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STUDY OF LOCAL WEST SUMATERA STOVE PERFORMANCES IN BOILING GAMBIR (Uncaria Gambir Roxb.)

Firdaus[a],

M. Hatta Dahlan[b], M. Faizal[c]

*[a]Student of doctoral program of Environmental Science
Sriwijaya University
e-mail firdausmtmd@gmail.com
[b]Promotor, [c]Co-promotor*

Abstract

Gambir (Uncaria Gambir Roxb.) is one of traditional export commodity of West Sumatera Province. This product is mainly used for raw material of pharmaceutical industry, batik coloring, leather thinner and clarifier in beer refineries. The paper describes how the local West Sumatera stove works to boil gambir leaves and branches. The study was conducted in Siguntur Village, Pesisir Selatan District, thirties kilometers from Padang. There were 400 home industries operates every day to produce gambir using old model local stove in this district. Gambir leaves and branches are harvested twice a year and one home industry operates one month each harvesting period to produce around one tone of dried extract gambir and consumed 1.5 cubic meters of fire-wood as the main fuel. The dried solid waste of leaves and branches after being pressed, called katapang, is used as additional fuel. Material constructions of the stove are mixture of clay and cement. Five aspects were considered in local stove performances evaluation, namely: heat efficiency, service life and simplicity in operation, health and safety, economics, and local environmental aspects. The methods used in this study were identification and evaluation. Data was collected by surveying and interview, analyzing, and calculation. The results show that heat transfer efficiency is lower than twelve percents; short service life but very simple operation; indoor pollution due to smoke and burnt risk are high because of no chimney and hot flue gas temperature still higher than 200 ^{0}C; economically, the local stove is very cheap; while environmentally, it caused impact on the local deforestation.

Key words : deforestation, fire-wood, performance, pollution, smoke, stove.

1. Introduction

Gambir (Uncaria Gambir Roxb.) is one of traditional export commodity of West Sumatera Province. Since a tropical plant gambir growth well on Pesisir Selatan and 50 Kota districts. This product is mainly used for raw material of pharmaceutical industry, batik coloring, leather thinner and clarifier in beer refineries.

For pharmaceutical industry, Germany importer needs *catechin* contain 40~60%, while pharmaceutical Ciba Geigy company needs *catechin* contain at least 60.5%. For leather thinner, Cuirplastek R. Bisset and Cie Company needs tannin contain 40%.

In trading, what we called gambir is a dried extract taken from the leaves and branches of gambir plant. The extract contains *catechin* (gives sweat taste after being chewed), *catechu tanat* (tannin, gives bitter taste), and *quercetine* (yellow coloring). *Catechin* exists in two forms, *hydrate* and *un-hydrate. Hydrate catechin* (in the form of d, l, and dl) has melting point of 93 ^{0}C, and its un-hydrate form has a higher melting point, i.e. 174~175 ^{0}C. *Catechin* is solved in boiling water and cool alcohol.

Extraction process for gambir found in West Sumatera like in Siguntur village Pesisir Selatan district started with boiling, continued by pressing step to take the gum out of the leaves and branches. The gum is settled and seeped, and then molded and dried to get dried gambir. In the local West Sumatera stove, the flare is kept throughout the period of boiling since it determine the yield. According to the cultivator in this field, they need 1.5 cubic of fire-wood in boiling process per ton of dried gambir produced.

The study was conducted to discuss the performances of West Sumatera local stove in boiling gambir. Five aspects were considered, namely heat efficiency, service life and simplicity in operation, health and safety, economics, and local environmental aspects.

2. Method

Location of research was selected in accordance with purposive sampling to the operating *stoves which can be visited eazily from Padang. The study of West Sumatera local stoves* performances was conducted using identification and evaluation methods. Data was collected by field trip for an observation and documentation, interview, sampling, measurement and calculation using standard method. Identification covering raw material processed capacity and residence time per batch, model and material construction of stove, stove equipment, combustion chamber capacity, kind of fuel and how much fuel need, fuel cost, ignition and exthinguish technique, feeding of fuel mode, bottom ash content, and gas *emission referred to environmental quality standards.*

Measured parameter in this research were dimension of stove and its compartment (stove dimension, combustion chamber, stove wall thick, opening for entrances air and exit flue gas); dimension and mass of fire-wood; composition and moisture of fire-wood; mass of water; water temperature measurement every minutes; air flow rate entrances the stove; flow rate, composition, and temperature of flue gas exit, air temperature around the stove; *the outside wall temperature of stove; accumulation of bottom ash per batch, and residence* time of boiling.

Energy balances calculation was conducted by measuring biomass heating value, mass of fire-wood used, mass of water in the pan before and after boiling, flow rate and temperature of air entrances the stove, flow rate, temperature, and composition of flue gas exit the stove, water temperature in the pan every minutes, air temperature araound the stove, and the wall *stove temperature every minutes. Measurement of rate of and flue gas composition exit the* stove gave information about gas emission load.

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The performances of local stove evaluation covered five aspects, namely heat efficiency, service life and simplicity in operation, health and safety, economics, and local environmental aspects.

3. Results and Discussion

Observation and interview gave data that one home industry boiled about 80 kilograms of bundles of leaves and branches of gambir per batch with residence time was 2 hours. Boiling and pressing were conducted 2 times. Water need for each boiling was 40 liters. Boiling water rest in the pan was 20 liters and hot water from settling of the gum after pressing was 10 liter. Normally, there were five batch per day to produce 30 kilograms of dried extract gambir. Every harvesting period, one home industry produce 1 tone of dried extract gambir with the price 17,000 rupiahs per kilograms nowadays.

Production of dried extract gambir in Pesisir Selatan district reaches 80 tones per week. The home industries for this commodity is spread out in Suranti, Taratak, Tapan, Barung-barung Belantai, Tarusan, and Siguntur sub-districts. If one home industry in averages produce 200 kilograms of dried extract gambir so there are 400 gambir home industries operate in Pesisir Selatan district every day.

Local stove for boiling gambir in this study was classified to old model using a mixture of clay and cement as construction material. Typical and model of local stove made by local handyman is shown in Figure 1. The height of the stove is 80 centimeters with combustion chamber diameter 55 centimeters. The thick of the stove wall is varied smoothly from the bottom to the pot hole, namely around 28 centimeters at the bottom and 20 centimeters near the pot hole. The opening size for entrance of fire-wood fuel and combustion air is 33 centimeters height while its width is also varied, namely 60 centimeters at the bottom and 40 centimeters at the top. Combustion air entrances the stove by natural convection.

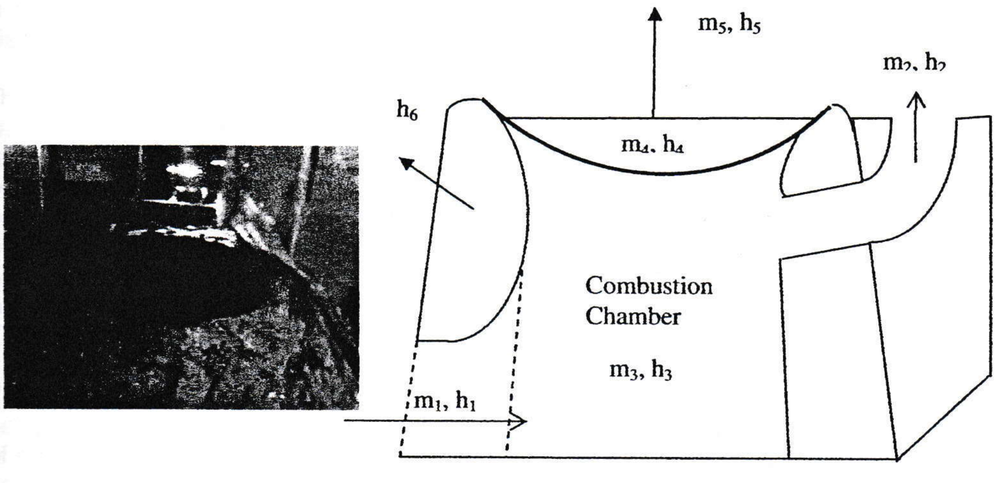

Figure 1. Typical and Model of Local Stove for boiling Gambir in Siguntur

The stove was operated twice a year. Operating time for one period around a month, *depand on leaves and branches quantity harvested after five months each. For each five* months period, the stove needs repaired before being operated. In other words, service life of the stove was only for one period of production. The pot hole was coated around by plastics waste to prevent leakage between the pot hole and the boiling pan.

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In some local stove there is a 'beetle hole' with diameter of 12 centimeters for exit of hot flue gas flow. The beetle hole position is in line with the opening for entrance air and as height as the pot hole. The distance between beetle hole and pot hole is 25 centimeters. Hot flue gas temperature exit is too high, 200-250 ^{0}C, depend on the flare. Water Boiling Test (WBT) showed that heat efficiency of the stove defined as heat absorb by water devided by heat combustion of fire-wood was 11.6%. Improved Stove having heat efficiency higher than 15% [2,3,4,6].

The hot flue gas was usually used to boil water or to cook rice. Besides that, the hot flue gas escape in working area in the hut was used to dry the wet mold gambir placed above the stove. Unluckily, direct contact between the dirty hot flue gas with the wet mold gambir caused the black color to the gambir. Moreover, in health and safety view point, the dirty hot flue gas gave impact to worker. Not only the worker could suffer breathless but also burn by spark of fire.

In economics aspect, local stove for boiling gambir is very cheap. It is only need to buy one sack of cement and payment for handyman to repair the stove in the beginning of every production period. While cost for fire-wood is nowadays 350,000.- rupiahs to produce 1 tone of mold extract gambir.

In environmental aspect, there are two cases need attention namely fuel consumption and flue gas emission. There are two kinds of fuel usually used in local stove, namely fire-wood and "katapang". Fire-wood is nowadays sent from Taratak sub-district, while katapang, dried gambir leaves and branches waste of pressing, is available in the hut area. The quantity of fire-wood need is about 50 kilograms per day and katapang is about 1 kilogram. The stove is fed with seven rods of fire-wood with avarage effective diameter of 4 to 5 centimeters to keep the flare. Each home industry bought 1.5 cubic of fire-wood for every production period. Four hundreds of home industries of gambir commodity operated in Pesisir Selatan district need 20 tone of fire-wood every day. Heating value (dry base) of the fire-wood used was 19,1 MJ/kg. The impact of fire-wood need was clearly local deforestation. The flue gas is not harmful to the environment since the forest around the hut is still cared while the distance between the huts is not less than 1 kilometer.

The ignition of the stove is only done on the first day of each production period. As a trigger flame, the worker was used to burn dried leaves, paper sheet, or waste plastics. Since the ember at the bottom of the stove was not suppressed so the ignition for the next days was only done by feeding katapang. Extinguishing was only done in the last day of production period by watering the ember. Addition of fire-wood was done by the worker manually depend on the flare and the residual fire-wood in the stove. The bottom ash content accumulated was about 5 kilograms per day and the bed of ember as thick as 12 centimeters. Air emission load was 2,4 m^3/minutes and flue gas composition was shown in Table 2.

To measure stack temperature, the chimney was added on the beetle hole of the stove as height as 1.10 meters. Air emission temperature measurement was conducted on the height of one meter above beetle hole. Emission test showed good combustion in the boiling stove used in Siguntur village Pesisir Selatan district. Nitrogen dioksid (NO_2) content in the emission air was far below maximum quality standard refer to Minister of State Environmental Regulation No 07 in 2007, namely under 1000 mg/m^3 (1000 ppm). It was because of the air entrance the combustion chamber was much more than needed stoichiometrically as showed by high residual content of Oxygen in the flue gas, namely, 12,9%.

Table 2. Air Emission Analysis of Gambir Boiling Stove in Siguntur Village Pesisir Selatan Districs

No	Parameter	units	Test result
1	Nitrogen Dioksida (NO_2)	ppm	152
2	Carbon monoksida (CO)	ppm	700
3	Carbon Dioksida (CO_2)	%	7,6
4	Oksigen (O_2)	%	12,9
5	Stack temperature	^0C	130

4. Conclusion

1. Heat efficiency of the stove in boiling gambir under studied in Siguntur was 11.6 %.
2. Technically, the stove showed short service life but very simple operation.
3. Health and safety aspect showed that indoor pollution due to smoke and burnt risk were high because of no chimney and hot flue gas temperature was still higher than 200 ^0C.
4. Economically, the local stove was very cheap.
5. Environmentally, the local stove gave impact on local deforestation to fulfill fire-wood need.

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