Impact assessment of aromatic crops distillation technology
by the Indian cultivators: A case study
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Abstract

CSIR-Central institute of medicinal and aromatic plants, Lucknow has developed number of agro and processing technology through its research and development programmes. Medicinal and aromatic plants are processed in the form of powders, extracts, crude herbs and essential oils and value addition of the products. Distillation technology is the key factor to determine quality production in high recovery and low cost input. Indian perfumers and farmers are using three types of distillation unit for extraction of herbs. Present studies have been carried out to assess impact of innovating technology based on interactive research inputs taken from 200 farmers exhibited better oil recovery with minimum cost input. CIMAP improved field distillation unit demonstrated better results in case of low consumption period (3.25 hrs), high recovery of oil (54.6 litre), high oil recovery percentage (79.3%) and low cost (Rs.346) per shift distillation time.

Keywords: aromatic crops, cultivators, perfumer, distillation unit, performance index

Introduction

India plays major role in the production of aromatic crops like Mint, Geranium, Vetiver, Basil, Lemongrass and Palmarosa. Indian farmers are adopting aromatic crops due to its assured marketability of essential oils. Rural economy of Indo-gangatic plans and Bihar has drastically changed due to aromatic crop adoption in the crop cycle in respective areas. Menthol mint oil is becoming the gold coin in rural market and fulfilling the day to day livelihood of poor farmers. Aromatic oils production and total acreage are increasing two folds every years. Essential oils is now become the integral part of modern life uses across the world (Guenther, 1948). Aromatic oil used as a natural preservatives and fragrance in cosmetic product, with wide range of using/application on antimicrobial food preservatives (Burt, 2004), growth promoter (Calsmiglia et al., 2007), pesticide and insecticides (El-Shafei et al., 2010; Phillips et al., 2010). National Research Development Corporation (NRDC), Govt. of India reported that total demand for essential oil is promising between the fragrance industries (60%), flavour industry (20%), and pharmaceutical industry (20%). Over all the area covered under aromatic plants were 509 lakhs hectare with a production rate of 573 lakhs ton of aromatic oil in 2010 but it is not fulfil the requirement of Indian Industries.

In case of geranium oil requirement in India is 200 ton but production is only 1.5 to 2 tons at present remaining requirement fulfil through import (Krishna et al., 2006). Central Institute of Medicinal and Aromatic Plants, Lucknow has developed more than two dozen commercially viable medicinal and aromatic crops agro and processing technologies. Innovative research leads to develop several plants derived herbal products and plant
varieties for quality raw materials production hence, increasing income and employment in the rural sector.

Description of distillation technology

Indian perfumes are using traditional system for essential oil distillation, which is the oldest, and easiest method used since ancient’s time. Hydro and direct steam distillation with cohabating methods are employed in extraction of oils. These all based on the principle where plant materials is contacted with boiling water or steam which vaporizes the essential oil and is cooled through condensing unit and finally oil and water separated through separator. According to survey conducted by extension scientist in the aromatic crops growing areas of western and northern Uttar Pradesh and Bihar. It was observed that the present conventional distillation technology. The process is consuming more firewood and fuel, labour and time consuming and low productive. During the process, the plant material near the bottom walls of the still comes in direct contact with the fire from furnace. It leads to get charred and imparting an objectionable odor to the essential oil. It also observed that prolong action of hot water leads to hydrolysis of various essentials esters present in the essential oil and improper designing of the furnace, flue ducts and chimney causes a lot of pollution in the workplace.

Users feedback studies indicates that there is ample of scope for improvement in their design for increasing fuel efficiency, time saving, economical viable and portable multi-utility/quality productive unit in rural areas as well as for small scale perfumers. Keeping in view, CIMAP has developed improved field distillation unit for extraction of various essential oils. To make it multi-utility portable application, CIMAP, also design a small distillation unit for extraction of Rose, Geranium and Spices oils and also production of vetiver and rose water. This study deals with distillation technology assessment and its methods for aromatic herbs including feedback from farmers/distillers and industries in respect of conventional and improved method of distillation for innovative in low consumption period, high recovery and low cast inputs in distillation of various aromatic herbs.

Materials and Methods

In depth interview and discussion based approach

CIMAP conducted survey and carried out in depth interview and discussion as research inputs provided from the farmers/perfumers/distillers. The study conducted in the extension activities organised by CIMAP in the form of Kisan mela, awareness gosthi, training programme etc. About 200 aromatic plants growers using various distillation units, interviewed discussions were conducted both in Hindi and in local languages. The data were recorded in form of feedback in step wise manner like their age, address, level of education and occupation followed by distillation consumption period, oil recovery in volume and percentage along with per shift distillation time from both of the rural and improved distillation unit and its cost. A comparative performance index and description of distillation units using by growers was also compiled in tabular form.

Results and Discussion

CIMAP has developed user’s feedback mechanism and land to lab programme where extension scientists provided vital information about problems/challenges faced by users. This information gets rectified and converted into application mode. Hence, new intervention created and modified for excellence of clientele satisfaction through new/improved processing technologies for need based problems and cost of unit (Table 2). Keeping in view
of users feedback factors like easy usability, affordability, high recovery, quality control, safe and eco-friendly, the scientists of CIMAP have developed a new type of multi utility distillation unit, which can serve the purpose of above including extraction of spices and precious essential oil distillation including rose water preparation by small entrepreneurs and farmers.

**Fig. 1. Traditional Distillation Unit**

**Deg/Bhapka method**

In this method, the plant material is dipped in water hence it was called water/hydro distillation. Material is kept in copper deg fitted on the bricks furnace. A copper vessel with a long neck is placed in a water tank which acts as condenser. A bamboo pipe is used to carry vapour and oil for separation (Kapoor, 1991). Deg method is used for easy transportation and to distil at field site. Bhapka method is very old and traditionally used by attar manufacturer especially in Uttar Pradesh (Kannauj, Ghazipur) Odisha, Tamil Nadu and Andhra Pradesh states. The capacity of one deg is about 40 kg per batch. This method is used by the kewda essential oil and attar producers of Odisha (Mohapatra and Sahoo, 2007).

**Rural field distillation unit**

This method is most popular in rural areas where low cost aromatic crops (mint, grasses and basil) are being commercially cultivated. It is very simple to fabricate and installed at farmers field. The plant material is loaded on a grid below which water is boiled. The stem produced from boiling water, which passes through herbs and vaporises the essential oil. This type of unit is also called, directly fired type distillation unit (Fig.1). It is generally made up of low cost mild steel material and easy in operation. Due to low cost and poor quality, it is not safe, fuel and time consuming (5-6 hrs) and giving low recovery (7-8 lit/tank).

**New improved field distillation unit**

To couple up the various problems identified through survey and feedback in traditional and rural field distillation units, CIMAP scientists have carried out research in design development of these units and developed two different types of distillation units, which are suitable and economical for field distillation (Table 1). These units are CIMAP improved field distillation (One ton capacity) and CIMAP multi-utility portable distillation unit (Fig.2) CIM-Asvika. These units are becoming very popular among the farmers, small distillers, and entrepreneurs. The fabricated units have been provided to customer along with design at a reasonable cost to the farmers in the various parts of the country. It is an advance technology for rural entrepreneurship in the aromatic crop grown areas. Improved field distillation units has
### Table 1. Economic benefit of distillation units

<table>
<thead>
<tr>
<th>State</th>
<th>No. of farmers</th>
<th>Distillation unit type</th>
<th>Ave. Oil recovery /shift/ ton capacity</th>
<th>Ave. Distillation time (hrs)</th>
<th>Ave. Cost per Shift distillation (Rs)</th>
<th>Ave. Oil recovery %</th>
<th>Ave. cost of 5 q distillation unit with no. of farmers</th>
<th>Ave. Cost of 10 q distillation unit with no. of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>East U.P.</td>
<td>20</td>
<td>Rural type distillation unit</td>
<td>34 Lit.</td>
<td>6</td>
<td>700</td>
<td>50%</td>
<td>30000 (16)</td>
<td>80000 (4)</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Improved distillation unit</td>
<td>55 lit.</td>
<td>3½</td>
<td>350</td>
<td>80%</td>
<td>50000 (35)</td>
<td>250000 (5)</td>
</tr>
<tr>
<td>West U.P.</td>
<td>25</td>
<td>Rural type distillation unit</td>
<td>32 lit.</td>
<td>5½</td>
<td>750</td>
<td>52%</td>
<td>30000 (22)</td>
<td>800000 (3)</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Improved distillation unit</td>
<td>53 lit.</td>
<td>3¼</td>
<td>340</td>
<td>78%</td>
<td>50000 (13)</td>
<td>250000 (2)</td>
</tr>
<tr>
<td>Bihar</td>
<td>40</td>
<td>Rural type distillation unit</td>
<td>32 lit.</td>
<td>5¼</td>
<td>725</td>
<td>52%</td>
<td>30000 (36)</td>
<td>250000 (4)</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>Improved distillation unit</td>
<td>56 lit.</td>
<td>3½</td>
<td>350</td>
<td>80%</td>
<td>50000 (50)</td>
<td>250000 (10)</td>
</tr>
</tbody>
</table>

### Table 2. Comparison of conventional, local and improved field distillation unit

<table>
<thead>
<tr>
<th>Items</th>
<th>Primitive/conventional</th>
<th>Rural type field distillation unit</th>
<th>Improved field distillation unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Water/hydro distillation-Process is slow and the distillation time is much higher and consuming more fuel.</td>
<td>Water and steam distillation-Low steam generation, lesser time consuming than conventional type but inferior than improved one. Constructed with more fuel consumption, cheaper quality material.</td>
<td>Technologically improved over easier, higher steam generation due to more heating surface area and consuming lesser time. More fuel efficient and save 20-30% fuel, technically designed with better quality material.</td>
</tr>
<tr>
<td>Tank</td>
<td>Made up of copper called ‘Deg’, Bamboo pipe, copper vessels etc.</td>
<td>Mild/Stainless steel, tank shape varies circle, oval and cylindrical</td>
<td>Using high quality mild steel/stainless steel, cylindrical distillation tank fitted on a square inbuilt boiler/calandria having smoke pipe.</td>
</tr>
<tr>
<td>Capacity</td>
<td>Capacity is around 40 kg per batch.</td>
<td>Capacity varies from 5 quintal per batch.</td>
<td>Capacity varies from 10 quintal per batch.</td>
</tr>
<tr>
<td>Condenser</td>
<td>Material dipped in water, bamboo pipe is used for vapour connection, small furnace, and water tank is used for consideration of oil and vapour in a copper vessel.</td>
<td>Material is loaded on a grid below which water is boiled. Furnace has no design, vapour and oil passed through long vessel and then simple coiling in water tank, manual discharge of distillation waste.</td>
<td>Cylindrical distillation tank fitted with specifically designed furnace having fire gate, fuel duct and fire door. Furnace connected with chimney of optimum height, tube type condenser, stainless steel type separator with inbuilt baffle, chain pulley hoist system for easy discharge of waste.</td>
</tr>
</tbody>
</table>
Operation
Easy, simple and portable and used for rooh and attar of Gulab, Khus, Rajnigandha, Bela etc. Easy to fabricate, installed at farmers field, low cost, simple construction, easy operation, not safe and less recovery of oil and time consuming, used in Menthol mint, Citronella, Lemongrass, Basil, Palmarosa, Geranium, Vetiver, Chamomile, etc.
Slightly costly, economic and efficient, fuel and time saving, eco-friendly and safe, can be used in Menthe, Citronella, Lemongrass, Basil, Palmarosa, Geranium, Vetiver, Chamomile, etc.

Quality of oil
Poor quality of oil due to direct contact of material with fire which imparting an objectionable odour to the essential oil. Deterioration of essential ester of essential oil. It also causes air pollution at work place.
Oil recovery less than improved field distillation unit, utilizes more quantity of agro waste/spent marc as fuel due to inferior technology. Deterioration of essential ester of essential oil due to high temperature in condensation.
Good oil recovery, 10-15% higher, utilizes agro waste/spent marc as fuel, no smoke in work area. No deterioration of essential ester of essential oil.

Self life
2-3 years 4 years 10 years

Cost of unit
Rs. 30,000/- Rs. 50,000/- Rs. 250000/-

Table 3. Performance index of CIM-ASVIKA

<table>
<thead>
<tr>
<th>Performance Index</th>
<th>States and no. of farmer use CIM-ASVIKA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.P (10)</td>
</tr>
<tr>
<td>Cost</td>
<td>Low cast</td>
</tr>
<tr>
<td>Usability</td>
<td>Portable easy to operate</td>
</tr>
<tr>
<td>Technology tested by farmers/users</td>
<td>Yes, Fit for various application</td>
</tr>
<tr>
<td>Capacity</td>
<td>10 Kg flowers per batch</td>
</tr>
<tr>
<td>Cost of Rose water production</td>
<td>Rs 475/- per batch</td>
</tr>
<tr>
<td>Time of distillation and raw material quality per day batch</td>
<td>Three batch in a day of 30 Kg flowers (4 hours)</td>
</tr>
<tr>
<td>Rose water production per day</td>
<td>30 litre</td>
</tr>
<tr>
<td>Net return / acre</td>
<td>110 litre of rose water @ 185 per litre</td>
</tr>
</tbody>
</table>

technological advantage in terms of higher steam generation, more heating surface area, better oil recovery (15-20%) higher with lesser time for distillation. It is efficiently and technically designed for fuel efficient (20-30%) and uses of agro-waste and spent marc.

CIM-Asvika-distillation unit is especially designed for producing good quality oil and rose and Khus water. It can also be used for extraction of spices and other aromatic oils of high grades. It is made up of stainless steel, simple low cost, portable type, highly efficient and low fuel consuming distillation unit. This unit can produce 10-15 kg fresh rose water from 12 kg of rose flowers. The cost of this unit is about Rs. 12000/unit. It can be operated by firewood, agro waste, liquefied petroleum gas, kerosene burners.

User’s feedback/Bottleneck of technology

Aromatic crop cultivation and trading in India is becoming popular enterprises along with traditional agriculture, small-scale aromatic oils traders, pansari, distillers, and fabricators and planting material nursery growers are already in this sector. The user’s feedbacks were collected from the growers, distiller and fabricators.
fifty districts of Uttar Pradesh and Bihar through extensive survey. The farmers were interviewed during survey and analysed critically (Table 1). During survey, it has been stated the majority of farmers are using local fabricated unit made up of poor quality mild steel material with an average cost Rs. 25000 to Rs.90.000 per unit depending upon the capacity of tank (5 quintals to 1 tonne capacity). During survey it was also observed that traditional attar manufactures of Ghazipur (UP) are facing raw material problems. Most of the attar manufactures are shifting their distillation facilities in location specific area for the extraction of essential oil and attar preparation depending upon availability of raw materials. Distillation of oil and its production unit are generating hugs business in various location specific areas where cultivation of aromatic crops is in practise. The fabricators of these units are mainly from district of Barabanki, Rampur, Moradabad, Sambhal and Badaun (UP); Zind (Haryana); Bhopal (MP) and Raipur (Chhattisgarh).

Performance index of innovative distillation technology

Performance index of newly developed multi-utility portable distillation technology was evaluated amongst the farmers of Uttar Pradesh and Bihar. These units were sold to farmers and received feedback of the technology. The performance report indicates that 95% farmers are satisfied with CIM-ASVIKA in terms of usability and quality uses in micro enterprises development. A Farmer from District Barabanki of Uttar Pradesh who is cultivating ornamental flowers to meet the local market demand adopted innovative distillation technology and started the cultivation Desi Gulab for manufacturing the rose water. Farmer has taken up the small level production of rose water and selling it in local market. As Self Help Group has been formed in village Samraha Udholi of Barabanki and women groups have started cultivation desi rose for the production of the rose water. It produces nine litre rose water from ten kilograms flower and earned Rs. 1200/- with an expenditure of Rs. 475/- (Table. 3) and selling in open market under brand name, Sakhi Gulabark.

Conclusion

CIMAP outreach activities have been creating new avenue in term of employment generation and income enhancement of rural people by using agro and processing technologies of various medicinal and aromatic plants. CIMAP rural technology is also helping women empowerment in agriculture sector especially in post harvest technology management. It is proved that CIMAP based rural technologies of distillation of essential oils and rose water is able to create rural empowerment as well as small scale entrepreneurship. User’s feedback indicates that the technology developed by CIMAP is safe, economical and eco-friendly as being adopted by large number of small farmers and entrepreneurs. CIMAP outreach bio-village approach to the farmers of salt affected area of Raibareli and Sultanpur an converting into technology enabled village through transfer the capability and knowledge of cultivation and processing of aromatic crops.

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References


