# PRODUCTION OF HIGH-POLYPHENOL CATECHIN OF GREEN TEA BY USING ZEOLITE-ADSORPTION FLUIDIZED BED DRYER

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***Abstract***

*This study aims to assess the development of mixed-adsorption drying process to reduce the water content, enzyme inactivation polyphenols and catechins epimerisasi events and avoid thermal degradation, in order to obtain high berkatekin green tea products. Targets to be achieved in the form of technical data for the design and operation of laboratory processes and data scale-up mixed-adsorption drying apparatus. Research has been done include : design and fabrication fluidisas and dryers, continued study of the effect of process variables on the adsorption of mixed- drying apparatus. Studies carried out by changing the variable air temperature dryer, tea and zeolite weight ratio, the flow rate of hot air and humidity system as a function of time . During tempuhan, measured temperature, humidity, levels of catechins, polyphenol oxidase enzyme activity and water content. The measurement results are used to validate the model that had been developed by looking at the profile of heat and mass transfer. The results of the research is the development of a fluidized bed dryer to get green tea products with relatively high levels of catechins . Temperature and drying air flow rate affects the drying rate curve or drying time, while the residence time effect on fluidized bed drying process and the results obtained catechins.*

***Keywords: catechins; enzime inactivation; fluidized bed drier; green tea; moisture content***

## Introduction

Tea as a healthy and refreshing drink is one of the Indonesian plantation commodity. Indonesian tea area are covering 157,000 ha plantation consisting of 54% people, 24% of the country estate, and 22% private estates. That overshadowed the world tea market oversupply symptoms and the production costs are likely to increase, requiring the tea producers to improve the competitiveness and added value. Environmental issues have contributed to the development of new market segments for tea products that consumers want products that are environmentally friendly and healthy. Health aspects of tea sharply highlighted the last few years is in line with the tendency of people consuming food or beverage substitution as a counterweight diet rich in fat and cholesterol (Yulianto, et al., 2006; Alamsyah, 2006).

Catechin ($C_6H_6O_2$) in tea is the main component that accounts for approximately 30% of the dry weight of tea (Bokuchava and Skobeleva, 1969; Lunder, 1989; Graham, 1992; Price and Spitzer, 1993; Wang and Helliwell, 2000; Alamsyah, 2006). Catechins are relatives of condensed tannins are also often called polyphenols because of its hydroxyl functional groups. Catechins are the main compounds that determine quality, good taste, appearance, or color of steeping water (Graham, 1992). The content of catechins in shoots of the tea plant (*Camellia sinensis*) *assamica* varieties more than *sinensis* variety (Yamanashi, 1995). Nevertheless, sinensis varieties have better flavor because it has a higher amino acid content. Tea plants grown in Indonesia is almost 100 % assamica varieties. The resulting tea shoots 80 % is processed into black tea , while the rest is processed into green tea. Black tea contains catechins less than green tea due to the processing of black tea catechins are designed to undergo oxidation to improve the color, taste, and aroma (Alamsyah, 2006).

Located on the healthful effects of tea catechin compounds it contains (Copeland et al., 1998; Wanasundara and Shahidi, 1998; Zandi and Gordon, 1999; Nwuha et al., 1999; Wang and Helliwell, 2000; Sava et al., 2001; Alamsyah, 2006). Research with Japanese green tea catechins proved that can reduce the risk of various diseases such as contaminated reduce the risk of cancer, heart health, anti-oxidant, anti-microbial, even able to extend the period of menopause and others (Oguni, 1993; Bruneman, 1991; Chen, 1991; Fujiki et al., 1992; Hayatsu, 1991).

Processing of green tea, in principle, be done with inactivate the enzyme polyphenol oxidase, that is by blanching (Ananingsih, et al., 2006, Kusumo, et al., 2012a). Blanching process can be done by hot water blanching and steam blanching. Blanching for inactivation of the enzyme polyphenol oxidase in green tea processing is done by steaming (steam administration) and how panning (penggarangan). Inactivation of the enzyme polyphenol technology by providing more steam certainly has an edge (Yulianto, et al., 2008; Kusumo, et al., 2012a; 2012b). However, to produce green tea catechins prepared consumed with high levels of moisture content of about 2-3%, still takes the form of the drying stage of the process. Drying green tea is in addition to reducing the water content as well to stop the enzymatic oxidation of polyphenols if there are still active enzymes (Alamsyah, 2006; Paramita et al., 2009; 2010a; 2010b; Kusumo, et al., 2012b).

During this time the dryer is used for the processing of green tea, use a dryer type endless chain pressure (ECP) drier with considerable energy needs, which is 0.09 kWh/kg of dry tea (Alamsyah, 2000a; Alamsyah, et al., 2000b; Yulianto, et al., 2007) . In terms of technology, this is still a conventional dryer, because: (i) events occurring case hardening, the outer particles have dried tea, but the inside is still wet, (ii) the tea will taste soft and moldy quickly caused by the outlet temperature is too high, if their withered light, (iii) bakey, burnt, over-fired (burned or charred), caused by temperatures that are too high, (iv) smokey (smell smoke), caused by a leak in the heating device, (v) tea dry undercooked, can be determined by kissed or touched caused by thick filling and drying time is too short, (vi) occurs trough fall, many teas are falling down in the dryer because the hole is too large tray, tray or plate there is bent, so that falls trough should be cleaned every day so as not to contaminate the others, and (vii) a lot of blow-out, a lot of powdered tea that is on the floor outside the dryer caused by the air flow rate is too large, come from rough shoots, damaged, and the withered too heavy (Alamsyah, et al., 2000b; Yulianto, et al., 2007). As a result of green tea products produced has a relatively high water content. Water levels are still high, allowing the process of enzymatic oxidation of polyphenols, so the levels of catechins of green tea produced is also relatively low. It is necessary to find an alternative to other dryer, using a fluidized bed dryer.

The development is expected to produce a fluidized bed drier green tea is ready to be consumed with a high catechin content and moisture content of about 2-3%. The advantages of using a fluidized bed dryer are: (i) the material will be mixed perfectly dried by hot air, so it will increase the heat transfer coefficient, and cause drying will run faster, (ii) the water content of the drying results have a high degree of uniformity (uniform treatment ), (ii) large dryer capacity, (iii) a high degree of automation, (iv) the moving part, (v) maintenance and easy sanitation, (vi) uniform temperature along the stretch of that event case hardening on rare teas, and (vii) friction between the particles of tea is relatively small because each grain is covered with a layer of fluid.

However, the main problem in implementing industrial fluidized bed drier in green tea are catechins epimerisasi incident into such isomers of intermediate products of thermal degradation of theaflavins and catechins. This phenomenon occurs because the dryer operating conditions are relatively high, causing polyphenolic compounds transformed into theaflavins and isomer-isomer. As a result, reducing the levels of catechins (polyphenolic compounds) produced green tea (Alamsyah, 2000b; Yulianto, et al., 2007) . To that end, the drying process should be done at a relatively low temperature. Therefore , the drying process by means of adsorption becomes an attractive option to replace conventional green tea dryer system. Dehumidification (moisture content reduction) as a medium of air conditioning using adsorbents (silica, alumina, sand, LiCl, alkaline or zeolite) has the potential to improve product quality, and energy efficiency of the dryer (Leavitt and Tonawanda, 1991; Sircar, 1991; Grandmougin et al., 2003; Revila et al., 2006; Bussman, 2007; Kusumo, 2009; Djaeni et al., 2011; Atuonwu et al ., 2011).

Fluidized bed drier using a synthetic zeolite adsorbent is expected to take less time to reach a constant weight green tea compared to drying without the use of zeolite. This is because the zeolite has a high affinity for water (Leavitt and Tonawanda, 1991), so as to speed up the drying process of green tea. In addition, the relative humidity (RH) is a function of temperature and moisture content, the less the amount of moisture in the air causes the air RH lower, so the more water from green tea vaporised into the air and then adsorbed by the zeolite. This causes the equilibrium moisture content will be faster (Djaeni et al., 2011).

Results of a study conducted Atuonwu et al. (2011) stated that the zeolite adsorption dryer can reduce energy needs between 45 % - 55 % compared to conventional convection dryer. Theoretical analysis shows that the adsorption dryer is very likely applied in the production of green tea consumption to save energy. However, green tea adsorption dryers with zeolite is still constrained in the determination of the process so that the relative humidity (RH) of the air is relatively low and the temperature difference between the air-tea much as possible, so that will cause the drying rate becomes very large.

This research focuses on aspects of heat and mass transfer events of tea into the water phase and the air phase into the zeolite, as well as the energy efficiency of simulation-based pinch technology. Therefore, research on green tea fluidized bed dryer continuously by using a zeolite adsorption method needs to be done.

## Materials and Methods

### Materials

Green tea was obtained from local tea factory of Rumpun Sari Medini. Zeolite was bought from Bratechem (Semarang, Indonesia).

### Drying treatment

Before drying, the zeolite activation needs to be done first. Activation zeolite done physically. The zeolite is heated in a furnace to a temperature of 400 °C for 4 hours (Djaeni et al., 2011). After the zeolite has been activated, then the zeolite used in the drying of green tea. Initially green tea and zeolite weighed and mixed with a certain ratio, then put in a fluidized bed. As a medium, the outside air is heated to a certain temperature appropriate operating conditions at the camp entrance and flowed until the mixture is un-fluidized on specific humidity anyway. Response in the form of temperature, weight green tea and weight zeolite, measured every 10 minutes to obtain a constant weight of green tea. Of green tea and weight data of zeolite, the operating time can be determined during the process of drying speed in various conditions. Samples measured levels of catechin and its water content. Besides processing system measured humidity. The measurement results are used to validate the model that had been developed by looking at the profile of heat and mass transfer.

Research variables are varied air temperature dryer, tea and zeolite weight ratio, the flow rate of hot air and humidity system as a function of time. Inlet air temperature was set at 40, 50, 60 and 70 ° C, because in order to avoid thermal degradation and de-epimerisasi catechin catechins, and a temperature range of polyphenol oxidase enzyme inactivation. Tea and zeolite weight ratio is set at 100, 75, 50 and 25%, because it is a zoelit activation range. Hot air flow rate was set at 40, 50, 60 and 70% valve opening, and the system needs humidity of 50, 60, 70 and 80%.

## Results and Discussion

### Design and fabrication mixed-adsorption drying

The design is done in the Computing Laboratory of Chemical Engineering and manufacturing untag mixed-adsorption drying is done in CV Workshop. Glass Blower Yogyakarta over 2 months. Fabrication dryers are used for water meredukasi, polyphenol oxidase enzyme inactivation process and de-epimerisasi catechins presented in Figure 1. Dimensional fluidized bed dryer dryer design obtained by Mujumdar (2002). Broadly speaking FBD drier type consists of three main parts, namely: section heater (heater), consisting of: electric heater and vacuum/towing hot air (blower), thermocouples, hot air duct (ducting), a drying chamber consists of income section, the middle section, cooling section and expenditure, with other engine parts: perforated floor (grid plate/perforated plate), spreader, valve and directional air flow, the drying chamber.

Blower/fan to suck air, filtered by the filter and then go into the heater. The magnitude of the capacity of the air entering the bed is regulated by a regulator valve (filter and regulator valve can also be installed on the suction side of the blower). Damper serves to homogenize the inflow capacity, adjustable opening from the outside. Perforated plate / mesh is the place to put the tea leaves are dried. The door is used to insert and remove the tea leaves, the sight glass is used to observe the drying conditions. Hand out a screen mounted so that the dried tea leaves do not come out with the air.

### Implementation of batch drying

This stage aims to determine the effect of drying time, temperature, air flow rate on the rate of evaporation and drying rate. Beside that also studied the drying rate curve (drying rate curve) from green tea, to do with the temperature and air flow rate.

### Effect of drying time on the water content

Figure 2 presents the relationship graphic drying time on water content of green tea produced at various temperatures. The longer drying, moisture content of green tea produced decreases. This happens, because the longer the drying time causes the hot air contact with green tea for longer, thereby increasing the heat transfer rate, resulting in water that is in the tea leaves are relatively much regardless. Drying green tea starts from the initial moisture content and ends when there is no longer water content changes, where the final moisture content approaching equilibrium moisture content. In green tea type fluidized dryer adsorption, heat conduction occurs transition is the internal heat transfer (in tea) and convection heat transfer in molecular flow to the surface of the tea. The heat is used to evaporate the water in which the water vapor moves from the tea into the air and by air taken out of the dryer. In the early drying of the tea water evaporation takes place easily and smoothly because the very large temperature difference between the air and the tea.

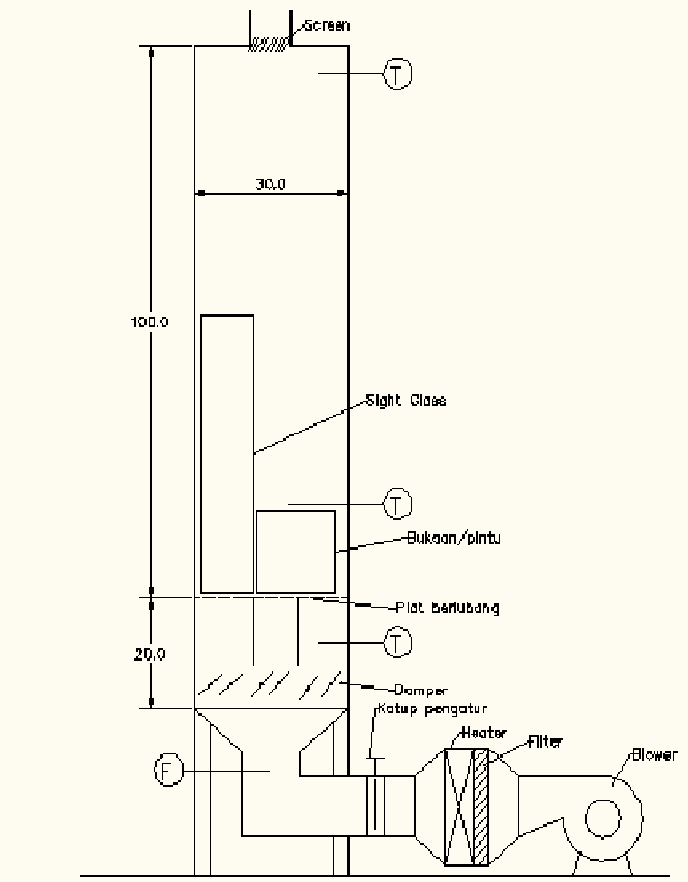


Figure 1. Dimensional of fluidized bed dryer

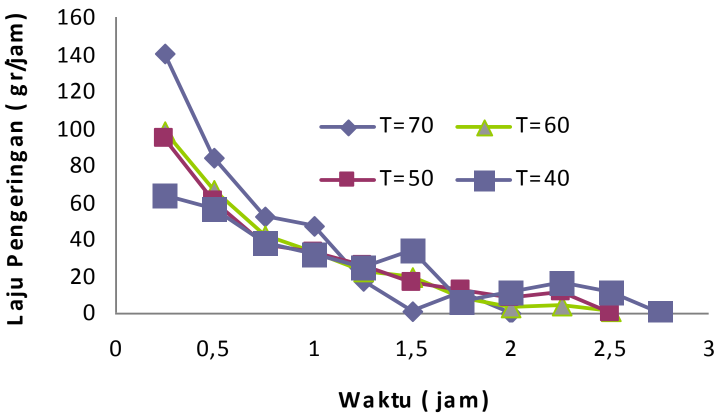


Figure 2. The drying rate of green tea as a time function at various temperatures

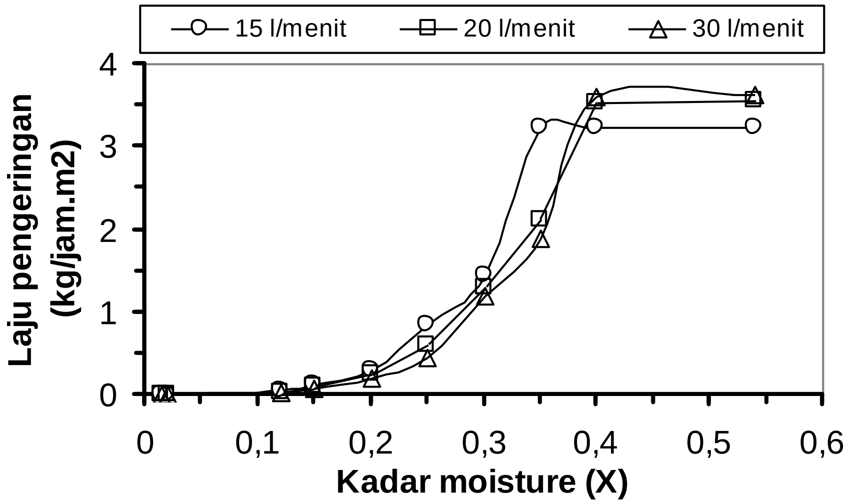


Figure 3. Effect of air flow rate and moisture content on the drying rate of green tea at 60 °C of temperature

The longer the drying, the release of water from the tea increasingly difficult, meaning drying speed is decreasing. The temperature slowly rose tea, faster and faster, until finally the temperature of the tea is almost the same as the air temperature. The difference between tea and the air temperature (the driving force) is very small causing the drying rate becomes very small even approximately constant. Seen that to achieve a moisture content of 2 % required a different drying time. The higher the temperature dryers, water levels reached the lower end. Final moisture content is also influenced by the speed of the drying air. The lower the relative humidity reached the final levels are also lower.

**Evaporation rate**

The rate of evaporation of water can be described as a decrease in moisture content during the drying material (Figure 2), which is taken by the tea interval passes through the dryer. The duration of drying the tea is important because it is closely related to the polyphenol oxidase enzyme inactivation due to contact with high temperature.

Figure 2 shows the drying rate decreases with time until a constant state. Tea drying rate is influenced by three factors, namely temperature, humidity and air velocity passing through the drying chamber (Lengros et al., 1975). Temperature is a measure of the energy content of the hot, moist air showed the ability to absorb moisture was adequate airflow will be able to carry out water vapor drying chamber.

Phase decreases the drying rate is affected by the diffusion of water from the surface to the inside of the tea and water evaporation from the surface of the tea. This leads to decreased drying rate period longer than the period of the drying rate remains. At the time of the drying rate decreases took place, the heat energy from the air conditioning is used to evaporate the remaining water and tea free of surface bound water from the cell cavity. The bound water rise through capillary pipes to the surface of the tea due to differences in water vapor pressure, capillarity nature and magnitude of the specific heat of the material that is different for each commodity.

Figure 2 shows the higher the temperature, the drying rate is formed will be steeper, meaning drying takes place quickly. It is influenced by the concentration of water in which the tea at high temperature bonding of water with Figure 3 shows the results of the rate of drying curve of green tea leaves in the drying air flow rate of 15, 20, and 30 liters/min, with a fixed temperature of 60 °C. All three curves also have the same pattern that has a constant drying rate and falling drying rate periods. The higher the drying air flow rate, the greater the drying rate constant prices, the shorter the period, and the greater the price of its critical moisture content. This is understandable because of the higher flow rate of drying air at the same temperature, the greater the mass it contains sensible heat is also higher. Drying rate curve for an air flow of 20 liters/min and 30 liters/min almost coincide, so that the air flow rate of 20 liters/minute is the optimum flow rate. tea weaker, and the difference in water vapor pressure greater resulting in more evaporation.

**Conclusions**

The design of fluidized bed dryers managed to get a green tea product with relatively high levels of catechins. Temperature and drying air flow rate affects the drying rate curve or drying time, while the residence time effect on fluidized bed drying process and the results obtained catechins.

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