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# Drying of Turmeric Rhizomes and Extraction of Curcumin from Turmeric

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***Abstract:***
*Turmeric is widely used in food, textiles and pharmaceuticals. In this work, different methods for drying of turmeric and extraction of curcumin were evaluated. Drying of turmeric rhizomes using Air dryer and Solar conduction dryer was reviewed. The extraction of curcumin with Solvent extraction and Supercritical fluid extraction and Pressurised liquid extraction was studied.*
***Keywords****: Turmeric; curcumin; drying; extraction.*

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## I. Introduction

Turmeric is obtained from the root of the *Curcuma longa* plant which belongs to the ginger family. The most useful part of this plant is the root containing rhizome. The rhizome has a tough brown skin and deep orange flesh. Traditionally, turmeric has been used as a condiment, textile dye and medicinal purposes.

Turmeric is well-known for its antioxidant properties. The antioxidant properties of turmeric can be attributed to Curcumin. Curcumin is the main colouring substance in Curcuma longa and the two related compounds demethoxycurcumin (DMC) and bisdemethoxycurcumin (BDMC), are altogether known as curcuminoids [1]. Along with curcuminoids, turmeric also contains turmerones i.e. ar-turmerones, α-turmerones and β-turmerones which are responsible for the flavour of turmeric[2].

Fig. 1 gives the structures of Curcumin, DMC and BDMC.

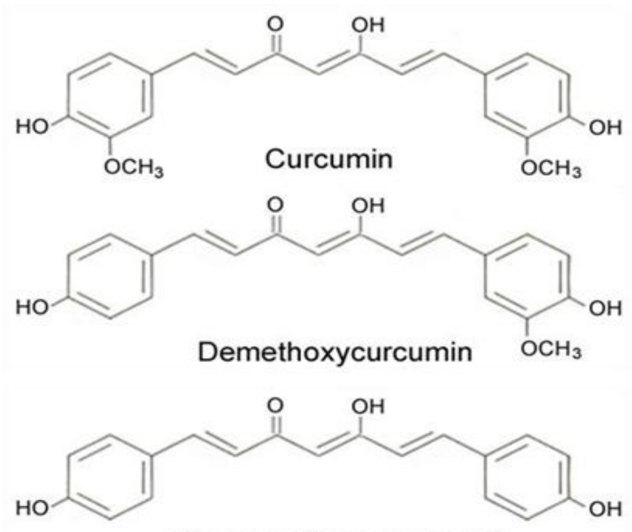


**Figure 1**: Structure of Curcumin, DMC, BDMC

Curcumin is used as a dietary supplement because of its anti-mutagenic, anti-inflammatory and anti-arthritic properties. It is also used as a food colourant. To meet the ever-increasing demand for curcumin, synthetic curcumin is used. Synthetic curcumin, which is produced from petroleum-based products, is not proved to be as beneficial as natural curcumin.

## II. Methodsof drying

### 2.1 Air Drying

Mulet et al. studied the drying kinetics of turmeric rhizomes using an air dryer. In their study, rhizomes with initial moisture content 3.3 ± 0.2 kg water/kg dry mass were dried at 60℃, 70℃, 80℃, 90℃ and 100℃[3]. It was observed that as the temperature increases, the drying time reduces. Moreover, the rate of drying of sliced rhizomes was more than that of whole rhizomes. Their findings are summarized in table no.1.

**Table 1**: Initial and final moisture content of whole rhizomes dried at different temperatures [3]

| Temperature (°C) | Final moisture content (kg water/kg dry mass) | Drying time (h) |
|---|---|---|
| 60 | 0.484 | 6.461 |
| 70 | 0.460 | 5.187 |
| 80 | 0.447 | 3.186 |
| 90 | 0.398 | 2.340 |
| 100 | 0.429 | 1.445 |

### 2.2 Solar Conduction Drying

Borah et al. studied the drying of whole and sliced turmeric rhizomes using a solar conduction dryer (SCD)[4].Their observations are reported in table no. 2.

**Table 2:** Data for rhizomes dried in a SCD [4]

| | |
|---|---|
| **Drying temperature (°C)** | 39 to 51 |
| **Ambient temperature range (°C)** | 25 to 28 |
| **Initial moisture content (%)** | 78.65 |
| **Final moisture content of sliced rhizomes (%)** | 5.5 |
| **Final moisture content of solid rhizomes (%)** | 6.36 |
| **Time required for drying (h)** | 12 |
| **Overall thermal efficiency (%)** | 55 |

## III. Methods of extraction

Curcumin is a yellow-orange crystalline powder. It is a hydrophobic natural phenolic material. It is stable at high temperatures and at acidic pH but, it is unstable in alkaline conditions and in the presence of light.

### 3.1 Solvent extraction

Solvent extraction using Soxhlet apparatus is one of the most popular methodsto obtain essential oils from parts of a plant. Recently we have studied solvent extraction for the extraction of essential oils from ambrette seeds[5].Solvent extraction is a competent method for the extraction of curcumin from turmeric.

Fig. 2 gives a schematic for the extraction procedure. Here, turmeric rhizomes are dried, powdered and extracted with an organic solvent. The solvent is further evaporated to yield the oleoresins. The composition of the oleoresins depends on the solvent used.

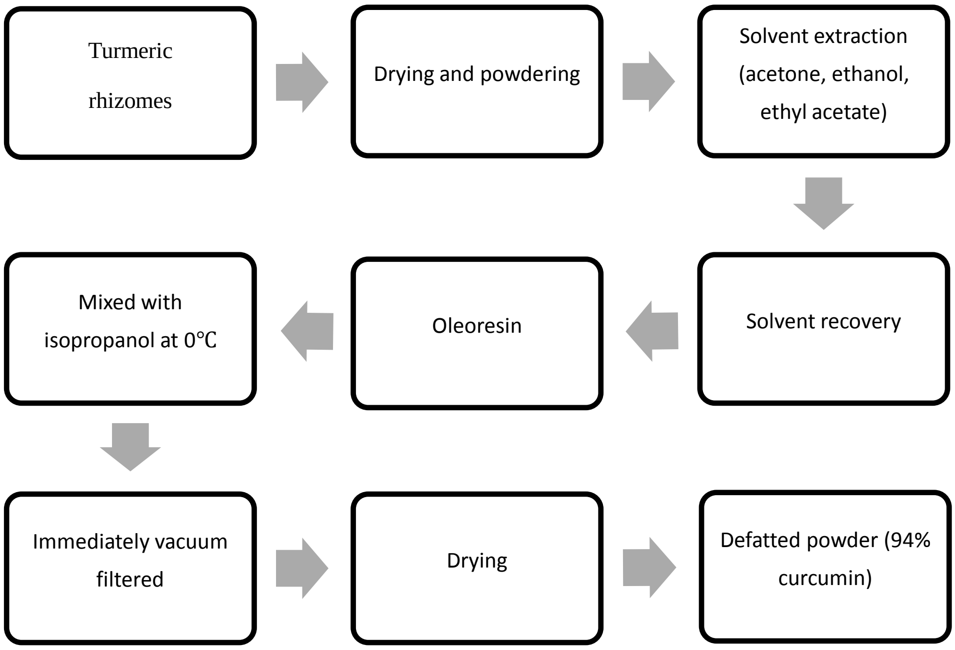


**Figure 2:** Solvent extraction procedure as suggested by Verghese[6]

For the isolation of curcumin from oleoresins Verghese[6] suggested that the powdered turmeric can be first extracted with either acetone, ethanol, ethyl acetate or chloroform to obtain the oleoresin. He further followed the extraction by mixing of the oleoresins with equal quantities of isopropanol at 0℃ and vacuum filtration. The defatted powder obtained by the drying of the filtrate was reported to contain 94 % of curcumin[6].

#### 3.1.1 Selection of solvent

Kulkarni et al. [1] reported that oleoresins extracted by using either acetone, methanol, chloroform or ethyl acetate contain 4 to 6% of curcuminoids.[1] Carolina et al. [2] reported petroleum ether to be a good solvent for the extraction of essential oils [2]. Table no. 3 gives the properties of solvents.

**Table 3**:Properties of solvents

| Solvent | Solvent formula | Polar/Non-polar | Relative polarity[7] | Boiling point (°C) [7] |
|---|---|---|---|---|
| Pentane | $C_5H_{12}$ | Non-polar | 0.009 | 36.1 |
| Hexane | $C_6H_{14}$ | Non-polar | 0.009 | 69 |
| Pet ether | Mixture of pentane and hexane | Non-polar | 0.009 | 42-62 |
| Ethyl acetate | $C_4H_8O_2$ | Polar aprotic | 0.228 | 77 |
| Chloroform | $CHCl_3$ | Slightly polar | 0.259 | 61.2 |
| Acetone | $(CH_3)_2CO$ | Polar aprotic | 0.355 | 56.2 |
| Ethanol | $C_2H_5OH$ | Polar protic | 0.654 | 78.5 |
| Methanol | $CH_3OH$ | Polar protic | 0.762 | 64.6 |

Since curcuminoids are polar, polar solvents are preferred for the extraction of curcuminoids. Whereas, non-polar solvents are better for the extraction of essential oils due to the non-polar nature of turmerones. From the above table, we can conclude that methanol, ethanol, acetone, chloroform and ethyl acetate are good solvents for the extraction of curcuminoids. But chloroform is not preferred due to its toxicity. Pentane, hexane and pet ether are good solvents for the extraction of turmerones.

### 3.2 Supercritical Fluid Extraction (SFE) and Pressurized Fluid Extraction (PLE)

A schematic representation of the procedure of SFE and PLE is shown in fig. 3.

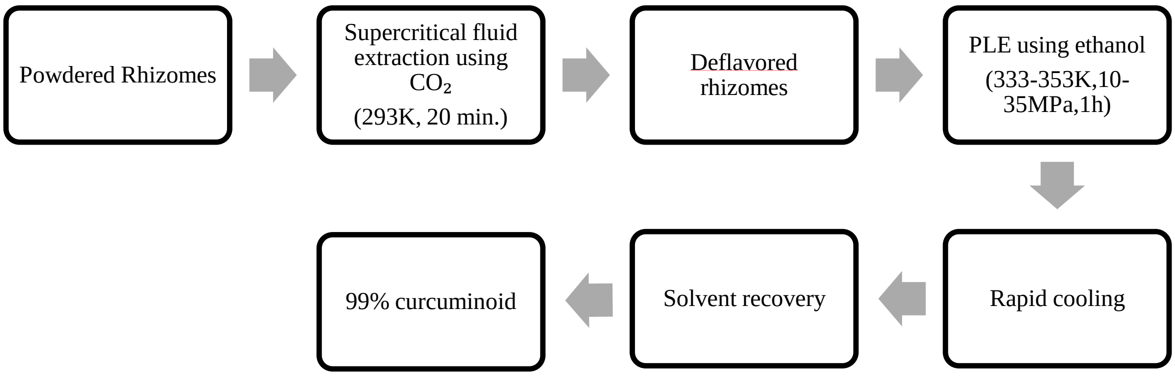


**Figure 3**: Procedure for SFE & PLE [7]

Osrio-Tobón et al. [8] suggested an integrated process for the extraction of curcuminoids. They reported the following procedure; first, powdered rhizomes were deflavoured using supercritical $CO_2$: 99.9% purity $CO_2$ at 263K was passed through the bed of powdered rhizomes for 20 mins. Supercritical $CO_2$ is very efficient for removing the volatile oils i.e. turmerones[9][10]. They further followed the SFE with PLE of the deflavoured rhizomes using ethanol (99.5% purity) as a solvent and at temperature of 333 to 353 K and pressure of 10 to 35 MPa for 60 mins. The extract obtained after PLE was rapidly cooled and the solvent was evaporated using a rotary evaporator.

At a temperature of 333K and 10 MPa, the yield and curcuminoid content were reported as 99% and 39% respectively[8].

## IV. Conclusion

It is observed that solar conduction drying is a more energy-efficient process for the drying of turmeric rhizomes, but the drying time is much higher than that of air drying. It is concluded that SFE and PLE is preferred to solvent extraction because it requires less time as compared to solvent extraction (80 mins vs 6h). However, solvent extraction requires equipment of less complexity as compared to SFE and PLE.

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## Glossary

| | |
|---|---|
| DMC | demethoxycurcumin |
| BDMC | bisdemethoxycurcumin |
| SCD | Solar conduction dryer |
| SFE | Supercritical Fluid Extraction |
| PLE | Pressurized Fluid Extraction |

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