Recent Development of Extraction Processes and Extraction of Essential Oil from Coriander by Clean Technology

Geed S. R, Singh R. P, Rai B. N

***Abstract:** By increasing demand of essential oil in medical and cosmetically field various different extraction technologies are used to extract a essential oil Semi-continuous supercritical carbon dioxide extraction or clean technology unit was used to extract the essential oil from the coriander seeds. Dried seeds were subjected to extraction after grinding to particle size of 300µm. The extraction was carried out at three different pressure levels (30, 35 and 40 MPa), three temperature levels (308, 313, 318 K) and three levels of supercritical CO_2 flow rates (10, 15, 20 g/min). The highest essential oil was obtained at 40MPa, 313 K and 15 g/min combination of parameters and the highest yield was equal to 3.20 gm/100gm. The study showed that the temperature has more significant effect than the pressure while the flow rate was having no significant effect on the yield of coriander seed oil*

***Keywords:** Recent technology, clean technologies, coriander seed; supercritical carbon dioxide; temperature; essential oil.*

I. INTRODUCTION

A wide range of technology are available for the extraction of medicinal active compound and essential oils from the medicinal plants the choice of appropriate technology is depend on economic feasibility and suitability of the process to the particular situation The extraction and characterization of active compounds from medicinal plants have resulted in the discovery of new drugs with high therapeutic value (**Colegate and Molyneux, 1993; Donehower and Rowinsky,1993**)A classic example (**Colegate and Molyneux, 1993**).Another noted example is taxol, recently proven to be effective against breast and ovarian cancers, which was initially discovered in bark of yew trees(**Donehower & Rowinsky,1993**)The use of medicinal plants (herbs) has a long history throughout the world and herbal preparations, including herbal extracts, can be found in the pharmacopoeias of numerous countries (**Hostettmann *et al*.,1995**)In recent years there has been a interest in natural or herbal remedies worldwide, partly because of the realization that modern medicine is not capable of providing a "cure-all" solution against human diseases and that the presence of unwanted side-effects is almost unavoidable. Unlike modern drugs that invariably comprise a single active species, herb extracts or prescriptions contain multiple active constituents.

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***** Correspondence Author (s)
Geed S. R, Department of Chemical Engineering, Indian Institute of Technology (BHU), Varanasi, India.
Singh R. P, Department of Chemical Engineering, Indian Institute of Technology (BHU), Varanasi, India.
Rai B. N, Department of Chemical Engineering, Indian Institute of Technology (BHU), Varanasi, India.

Interestingly, natural compounds contained in these "herbal cocktails" can act in a synergistic manner within the human body, and can provide unique therapeutic properties with minimal or no undesirable side-effects (**Kaufman *et al.*, 1999**).A key factor in the widespread acceptance of natural or alternative therapies by the international community involves the "modernization" of herbal medicine. In other words, the standardization and quality control of herbal materials by use of modern science and technology is critical. At present, however, quality-related problems (lack of consistency, safety, and efficacy) seem to be overshadowing the potential genuine health benefits of various herbal products, and a major cause of these problems seems to be related to the lack of simple and reliable analytical techniques and methodologies for the chemical analysis of herbal materials (**Picker ,1999;Anderson, Burney,1998**). Locally available plants and herbs with their medicinal compound and applications are shown in the tables from the table it has been seen that coriander is rich source of different acid and essential oil it has been various medicinal properties such as antibacterial activity anticonvulsant effect ant fertility activity ,anxiolytic activity etc.

Table 1.1 Locally Available Plants and Herbs nearby Varanasi (UP) India with their Medicinal Compound and Applications

Sl. no.	Name of the plants and herbs	Plants part used	Extracted ingredients	Medicinal use
1	*Azadiracha indica* (Neem)	Leaves	Nimbidin	Active antibacterial ingredient an antibacterial, antiviral
2	*Curcuma longa* L. (Turmeric)	Rhizome	Active compound curcumin, vitamin D	Stomach and liver ailments,skin,pulmonary, gastrointestinal system anti-,inflammatory,antioxidant,antitumour, and antiviral activitie
3	*Ficus recemosa* L. (Umbar)	Fruit pulp	Phytosterols, amino acids, furanocoumarins, phenolic components, aliphatic alcohols	Antidiabetic, cognitive enhancer, wound healing, anticonvulsantanti inflammatory, analgesic
4	*Syzygium cumini* L. (Jamun)	Seeds	Carbohydrates,Dietay fibre fat, Vitamin C, Calcium	Antiviral activitie, antibacterial
5	Apple pomace	Pomae	Pectin,phosphorous, potassium, calcium, iron, and magnesium	weak bones (osteoporosis), weight loss,upset stomach,sore throats,sinus problems,high blood pressure
6	Guava	Green, yellow pepper and cayene pepper	Ascorbic acid, vitamins	Antidiabetic, analgesic
7	*Ocimum tenuiflorm* Holy Basil or Tualsi	Leaves	Assential oil	Balancing different processes in the body,and helpful for adapting to stress.
8	*Menthaars* (Mint or pudina)	Leaves	Menthol from mint essential oil	Vomiting, ,cosmetics,stomach ache and chest pains
9	*Zinger officinale* (Adrak)	Bulb	Ginger oil (contains a high proportion of sesquiterpene hydrocarbons,predominantly zingiberene)	Diarrhoea, decrease nausea and vomiting associated with several Conditions
10	*Corinadrm sativum* (Dhania)	Seeds, leaves	essential oils	Antibacterial activity, Anticonvulsant effects, Antifertility activity, Anxiolytic activity
11	*Phyllanths Emblica* (Amla)	Fruit	Essential oil	Vomiting
12	*Phoenix dactylifera*(Date)	Fruit	Essential oil	Constipation (Improves digestion)
13	*Carica papaya* (Papita)	Fruit	Provitamin A carotenoids, vitamin C	Ring worm Anti-fungal Destroy small colony of fungi spores.
14	*Allium sativum* (Lahsun)	Bulb	Vitamin C, Niacin, Calcium, Iron	Abscess Helpful in wound healing, digestive disorders, and fungal infections
15	*Aloe era*, aloe, burn plant	Plant	Saponin	Antimicrobial agent act as multipurpose skin treatment

Coriandrium Sativum

Coriander (*Coriandrium sativum*) is an annual herb having family *Apiaceae*. The name coriander originates in the plant's strong bug-like smell of the leaves. The Greek word koros means insect or the Greek word koriannon meaning bug. It is most widely use flavouring herb in the world. Coriander seeds are used in traditional Indian medicine as a diuretic, dyspepsia and indigestion, seeds lotion for rheumatic pain. The present investigation was aimed to optimize process to extract essential oil from coriander seeds after detailed study on effect of processes parameter on its yield.

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II. RECENTLY USED EXTRACTION METHODS

However now days different modern technology were developed by several scientist to extract bioactive compounds some of suitable methods for extraction of essential oil or medicinal ingredient from medicinal plants and herbs are given below

1. Distillation for extraction of oil
2. Microwave-assisted extraction
3. Solid phase extraction
4. Ultrasonic extraction
5. Supercritical fluid extraction

1.1 Distillation for extraction of oil

The choice of a particular process for the extraction of essential oil is generally dictated by the following considerations

a) Sensitivity of the essential oil to the action of heat and water

b) Volatility of the essential oil

c) Water solubility of the essential oil

Essential oils with high solubility in water and those that are susceptible to damage by heat cannot be steam distilled. Also, the oil must be steam volatile for steam distillation to be feasible. Most of the essential oils in commerce are steam volatile, reasonably stable to heat and practically insoluble in water; hence they are suitable for processing by steam distillation. Essential oils are a mixture of various aroma chemicals, basically monoterpenes, sesquiterpenes and their oxygenated derivatives, having a boiling point ranging from 150° to 300° C.

1.2 Microwave-assisted extraction

In microwave-assisted extraction methods radiations are interacts with dipoles of polar and polarisable materials. Polar molecules try to orient in the changing field direction and hence get heated. In non-polar solvents without polarisable groups, the heating is poor (dielectric absorption only because of atomic and electronic polarizations). This thermal effect is practically instantaneous at the molecular level but limited to a small area and depth near the surface of the material. The ability of microwave radiation to heat solid material effectively can also be used for obtaining essential oils. Thus, the herb is placed in a microwave cavity and irradiated with microwaves. This process yields essential oils consisting of relatively low volatile fractions as compared to hydro distillation.

1.3 Solid Phase Micro-extraction

Solid phase micro-extraction (SPME) was developed by Professor J. in 1090's Pawliszyn to provide a quick and solvent less technique for the isolation of analytes from a sample matrix. Solid phase micro-extraction (SPME) is a technique used in the quantitative analysis of analytes in aqueous and gaseous phases. This novel technology captures aroma molecules surrounding flower petals without touching the flower or other part of the plant. SPME has gained widespread acceptance as the technique of choice in many fields of application, including forensics, toxicology, and the analysis of flavours, fragrances, and environmental and biological matrices. SPME is ideal for field monitoring. SPME sampling can be performed in three basic modes: direct extraction, headspace trapping and extraction with membrane protection.

1.4 Ultrasonic extraction

Ultrasonic extraction of medicinal compounds from plant materials can be found in the literature as early as the nineteen-fifties, mechanistic aspects of the usefulness of ultrasonically assisted extraction are worth noting. Fundamentally, the effects of ultrasound on the cell walls of plants can be described as follows (**Vinatoru, 2001**).

1). Some plant cells occur in the form of glands (external or internal) filled with essential oil. A characteristic of external glands is that their skin is very thin and can be easily destroyed by sonication, thus facilitating release of essential oil contents into the extraction solvent; and

2). Ultrasound can also facilitate the swelling and hydration of plant materials to cause enlargement of the pores of the cell wall. Better swelling will improve the rate of mass transfer and, occasionally, break the cell walls, thus resulting in increased extraction efficiency and/or reduced extraction time. As a novel approach to extraction and sample preparation for medicinal herbs, (**Fang *et al.*,2000**) recently employed ultrasound to assist the surfactant-mediated extraction of ginsenosides from American ginseng.

1.5 Supercritical Fluid Extraction

Supercritical fluid extraction by using $C0_2$ as a solvent is also called as clean technology or green technology In the second half of last century, an increasing interest has been paid to supercritical fluids as alternate solvents for the extraction of natural bioactive molecules from plants. The main reason for the interest in supercritical fluid extraction (SFE) was the possibility of carrying out extractions at temperature near to ambient, thus preventing the substance of interest from incurring in thermal denaturation (**Sukhdev swami Handa *et al*.**)

III. MATERIALS AND METHODS

The sample of coriander seeds was collected from local market of Varanasi, Uttar Pradesh. A cylinder of carbon dioxide (99% purity) was supplied by Luthra Gas Supplier,Varanasi. Analytical grade n-hexane (Boiling point: 65.5ºC), CDH laboratory reagent was purchased from Central Drug House (P) LTD, New Delhi. The moisture content and oil content of coriander seeds was determines as per procedure given in the **AOAC method (1980)**. A batch type SFE 500 model of Thar technologies was used to optimize the process parameters. Prior to experimentation, seeds were finely powdered to size of about 250 µm. The grinding is done to enhance extraction process through enlargement of surface area. During experimentation, sample was mixed with glass beads to achieve ration of 2:1 v/v. The process parameters were controlled using "*Process Suite software*". In each experiment, 100 g sample was charged into the extraction vessel along with glass beads and run for about 4 hours or up to completion of extraction. The extract was collected at every 30 minutes interval to insure completion of extraction process, and obtained oil was weighed immediately after collection. An orthogonal array design (L9 (3^3)) was used to organize the combination of the process parameters. All statistical analysis was carried out using Minitab 16.1 (Minitab Inc. State college, PA, USA).

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Experimental Set Up

Stages of Seed Material Observed

1. Coriander seed
2. After grinding
3. After extraction
4. Oil collected after extraction

1. Coriender Seed

2. Before Extraction

3. After Extraction

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4. Oil Collected After Extraction

IV. RESULTS AND DISCUSSION

The coriander seeds were found to have moisture content of about 11.37 %. The soxhlet analysis showed that the seeds have 3.0 % oil content. This value may be affected by high temperatures due to volatility of some compounds present in essential oils.

The results obtained using supercritical carbon dioxide extraction method to extract coriander seed essential oil are as shown in Table 4.1.

Table 4.1 Yield of Essential Oil (g/100g) using Supercritical Carbon Dioxide

Pressure (MPa)	Temperature (K)	CO2 Flow rate (g/min)	Extraction yield, g/100g
30	303	10	2.16
30	313	15	2.28
30	318	20	2.3
35	303	15	2.41
35	313	20	2.46
35	318	10	2.55
40	303	20	2.86
40	313	15	3.2
40	318	10	2.98

The analysis of results showed that at higher pressure of 40 MPa, and temperature of 313 K was significantly higher for flow rate of 15 g/min and the maximum yield was 3.2 g/100g. The detailed study of each parameter effect is explained in subsequent paragraphs.

Effect of extraction pressure

The extraction pressure is a crucial parameter in pressurized extraction i.e. supercritical carbon dioxide extraction. The results showed the similar behavior which was observed by number of researchers i.e. increase in the pressure increases the oil yield (Figure 4.1). In orthogonal array design, three levels of pressure were selected (30, 35 and 40 MPa).

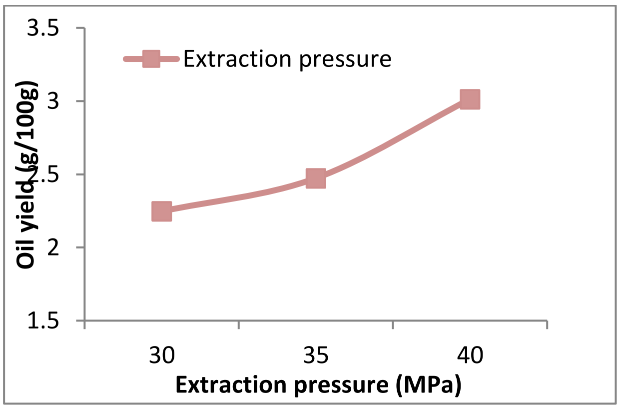

Figure 4.1 Effect of Extraction Pressure on Extraction Yield

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The relationship between pressure and yield was mainly due to variation in the solvent density and the solvent power of supercritical CO_2. At constant temperature, density of the solvent increases but the vapor pressure of the solute decreases with increase in pressure. However, elevation of pressure showed a positive effect on the extraction as increase in solvent density with pressure dominates over vapor pressure of solute. This dominancy caused the release of maximum oil from cell walls and results in increased oil yield.

Effect of extraction temperature

Three levels of orthogonal arrays were 303, 313 and 318 K. The temperature increment resulted in little increase in yield up to 313 K but further increase in temperature showed decreasing of oil yield (Figure 4.2).

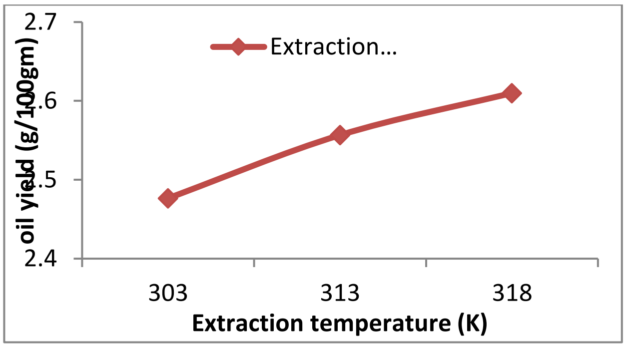

Figure 4.2 Effect of Extraction Temperature on Extraction Yield

The result showed that at higher pressure, solute vapor pressure increased with temperature compared to solvent vapor pressure. But after 313 the extraction yield was started to decrease due to start of crossover effect which is explained by Said et al. (2014) in their literature and thermal degradation of volatile compounds as well.

Effect of volumetric CO_2 flow rate

Though different literature showed non-significant effect carbon dioxide flow rate on the yield of extracting compound, an optimum flow rate must be required to obtain sufficient yield and to shorten the extraction time. Hence study was conducted at three different flow rates i.e. 10, 15 and 20 g/min. the result showed that increase in flow rate caused increase of essential oil yield (Figure 4.3). But more the flow rate more will be the loss of CO_2 which increases the cost of product. Since the flow rate of 15 g/min was recommended as the combination of 40MPa, 313 K and 15 g/min have highest oil yield.

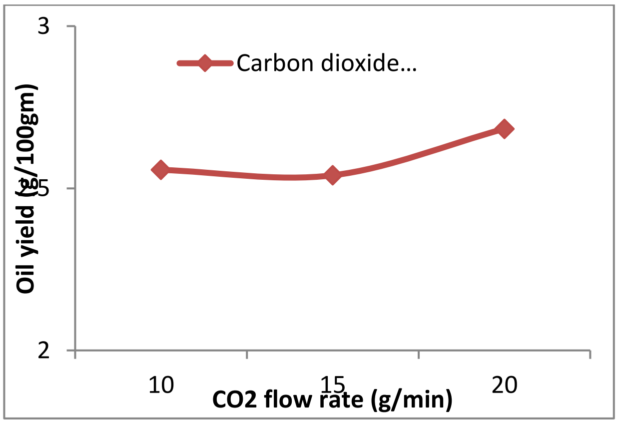

Figure 4.3 Effect of Volumetric CO_2 Flow Rate on Extraction Yield

V. CONCLUSION

By increasing demand of essential oil in medical and cosmetically field different extraction technologies are used to extract a essential oil. Coriander (Coriandrium sativum) is an annual herb having family Apiaceae. It is main source of essential oil particularly petroselinic acid (68.8%) and linoleic acid (16.6 %). An essential oil from the seed is used as food flavouring. The study showed that the temperature has more significant effect than the pressure while the flow rate was having no significant effect on the yield of coriander seed oil. The study provides an opportunity to pharmaceutical/cosmetic industries to obtain the highly pure oil using the optimized conditions. Supercritical fluids can be considered in a prominent way in the development processes of drug products for the 21st century.

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