, olive and peach stones, sugar cane bagasse, oil palm trunks, etc, have been found to be suitable precursors for activated carbon because of their high carbon and low ash contents [2]. Agricultural wastes are considered to be a very important feedstock in virtue of especially two facts: they are renewable sources and low cost materials [3].

Jackfruit is commonly used in South and Southeast Asian cuisines. Jackfruit was originally from India and spread out into tropic regions, including Indonesia. Jackfruit is very popular to Indonesian people. It can be eaten unripe or ripe, and cooked or uncooked. Many Indonesian cuisines use young jackfruit, such as gudeg, a popular traditional dish from Yogyakarta, Central Java. Even the seeds can also be used in certain recipes. Moreover, there is no in-season or out-of-season for jackfruit. Therefore, it can be harvested all year long. Those things indicate high demand of jackfruit in Indonesia and automatically result in high output of jackfruit peel waste.

Statistical Center Bureau gave the data of increasing production of jackfruit variety of *nangka cempedak* which is 537,186; 694,654; and 710,795 tones by the year of 2002, 2003, and 2004 respectively [5]. Although only production of one variety of jackfruit was revealed, it leads to a fact that Indonesia has abundant source of jackfruit, since besides *nangka cempedak* Indonesia also has numerous excellent jackfruit varieties. Some examples of them are *nangka celeng*, *nangka dulang*, *nangka kandel*, *nangka kunir*, *nangka merah*, *nangka salak*, *nangka mini*, and *nangka misin*. If it is assumed that outer peel constitutes about 59% of ripe fruit [6], approximate annual jackfruit peel wasted in Indonesia can be estimated to be more than 450,000 tones. Jackfruit peel wastes have no economic value and in fact often create a serious problem of disposal for local environments. Conversion of jackfruit peel into activated carbon would increase its economic value, help reduce the cost of waste disposal, and provide a potentially inexpensive raw material for commercial activated carbon. Therefore, in this research, raw material for activated carbon was obtained by collecting jackfruit peel waste of one variety of jackfruit, i.e. nangka kunir, from local fruit stores at Malang. The selection of *nangka kunir* is due to its high availability of the variety in East Java.

The activation of precursor to activated carbon can be carried out in two different methods, which are physical and chemical activation. In this study jackfruit peel was activated with chemical activation method using phosphoric acid as an activating agent. The advantages of chemical activation are low energy cost, since chemical activation usually takes place at a temperature lower than that used in physical activation, and yields of chemical activation are higher than physical one [7,8]. Chemical activation also has better development of a porous structure [9]. Study of various parameters by Ahmadpour and Do revealed that the most important variable to porosity of activated carbon development in chemical activation is the ratio of the chemical agent to the precursor. The other operation variables with a direct effect on the porosity development are activation temperature and method of mixing. Nevertheless, it has been found that ordinary-impregnation-method, i.e. precursor is immersed in aqueous phase of solution of activating agent, is the best method of mixing compared with physical and acid washed method [10].

The adsorption behaviour of activated carbon is determined not only by their porous structures but also by the chemical nature of its surface. The porous structure of carbon determines its adsorption capacity, while its surface chemical groups affect its interaction with polar and non-polar adsorbates [11]. It indicates that surface chemistry has a role in adsorption process. A thorough knowledge of activated carbon surface chemistry enables preparation of adsorbent with appropriate characteristic for specific application. Thus, pore characteristic and surface chemistry are worth to be investigated because of their important role in adsorption.

According to the knowledge of the author, there is only one international publication reported by Inbaraj and Sulochana about the usage of jackfruit peel as precursor for activated carbon production that used sulphuric acid as activating agent and emphasized on its application on Cd (II) adsorption [6]. Therefore, in this present study phosphoric acid, a well-known activating agent, is used to activate carbon from jackfruit peel and its kinetic and adsorption properties on Methylene Blue were investigated.

Methylene Blue (MB) is a dark green powder or crystalline solid, which can dissociates in aqueous solution like electrolytes into Methylene Blue cation and the chloride ion [12]. This cationic dye is usually selected as a model compound to evaluate the capacity of activated carbon due to its vast field of application, i.e. for coloring paper, temporary hair colorant, dyeing cottons and wools, and coating for paper stock [13]. In addition, such data of kinetic and adsorption isotherm properties will be valuable if designing wastewater treatment plant is required [14].

I.2 Objectives

1. To study the effect of impregnation ratio and activation temperature on the physical characteristic and surface chemistry of jackfruit peel activated carbon
2. To study the effect of pH on the kinetic and adsorption isotherm properties of Methylene Blue on activated carbon

I.3 Limitations

1. Raw material used was the peel waste of jackfruit (*Artocarpus heterophyllus*) variety *nangka kunir.*
2. Activation method used was chemical activation using phosphoric acid as activating agent.
3. Physical characterization of the activated carbons was studied using N_2 adsorption, SEM, and XRD.
4. Surface chemistry of the activated carbons was studied using FTIR, Boehm titration, and pH drift method.
5. Kinetic and adsorption isotherm were determined only for activated carbon with the highest Methylene Blue removal.

I.4 Benefits

Research for production of activated carbon from jackfruit peel waste can give several benefits in economic and science. Like other developing countries, Indonesia surely has abundantly available agricultural waste, such as the jackfruit peels, which have no economic value and in fact often create a serious problem of disposal for local environment. Conversion of jackfruit peel into activated carbon would add its economic value, help reduce the cost of waste disposal, and provide a potentially inexpensive alternative to existing commercially activated carbon.

To the science, this research can investigate about requirement of surface chemistry and pore characteristic of jackfruit peel waste activated carbon to get a good removal capacity on Methylene Blue adsorption.