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Analytical study of extraction, encapsulation and utilization of ginger oil

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Abstract
India is the largest producer of spices chiefly of mint, chills, turmeric, cinnamon, cumin, cardamom, and ginger. Ginger has a very high commercial value due to its therapeutic properties. It is widely used in aromatherapy, medicine and as well as flavoring food and drink industries. Ginger oil is produced commercially by steam distillation of freshly ground dry ginger. Encapsulation of flavours has been attempted and commercialized using many different methods such as spray drying, spray chilling or spray cooling, freeze drying, coacervation and other. Ginger oil is utilized in the bakery products due good digestibility function and useful against cough and cold.

Keywords: Ginger oil, encapsulation, steam distillation

1. Introduction
The spice ginger (*Zingiber officinale* Rosc) is obtained from the underground stems or rhizomes of a herbaceous tropical perennial belonging to the family Zingiberaceae, ginger is a slender perennial herb, 30–100 cm tall with palmately branched rhizome bearing leafy shoots. The leafy shoot is the pseudo stem formed by leaf sheath and bears 8–12 distichously leave. Spices are recognized as essential part of the Indian food industry as they have unique quality to enhance the flavour of the bland food.

Ginger oil is produced commercially by steam distillation of freshly ground dry ginger. The yield of oil varies from 1.5 to 3.0% with an average of 2.0%. Essential oils have a very high commercial value due to its therapeutic properties. It is widely used in aromatherapy, medicine and as well as flavoring food and drink industries. It has antibacterial and anti-inflammatory properties, can be used as a stimulant, and is well-known for its anti-nausea compounds. India is the largest producer and consumer of ginger in the world. Kerala is the largest ginger producing state in the country with production of 166.5 thousand metric tons in the state.

Pure essential oil can be derived from a part of ginger plant that is the ginger rhizome by using distillation method. Encapsulation describes different processes to cover an active compound with a protective wall material and it can be employed to treat flavours so as to impart some degree of protection against evaporation, reaction, or migration in a food. Encapsulation of flavours has been attempted and commercialized using many different methods such as spray drying, spray chilling or spray cooling, extrusion, freeze drying, coacervation and molecular inclusion.

Encapsulation is a technology that allows sensitive ingredients to be physically entrapped in a matrix or “wall” material to protect these ingredients or “core” materials. Encapsulation helps to stabilize the core material, ensuring against volatile losses, nutritional losses, oxidation, masking or preservation of flavours and aromas and transform liquids into free flowing, easily handled dried powdered products. Acacia gum, commonly called Arabic gum, has been the encapsulating agent of choice for many years. Flavours can be among the most valuable ingredients in any food formula.

The choice of appropriate microencapsulation technique depends upon the end use of the product and the processing conditions involved in the manufacturing product. Encapsulation as a technology is now well developed and well accepted within the pharmaceutical, chemical, cosmetic, foods and printing industries. In food products, fats and oils, aroma compounds and oleoresins, vitamins, minerals, colorants, and enzymes have been encapsulated

There are two ways of extraction, that is using steam distillation and solvent extraction. In order to get oleoresin, solvent extraction technique is used but to obtain essential oil, steam distillation technique is used. Steam distillation method is used for temperature sensitive material like natural aromatic compounds. For this method, there is no solvent is used to extract the material but pure water is the main component to do it.

Aims and Objective

- To extract the Ginger oil from raw Ginger rhizomes.
- To encapsulation of ginger oil.

2. Materials and methods

The various materials and methods required in the research project namely "Analytical study of extraction, encapsulation and utilization of ginger oil" are illustrated below.

2.1 Materials

Dry ginger is used for oil extraction. Since fresh ginger is available at low prices and because dry ginger has a slight musty odour, fresh ginger is also studied has a slight musty odour fresh ginger is also studied for preparing ginger oil. However, it has been shown that dried ginger yields more ginger oil as compared to the fresh ginger. If dry ginger is used for oil extraction, it should be harvested at a proper time when it contains maximum volatile oil and pungency with minimum fiber content. To get the best quality and high yield of oil, it should be extracted from freshly dried ginger chips of the best variety of fresh ginger as ginger on storing generally loses of essential oil and is attacked easily by insects. Dried ginger has to be ground to suitable partical size with any suitable pulverizer such as hammer mill before the extraction. Grinding the partical too small can rupture the surface. Thin slicing is preferred to avoid grinding. Peels of ginger contribute valuable raw material as they are found to contain 1-3% essential oil.

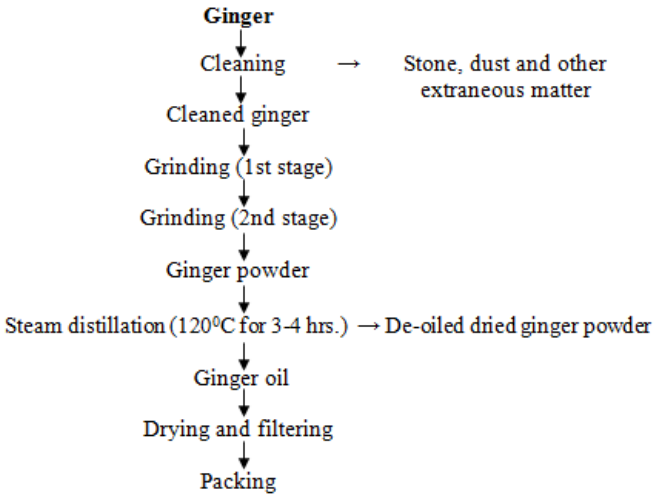
2.2 Methods

The method of extraction of ginger, encapsulation of ginger oil and preparation of ginger beverage implies following three main steps.

1) Extraction of ginger oil
2) encapsulation of ginger oil
3) Preparation of products from Encapsulated ginger oil\

2.2.1 Extraction of ginger oil

Ginger



The ginger used in this research was purchased at the Market. The ginger originated from Indian variety. As in most spices, the ginger has to undergo a series of pre-treatment during sample preparation to ensure maximum yield and quality of the essential oil as mentioned below.

(1) Slicing
(2) Washing and soaking in water
(3) Soaking in lime solution for 15 min
(4) dried until constant mass is achieve

The aim of pre-treatment process was to reduce enzymatic activity in ginger, the ginger sample was dried. It is in this drying period that the sample was weighed twice a day until it was dried. The dried ginger at this stage had reached its constant weight.

Fig 1: Fresh ginger from the market

Fig 2: Sliced ginger

Fig 3: Dried sliced ginger

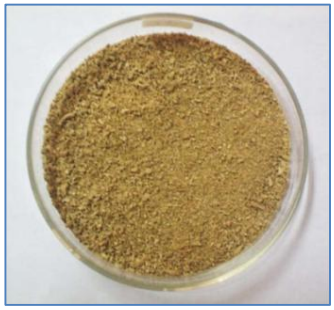


Fig 4: Ground dried ginger

The steam distillation process to extract the essential oil of ginger is slightly different from the steam distillation process. The only difference is that in this process the sample was submerged in water and using dried ginger. The experiment was carried out at atmospheric pressure. The1kg of sample is weighed and put into the still proper without using a basket. Then, 10 liters of distilled water was added into the vessel. The cover was then closed and heated for 4 hours. During the

whole experiment the condensation was going on, condensate content water and ginger oil. The condensate was channeled out in a separating funnel. The condensate was then allowed to settle for a few minutes before the ginger oil was collected. Next, the ginger oil collected was weighed to calculate the yield. Then, the ginger oil was brought back to lab in order to analyze it using a refractometer to get the RI value. The same steps were repeated for each of the sample with different parameters.

2.2.2 Encapsulation of ginger oil

As essential oils were sensitive to heat, so study is aimed to encapsulation of essential oil that allows sensitive ingredients to be physically entrapped in a matrix or "wall" material to protect these ingredients or "core" materials. Food manufacturers are usually concerned about the preservation of aromatic additives, since aroma compounds are not only delicate and volatile, but also very expensive. Encapsulation provides an effective method to protect flavour compounds from evaporation, degradation, and migration from food. Namely, creating a suitable microenvironment around flavours reduce the volatility and/or mobility of the flavour constituents and provides a better retention during the baking process.

Encapsulation of Ginger Oil by using spray drying

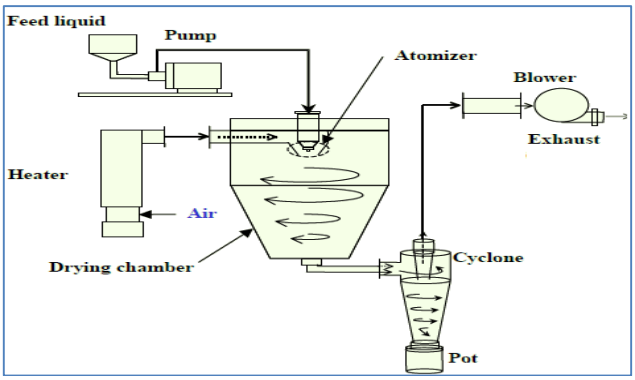


Fig 5: Spray drying

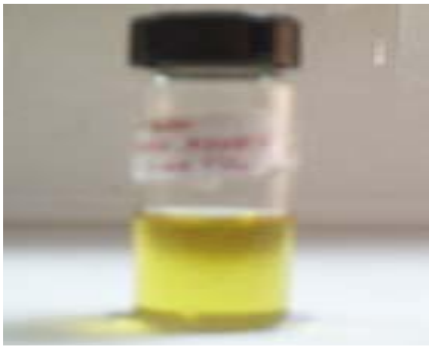


Fig 6: The ginger oil extracted by Steam distillation.

Preparation of Encapsules

Encapsulation of ginger oil was done spray drying method by using Gum Acacia as a carrier. Characterization of the ginger oil was made in accordance with essential oil international standards. These include sensorial characteristics (appearance, color and odor), physical characteristics (specific gravity, refraction index and optical rotation) and chemical characteristics (evaporation residues and carbonilic compounds). The work aimed at optimization of the processing condition for encapsulation of ginger oil by sensory evaluation, & chemical analysis mentioned in Table 1.

Preparation of mixture / slurry for spray drying

Wall materials were prepared by dissolving the desired amount in demonized water at 50ºC stirring overnight to enhance hydration. In a beaker 80 gm of gum acacia was dissolved with 200 ml of distilled water, solution was kept on stirring so that gum acacia get easily dissolved in that solution 20 gm of ginger oil was added and homogenized vigorously (10000 rpm/5min) with an Ultra Turrax M-45 homogenizer at ambient temperature (22°C) for 15 min. The obtained emulsion was maintained under slow agitation during spray drying. Maintain the P^H of the solution around 4.5 -5 and after homogenization of emulsion determine viscosity at 25ºC with Brookfield viscometer than continuous to spray drying.

Table 1: Operating condition for spray drying

Inlet temperature	140-180^0 C
Outlet Temperature	115 – 130 ^{0}C
Rational Speed of atomizer	30, 000 rpm
Feed Flow rate	30 ml/ min
Flow rate of air	110 kg/hr

2.3.3 Preparation of biscuits

Preparation of three different types of biscuit by using spray dried encapsulated ginger oil powder, ginger oil and one without any flavouring compound

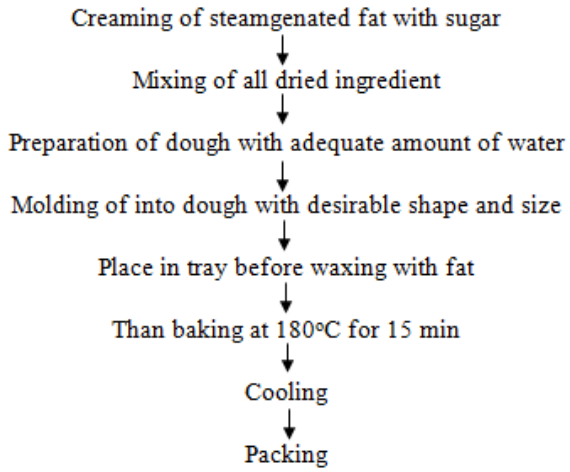


Fig 7: Flow sheet for preparation of biscuits

3. Result and Discussion

3.1 Chemical Composition Ginger and Oil: The ginger rhizome contains steam volatile oil, fixed fatty oil, pungent compounds, resins, proteins, cellulose, pentosans, starch and mineral elements. The composition of these components varies with type of cultivar, region, agro climatic conditions, maturity and nature of rhizome, i.e. fresh or processed shown in Table 2.

Table 2: Composition of Dried Ginger rhizomes

No.	Component	Percent
1	Moisture	10.85
2	volatile oil	1.0-3.3
3	Oleoresin	6.5
4	Starch	53
5	Fibre	7.17
6	Protein	12.4
7	Ash	6.64

3.2 Proximate Analysis of Ginger: The proximate analysis of ginger is completed with the help of particulars like

moisture content, ash, protein, fiber, oleoresin and starch and shown in Table 3. Oleoresin content of ginger was found to be 6.5% which is use as a flavouring compound in various product applications.

Table 3: Proximate Analysis of Ginger

No.	Particulars	Result (%)
1	Moisture content	11.85%
2	Ash content	7.92%
3	protein	16.15%
4	Fiber	7.12%
5	Oleoresin	6.50%
6	starch	50.60%

3.3 Physico-chemical Properties of Ginger Oil: The dried ginger was steam distilled according to the method of the literature. After extraction analysis of ginger oil was carried out. Ginger has Pale yellow to brown colour with warm, spicy & pungent attributes of Ginger and other parameter shown in Table 4.

Table 4: Physico-Chemical Properties of ginger oil

No.	Particulars	Value
1	Colour	Pale yellow to brown
2	Odour	A warm, spicy & pungent attributes of Ginger
3	Moisture Content	8.55%.
4	Appearance	Mobile liquid
5	Flash Point° C	57
6	Solubility	Soluble in alcohol (95%)
7	Acid Value	5.15
8	Specific Gravity @ 20° C	0.8680 - 0.8830
9	Refractive Index @ 20°C	1.4850 - 1.4950
10	Non Volatiles	4.00%

3.4 Physical and Chemical Properties of Encapsulated Ginger Oil Powder: The various physico-chemical properties of encapsulated ginger oil powder including flow rate, bulk density, moisture content, average particle size, efficiency of encapsulation an yield efficiency are summarized in Table 5.

Table 5: Physical and Chemical Properties of Encapsulated Ginger Oil Powder

S. No	Physical properties	Inlet temperature of spray drier
		160
1	Angle of repose	72º-34,
2	Flow rate	2.5ml/sec
3	Bulk density	0.52
4	Encapsulation efficiency	94%
5	Moisture content	4.01
6	Encapsulation yield efficiency	95%
7	Average particle size (µm)	41.2

4. Conclusion

The experiments were carried out by Steam distillation to identify the optimum operational conditions that would result in a high recovery of ginger oil. The operational conditions involved were the best sample type, operating pressure and temperature, the ratio of ginger to water, extraction time. The best sample type for the production of ginger oil is ground dried ginger with at least 90 percent of dryness as drying causes the parenchyma cell walls and the oil cells to break. In this case, the ideal operating temperature was 120^0C for 4 hr. The study concern to extraction of ginger oil by steam distillation gives the 2.5 % yield.

Gum acacia was employed as a main coating agent by taking into consideration economic merit. Encapsulated ginger oil powder had good retention properties and encapsulation efficiency is high. If more than 160ºC temperature gingers oil powder losses the retention power and efficiency also reduce their flavour compound. Finally application of extracted encapsulated ginger oil powder in baked product have optimum temperature 180ºC and baking time for 12-15 min. at this condition high flavour retention found.

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