

## Development of low cost agarwood essential oil extraction system for agar tree growers in Bangladesh

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### Abstract

This experiment was conducted to bring in a suitable and economic agarwood oil extraction method for Agar tree (*Aquilaria agallocha*) growers in Bangladesh. Agarwood was collected from Fotikchori upazila of Chittagong district and a prototype of hydro-distillation extraction chamber was developed at the lab of Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh during January to March 2013. Using the prototype, 7 ml of agarwood oil was extracted from 15 kg matured agarwood. It was found from the calculation that the developed system can bring yearly benefit of Tk. 7,78,389 with benefit-cost ratio as 2.33. This development was, therefore, proven very beneficial for Bangladeshi agar tree growers.

**Keywords:** Agar tree, Agarwood, Oil extraction, Low cost, Hydro-distillation

### Introduction

Agar, eaglewood, *gaharu* and aloeswood are alternative names for the resinous, fragrant and highly valuable heartwood produced by *Aquilaria agallocha* Roxb. (Thymelaceae) and other species of the tree genus *Aquilaria*. Agarwood is extremely highly valued by luxury perfume, fragrance and soap manufacturers. Both agarwood smoke and oil are customarily used as perfume in the Middle East (Barden *et al.*, 2000). There are fifteen species in the genus *Aquilaria* and eight are known to produce agarwood (Ng *et al.*, 1997). In theory agarwood can be produced from all members; however, until recently it was primarily produced from *A. malaccensis*, *A. agallocha* and *A. secundaria* (Broad, 1995). Occasionally the heartwood gets infected by a mold, *Phaeoacremonium parasitica* (Gibson, 1977). As a response, the tree produces a resin high in volatile organic compounds that aids in suppressing or retarding the fungal growth. Oldfield *et al.* (1998) stated that resin production is in response to fungal infection. There are few small scale and personal agarwood plantations in Sylhet, Habiganj and Chittagong Hill Tracts in Bangladesh (Akter *et al.*, 2013). Agarwood oil extraction is done at some industries in Bangladesh, but the extraction processes are very complex, comprising of expensive mechanical, solvent extraction and cold processing system. In this context, the developed hydro distillation method is much more suitable for the cultivators of Bangladesh economically and technologically. Therefore, this experiment was carried out to develop a low cost hydro distillation system for agarwood oil extraction, to determine production by the developed system and to calculate economic benefits by it.

### Materials and Methods

#### Experimental site and period

Matured agarwood was collected from Fotikchori Upazila of Chittagong district and the hydro-distillation extraction model was developed at the Farm Power and Machinery Department Lab of Bangladesh Agricultural University, Mymensingh during January-March, 2013.

#### Collection of wood

A matured, artificially inoculated tree of about 15 years old was selected after observing the color of the wood by peeling off the bark. The selected tree was cut down and 15 kg matured woods were collected for the experiment.

### Chopping

Woods were chopped using a sharp, heavy knife into 2 to 3 inches long and 0.5 to 1 inch thin pieces for fermentation.

### Fermentation

Chopped woods were soaked in water in a steel drum. The water level was 3 inches above the wood layer and it was left for 40 days for fermentation. After fermentation wood chips turned black, soft and smelly. Water was also preserved for the next steps of processing.

### Construction of the extraction chamber

#### Materials used

The prototype (Fig. 1) was made by locally available cheap materials procured from local market. The materials used to construct the extraction chamber were- steel pipe (1", 1/2" and 1/4" dia.), steel flat sheet (16 SWG), C clamp, angles of steel pipe, pan, brick, polythene and gas burner.

#### Dimensions of heating chamber

Pan diameter = 27 inches  
 Pan height = 18 inches  
 Oven height = 36 inches  
 C clamp = 1.5 inch (height)

#### Dimensions of condensation chamber

Length = 8 feet  
 Width = 5 feet  
 Height = 40 inches

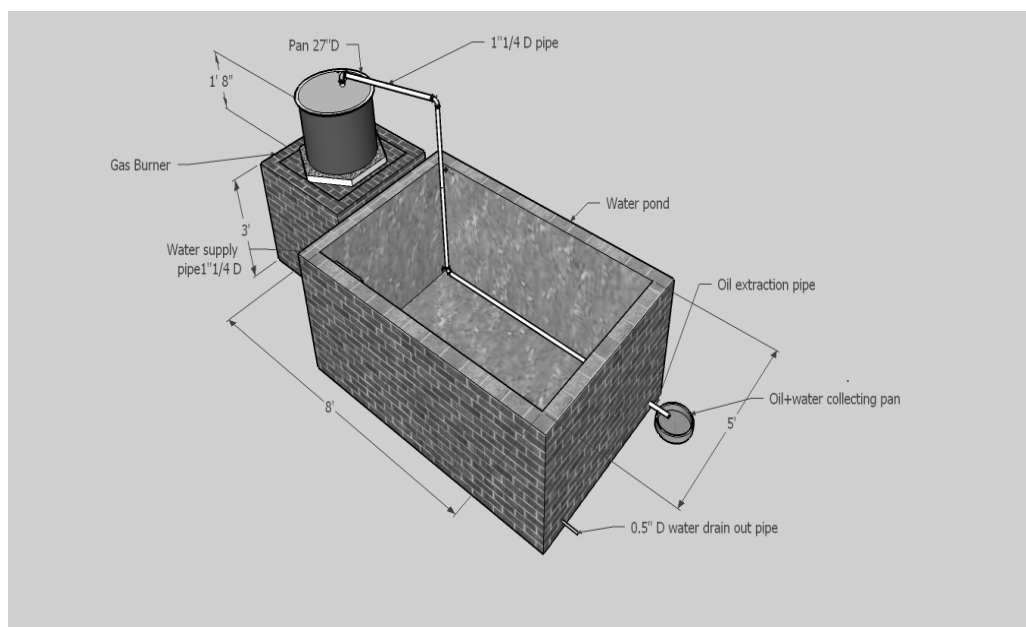


Fig. 1. Agarwood oil extraction chamber

## Heating

Fermented agarwood was divided into two equal parts, each of 7.5 kg and heated by a gas burner in two sessions.

## Condensation

Ice was added to the condensation chamber water to cool the steam passing through steel pipe to the collection pan. Amount of ice and temperature of water is shown in the Table 1.

**Table 1. Amount of added ice and corresponding water temperature**

Session	Amount of ice (kg)	Water temperature ( $^{\circ}\text{C}$ )	
		Before addition	After addition
1	8	25	18
2	5	24.5	20

## Amount measurement of extracted oil and remaining wood

Amount of collected oil was measured by a measuring cylinder and remaining wood was weighed after sun drying.

## Yearly Cost and benefit calculation

Total yearly production cost was calculated by equation (1).

$$\text{Total cost} = D + W_c + L_c + T_c + F_c + \text{O\&M} \dots \dots \dots (1)$$

$$\text{Here, } D = \text{annual depreciation of the extraction chamber} = \frac{\text{Purchase Price (Tk)} - \text{Selling price (Tk)}}{\text{time between buying and selling (yr)}};$$

according to Hunt (1995);  $W_c$  = price of wood,  $L_c$  = labour cost,  $T_c$  = transport cost and  $F_c$  = fuel cost

Yearly benefit and cost-benefit ratio were calculated by equation (2) and (3).

$$\text{Benefit} = \text{Total income} - \text{Total cost} \dots \dots \dots (2)$$

$$\text{Benefit-cost ratio} = \frac{\text{Benefit}}{\text{Total Cost}} \dots \dots \dots (3)$$

Yearly income was calculated on the basis of agarwood oil and by-product wood's market price which existed during the period of experiment.

## Results and Discussion

### Amount of oil and wood

A total of 7 ml oil was extracted from 15 kg agarwood. Amount of by-product wood (raw material of incense stick) was 12 kg.

### Cost and benefit

According to Bay of Bengal Perfumery Product Ltd. and Bismillah Agar Oil producer Company Ltd. Borolekha, Moulvibazar, Bangladesh. the price of agar oil and the by-product of agar wood were Tk. 624 per ml. and Tk. 25 per kg. respectively. The findings of the present experiment and assuming uniform production and cost, calculation exhibited that yearly production cost and benefit were Tk 2,33,600 and 7,78,389, respectively. Benefit-cost ratio was found as 2.33. Total cost, income, benefit and benefit-cost ratio are shown in Table 2 and Table 3 respectively.

**Table 2. Yearly total cost**

Price of wood	Tk. 67 /kg	Tk.167,500
Labor cost	Tk. 4500/ month	Tk.54000
Transport cost	Tk. 5000	Tk.5000
Fuel cost	Tk.450 /month	Tk.5400
Depreciation cost of chamber	Tk.1200 tk.	Tk.1200
Operation and Maintenance cost	Tk. 500	Tk. 500
Total		Tk.2,33,600

**Table 3. Amount of income, benefit and benefit-cost ratio**

Total Income per year (Tk.)	Benefit (Tk.)	Benefit-cost ratio
7,78,389	5,44,789	2.33

## Conclusion

In Bangladesh contemporary agarwood oil extraction processes are very complex, comprising of expensive mechanical, solvent extraction and cold processing system. In this context, the developed hydro distillation method is much more suitable for the cultivators of Bangladesh economically and technologically. In traditional systems big investment is required for installation of extraction chamber. But this developed hydro-distillation method can bring yearly benefit of Tk 7,78,389 where the benefit-cost ratio is 2.33. Therefore, this developed oil extraction system is very prospective for agar tree growers and agarwood oil traders of Bangladesh.

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