Madras Agric. J., 100 (10-12): 894-896, December 2013
https://doi.org/10.29321/MAJ.10.001430

Drying Characteristics, and Essential Oil Yield of Patchouli in ASTRA Model Agricultural Waste Based Crop Dryer

M. Anitha, N. Prakruthi, N. Raj Gangadkar,
S.A. Venu, C.G. Jayashree and V. Palanimuthu
Centre for Sustainable Technologies, Indian Institute of Science, Bangalore.

Patchouli is an important aromatic herb grown for its essential oil. Patchouli oil is found mainly in the dried leaves and a small quantity of oil is also present in the tender parts of the stem. Center for Sustainable Technologies, Indian Institute of Science, Bangalore has developed a simple batch type tray drier popularly known as ASTRA Model Agricultural Waste Based Crop Dryer based on the principle of a fuel efficient wood stove. The dryer was fired by using agricultural waste like wood briquettes. The fresh patchouli herbage required about 14 h of drying time to dry from an initial moisture content of 80 %(wb) to a final moisture content of 11-12 % (wb)in ASTRA Dryer. The mean essential oil yield was 2.24 per cent in samples dried in ASTRA Dryer.

Key words: Patchouli, Astra dryer, Patchouli oil, Wood, Briquettes

Patchouli, a small bushy perennial herb with fragrant leaves, is an important aromatic plant. Patchouli oil is a key constituent in exotic perfumes giving a rich, spicy fragrance. It can also be used as a perfume in its own right. It has also good fixative properties, especially in soap perfumes (Farooqui and Sreeramu, 2001).

Patchouli alcohol and nor patchoulenol are the most odour-intensive constituents of patchouli oil. Other components include alpha bulnesene, alpha, beta, delta patchoulene, alpha, delta guaiene, beta elemene and seychellene (Shankaranarayan, 2002).

Only few works are reported on the processing aspects of patchouli though considerable progress has been made on the cultivation front. It is reported that in commercial extraction facilities, the oil yield is only about 1-2.5 per cent or even less, either due to poor distillation technique/ equipment or due to improper handing of raw material before distillation (Anon., 2004b).

Materials and Methods

Raw Materials

For drying studies, the fresh patchouli (cv. Johore) was obtained from Department of Horticulture, UAS, Bangalore, and also from CIMAP, Bangalore.

The first harvest of patchouli crop was obtained after 5-6 months of transplanting. It was harvested when the foliage became pale green to light brown and when the stand emitted the characteristic patchouli odour in the morning hours. Subsequent harvests were done after every 3-4 months interval. The crop was maintained for three years.

The herbage was harvested at right stage and both leaves and twigs in the ratio of 80:20 were used for various drying experiments like tray drying, shade drying and drying in ASTRA.

ASTRA Model Agricultural Waste Based Crop Dryer

Center for Sustainable Technologies, Indian Institute of Science, Bangalore has developed a simple batch type tray drier popularly known as ASTRA Model Agricultural Waste Based Crop Dryer based on the principle of a fuel efficient wood stove. In this dryer, hot flue gases are conveyed through a duct that constantly heat the sucked drying air. The hot drying air is made to pass over the materials kept in stainless steel trays due to natural convection. The drying air removes the moisture from the material to be dried before being vented off at the top. The design of dryer is such that the cycle of heating, cooling, humidifying and reheating of drying air takes place throughout its passage i.e., from bottom to the top of the drier. The large area of flue duct contacting drying air (due to the internal design for ordered flow of air) result in higher heat transfer efficiency and thus over 90 per cent of heat generated by combustion is transferred to drying air. The bottom flue duct ensures safe hot air while reheating of the cooled and humidified drying air with in the dryer enable better drying of product. Temperature of drying air could be controlled reasonably by adjusting the burning rate of the fuel. 7.8 sq.m stainless steel tray area dryers are used in this study. The cost of the equipment is Rs 40,000 which works out to Rs 5200 per sq.m of stainless steel tray area.

*Corresponding author email: aniprakashreddy5@gmail.com

Drying of samples

The dryer was fuelled by agricultural waste like wood briquettes for about 30-45 minutes before the start of the experiment for initial warming up of the system. The temperature of drying air at different levels could be maintained between 45-95°C by controlling the rate of burning of fuel and shifting of trays from top to bottom periodically and vice

versa. When the desired drying air temperature was attained, the fresh patchouli samples (in sample trays) were dried at required temperature. Tray drying experiments were conducted with samples of 3 kg fresh herbage. Trays of 100 mm depth were used as sample holders and the herbage was spread evenly on trays to the required depth of 100 mm (initial bed depth). The drying experiment was replicated thrice. During drying, periodic weight loss of the samples (at hourly intervals) was recorded using a sensitive electronic balance and the drying air temperature was recorded at every one hour interval using a dial type thermometer. The moisture content of patchouli sample at a given time was estimated by toluene distillation method. Drying was continued until there was no more weight loss by the sample as indicated by constant consecutive weight readings. At this point, the herbage dried was assumed to be dried to its stable equilibrium moisture content of around 11-12 %(wb). After drying, the extraction of essential oil from dried patchouli was carried out by hydro-distillation technique.

Essential Oil Extraction by Hydro Distillation

The extraction of patchouli essential oil from the experimental samples of dried patchouli herbage (by convective tray drying, shade drying, drying in ASTRA model dryer) was done in the laboratory by hydro-distillation technique using a Clevenger's Apparatus.

Apparatus : a) Volatile oil trap: Clevenger type with standard taper joints for oils having densities near or less than that of water.

b) Flask 2000 ml round bottom, short neck with standard 29/42 taper joint.

A known quantity of dried patchouli herb (50 g) in the ratio of 80:20 (leaves: tender sticks) was transferred in to the round bottom flask and distilled water was added until the whole material was immersed in the water (1000 ml). Well cleaned (with chromic acid) Clevenger's oil trap was fitted in the flask and the trap was filled with distilled water. The flask was placed on an electrically heated mantle and the contents were allowed to boil slowly. The steam passing out of the flask along with the volatile oil was cooled in the water cooled condenser and was collected in the oil trap. The distillation was carried out for about 6 h (i.e., until there was no further oil collection). The patchouli oil being lighter than water and immiscible formed a separate layer over the water column in the Clevenger's trap. The amount of patchouli oil collected could be directly read from the graduated oil trap and thus oil extraction in percentage (ml/100 g sample) was worked out.

Results and Discussion

Drying characteristics

The drying behaviour of freshly harvested patchouli in ASTRA Model Agricultural Waste Based Crop Dryer is depicted in Fig 1. It was observed that the drying air temperature inside this ASTRA model Dryer varied from 45 to 95°C during drying experiments and the drying air temperature at 1h time interval inside the dryer is presented in Fig.2. For 100 mm of initial drying bed thickness, the fresh patchouli herbage required about 14 h of drying time to dry from an initial moisture content of 80 %(wb) to a final moisture content of 11-12 %(wb) in ASTRA Dryer. The reduction in moisture content with time was almost uniform in replications but still very slow as compared to convective tray drying.

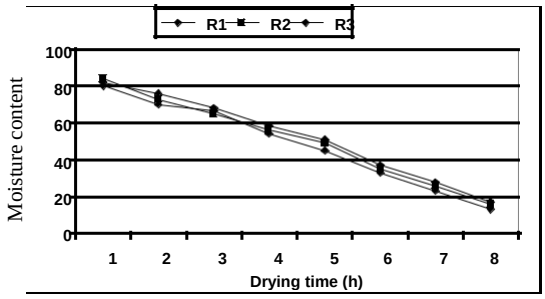

Fig. 1. Drying behaviour of patchouli herbage in ASTRA Model Waste Based Crop Dryer. Where, R1=R2=R3=Replications

Effect of drying technique of patchouli herbage on Essential oil yield

The quantities of essential oil extracted by hydro-distillation using Clevenger's apparatus from samples of patchouli dried under shade and in the laboratory convectional tray dryer and in ASTRA Dryer are presented in Table 1. It was observed that the mean essential oil yields were about 2.41 per cent in shade dried sample, 2.25 – 2.40 per cent in tray-dried samples and 2.24 per cent in samples dried in ASTRA Dryer. Statistical analysis detailed was F-test, data indicated that there was no significant difference between various drying techniques with respect to essential oil yield.

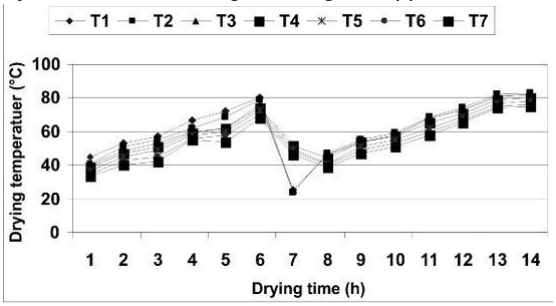

Fig. 2. Drying air temperature variation at different levels inside ASTRA Model Dryer during Patchouli drying. Where, T1=T2=T3=T4=T5=T6=T7= Temperatures in Astra dryer at different levels from bottom to top inside

Drying Characteristics in ASTRA Dryer

In ASTRA dryer, the drying period required was only about 14 h as compared to 54 h of shade drying, it was higher than the drying times observed in convective tray dryer. Since, the air movement

inside this dryer must be laminar (at low velocity) due to natural convection drying rate was relatively slow. Further, inside the ASTRA dryer, the temperature varied from 45-95°C at different levels (bottom to top) temperature varied at levels inside the drier, the temperature increases from the bottom to top as we feed the fuel (wood/ briquettes) the so trays are

Table 1. Effect of drying temperature of patchouli herbage on patchouli essential oil yield

Temperature (°C)	Mean essential oil yield (%)
30	2.40
40	2.30
50	2.32
60	2.29
Shade	2.41
Astra	2.24
CD	NS

NS – Not Significant

shifting periodically from top to bottom position and vice versa, in ASTRA dryer the more temperature can be noticed at bottom level so in order to get uniform drying of samples the trays are shifting periodically. Further, the drying air temperature control in this dryer was difficult and required lot of skill since, it was done only by adjusting the rate of burning of fuel (wood/briquettes). The dip in drying temperatures at the middle of drying period in was due to stoppage of dryer on the first day. The drying started when the dryer was warmed up to 45^0C in the following day. In the present study, the wood and briquettes were used as fuel and the calorific value of wood and briquettes was 3500 kcal/kg. Another disadvantage was elevated drying temperature of 95°C at the bottom level may lead to the loss of volatile compounds in the patchouli oil inspite of this the dryer was considered efficient because this dryer can be used by using agricultural waste and the time required for drying was also less.

Effect of drying of herbage on patchouli essential oil yield

This study indicated that the fresh patchouli herbage can be dried in a tray dryer without loss in essential oil recovery. The finding is a boon for farmers where the climatic conditions are unfavorable for shade drying. This study also indicated that the control of temperature was difficult in ASTRA dryer and heat sensitive crops have to be carefully handled if this dryer has to be used for them.

In the present drying study, the yields of patchouli essential oil, (2.25-2.41%) were comparable with the yield of 2.5-2.98% as reported by Guenther (1948) and Farooqui *et al*. (2001). The ratio of dried patchouli leaves to tender sticks in this study was all along maintained at 80:20 and therefore, the oil recovery was almost similar.

References

Andrea, L., Medina., Mary, E., Lucero. F., Omar Holguin., Rick, E., Estell., Jeff, J., Posakony., Julian Simon. and Mary, A. O'Connell. 2005. Composition and antimicrobial activity of *Anemopsis californica* leaf oil. *J. Agric., Food Chem.,* **53:** 8694-8698.

Anonymous, 2004a. Patchouli Essential Oil Information – 2004. (http://esssentialoils.co.za/essential_oils/ patchouli.html) 24th Sept., 2004.

Farooqui, A.A. and Sreeramu, B.S. 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd., Hyderabad. 424. p.

Okoh, A.P., Sadimenko, A.J. and Afolayan, 2008. The effects of drying on the chemical components of essential oils of *Calendula officinalis* L. *Afr. J. Biotechnol.,* **7:** 1500–1502.

Pallavi, G.S., Palanimuthu, V., Chandru, R. and Ranganna, B. 2006. Study of tray drying behaviour of aromatic patchouli herbage and its effect on essential oil recovery. Paper presented in National Seminar on "*40th Annual Convention & Symposium of ISAE* " organized by TNAU, Coimbatore, India, 19-21.

Sefidkon, K., Abbasi, G.B. and Khaniki. 2006. Influence of drying and extraction methods on yield and chemical composition of essential oil of *Satureja hortensis*, *J. Food Chem*., **99:**19–23.

Shanjani, P.S., Mirza, M., Calagari, R.P. and Adams. 2010. Effects drying and harvest season on the essential oil composition from foliage and berries of *Juniperus excel*, *Ind. Crop. Prod*. J., **32:** 83–87.

Valtcho, D., Zheljazkov., Charles, L., Cantrell., Tess Astatkie. and Alex Hristov. 2010. Yield, content, and composition of Peppermint and spearmints as a function of harvesting time and drying. *J. Agric., Food Chem.*, **58:** 11400-11407.

Received: April 3, 2013; Accepted: August 19, 2013