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Extraction of Curcumin From Turmeric Roots

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Abstract: The title of this artical is entitled as "*Curcumin Extraction from Turmeric Roots*". It is a research project taken from *indo NACOP CHEMICALS ltd.*, a herbal and natural colour manufacturing company. It is situated at Vinukonda, AP, India.

Turmeric, curcuma longa L of Zingiberaceae family is a widely cultivated spice in India and other Asian countries. Curcumin is the main coloring substance in Curcuma longa and two related compounds, demethoxycurcumin and bisdemethoxycurcumin are altogether known as curcuminoid Turmeric is rich in curcuminoids, and recognized for their broad spectrum of biological activities, curcuminoids vary in chemical structures, physico-chemical characteristics as well as the functional properties.

Curcumin extracted from turmeric (Curcuma longa L.,Zingaberaceae) root was found to be anti-angiogenic in a human tissue-based angiogenesis. As a liposoluble compound, curcumin can be extracted from turmeric root with organic solvents such as ethanol or acetone. Curcumin in its pure form has poor solubility in water, potentially limiting its medicinal use for humans when it is taken orally or injected. Experiments were undertaken to determine the extraction weight of different solvents for curcumin and optimum parameters and best solvent which gives high yield.

Keywords: *Turmeric root, Extraction, Acetone, Optimum yield*

1. Introduction:

Turmeric is the native of tropical South Asia. It needs temperatures between 20º C and 30º C and a considerable amount of annual rainfall to thrive. As a dried rhizome of an herbaceous plant, turmeric is closely related to ginger. The spice is also sometimes called "Indian saffron" thanks to its yellow color. Turmeric is a spice that comes from the root Curcumalonga L., a member of the ginger family (Zingaberaceae). Its bright yellow pigment is used as a food coloring agent. It has been used for centuries as a spice and a food preservative, and for its various medicinal properties.[1]

The extract of turmeric has many medicinal properties including antioxidant anti-inflammatory, antiviral, antibacterial, antifungal, and cancer chemopreventive actions. Curcumin, a yellow compound isolated from its rhizome, may be responsible for the bioactive effects. Recent research shows that curcumin may inhibit carcinogenesis and angiogenesis. They may have a potential to improve chronic inflammatory conditions in obesity. Curcumin is a liposoluble compound and can be easily dissolved into organic solvent such as methanol, ethanol, and acetone. However, poor water solubility often limits its biomedical uses using aqueous systems. This observation prompted us to examine turmeric extracts as a delivery system for curcumin and to examine the possibility of turmeric extract itself as candidate agent for pharmacologic evaluation. In this preliminary study, we used different solvents to extract the crude turmeric material and compared the curcumin concentrations in these extracts[2].

Curcumin's basic coloring substance in Curcuma longa and two related compounds, demethoxycurcumin (DMC) and bisdemethoxycurcumin (BDMC), are altogether known as curcuminoid. The chemical structures of three curcuminoids are shown below.

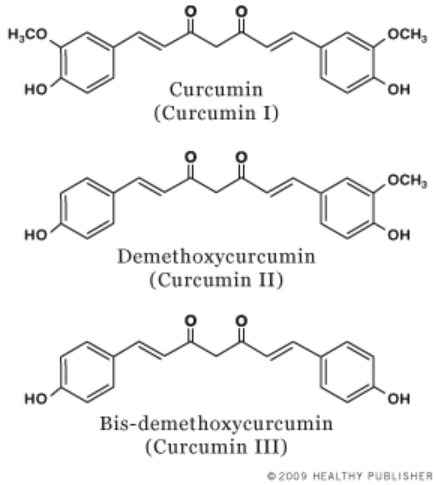

Figure 1

The total of curcuminoids which is about 4-6%, turmeric also contains 2-4% essential oil and 2-3% of fixed oil and various volatile oils, including turmerone, atlantone, and zingiberone. Other constituents include sugars,proteins and resins.

The choice of solvents for extraction is restricted to the few solvents of defined purity allowed by national and international food laws in the processing of food materials. Hexane,acetone, alcohol (ethanol, methanol), isopropanol and ethyl acetate are used in the extraction of oleoresins of spices. From consideration of solubility of active constituents, the curcuminoids are poorly soluble in the hydrocarbon solvents. Alcohol and acetone are good extractants and the yields can also be expected to be high because of extraction of non-flavor components. Soxhlet extraction of turmeric powder with acetone gave a yield of about 4.1% containing in 3 hours. Acetone as solvent was slightly superior to alcohol and ethyl acetate, the curcuminoids content also is on the high side, suggesting selective extraction. The results of extraction with acetone have, however been reported to give high yields of curcuminoids than alcoholic and remaining extraction.

2. Experimental Procedure:

Raw Material:

Curcuma longa (Turmeric) rhizome were collected from narayana brand variety consisting of 6% of curcumin.

Solvents: Solvents used are of AR / HPLC grade and obtained from E-Merck.

Process: The extraction requires the turmeric roots to be ground into powder by using mortar. After that it is air dried to remove the moisture present in the feed or ground powder, and then a known amount of turmeric powder say 10 grams is weighed accurately and then it is washed or treated with suitable solvent like acetone, ethanol etc., in the extraction column to extract the solute or curcumin present in the turmeric powder for a desired time. And then distillation is performed to separate the mixture of solvent and solute. It is performed just by heating the mixture up to the boiling point of either solvent or solute here we heat up to the boiling point of solvent because it is having low boiling point when compared to solute. The oleoresin so obtained is subjected to further washes using selective solvents. Here we use hexane as a solvent because it has high absorption coefficient. After washing has performed it

leaves out a powdered, purified food colour known as curcumin powder[3]. For information flow sheet see **fig.2**

Information Flow Sheet:

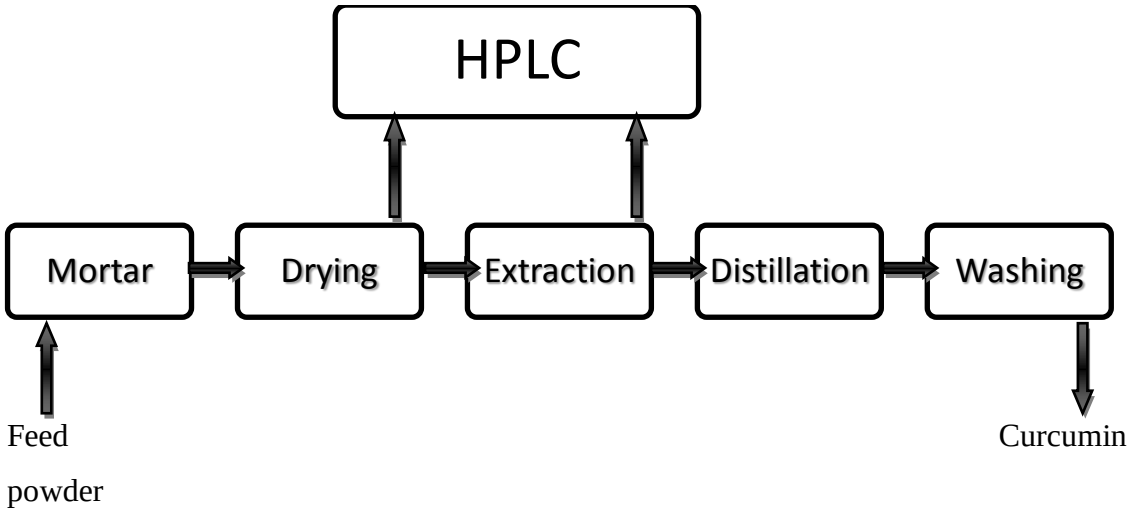

Figure 2

Operating Parameters:

- ✓ Feed size
- ✓ Temperature
- ✓ Solid to solvent ratio
- ✓ Time
- ✓ Solvents

Feed size*:*

Feed is taken in a size 100% passing through 80 mesh screen. Size of particle is taken in such way that the time taken for curcumin extraction reduces as the surface area increases. We should not go for ultra fine particles because it becomes uneconomical.

Temperature:

Process is conducted at room temperature (30^0C).

Solid To Solvent Ratio*:*

Solvent to solid ratio is maintained at 1:8.

Solvents:

Different solvents which can extract the solute in the feed are taken and then for each solvent experiment are done. Among these solvents the best suitable one is taken and the optimum condition is derived from that solvent.

Time:

Experiment is performed at different times i.e. from 1 to 4 hour.

3. Results And Discussions:

Analysis of Curcumin*:*

- ✓ The obtained product is having yellow colour.
- ✓ It is insoluble with water.
- ✓ 2 ml of curcumin turns red when 2 ml of sulfuric acid is added and stirred.
- ✓ A piece of filter paper is wetted with curcumin and dried. A few drops (2 to 3 drops) of hydrochloric acid, followed by a few drops (2 to 3 drops) of boric acid solution are dropped onto the piece of filter paper. Upon drying by heating, it turns cherry red. When a few drops (2 to 3 drops) of ammonia solution is added, it turns blue.

  The above Results show that the product obtained is curcumin.

Different Solvents:

See table-1 for different solvents cost, boiling point, weight of curcumin extracted for 1hour

Solvent	Boling pint (^{0}C)	Cost (Rs for 500ml)	Weight of curcumin extracted for 1hour (gm)
Acetone	56.48	185	0.24
Ethyl acetate	77.10	220	0.23
Ethanol	78.32	260	0.26
Methanol	64.80	250	0.25
Isopropanol	80.30	230	0.217

Table1: Different solvents cost, boiling point, weight of curcumin extracted for 1hour

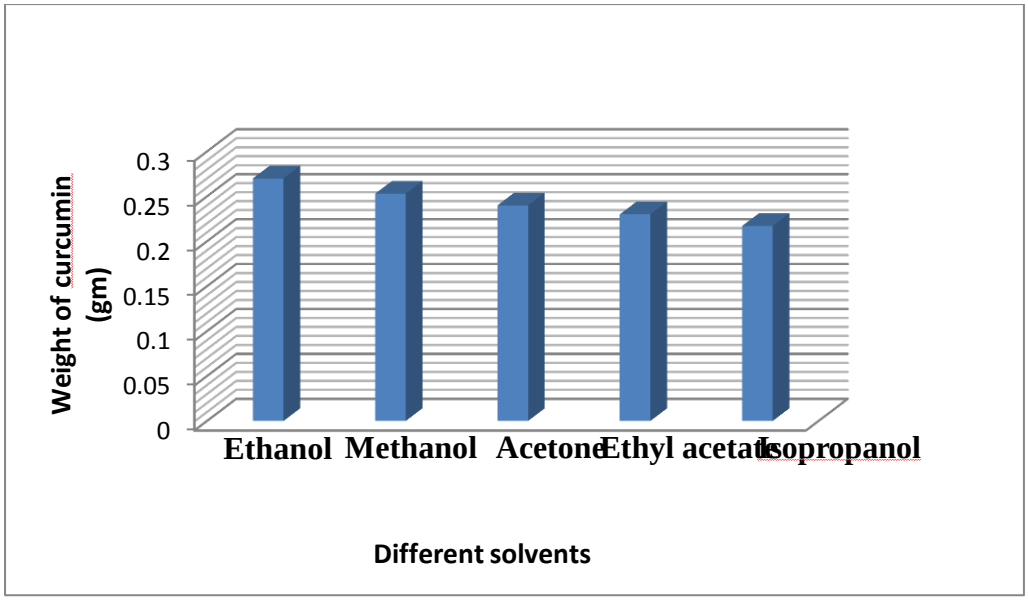

Figure 3: Weight of curcumin Vs solvent for 1 hr

Fig-3 shows weight of curcumin extracted with different solvents like acetone, ethanol etc for an extraction time of 1hour.

The weight of curcumin extracted with ethanol and methanol is high but they are having high solubility with curcumin or solute so that makes it becomes difficult for us to separate both solvent and solute and the boiling point and cost of both the solvents are high and both the solvents are banned due to danger for living organisms[5].

The weight of curcumin extracted with isopropanol is low and both cost and boiling point of isopropanol are very high.

Ethyl acetate, this is having high boiling point and the cost is low but weight of curcumin extracted is also low.

So, we are choosing acetone as the best suitable solvent for extracting curcumin from turmeric roots due to its low cost and low boiling point and a little less than high weight of curcumin extracted by using ethanol.

Hexane:

Here first the solid bed is treated with hexane for removing volatile oils and oleoresin from the feed or solid bed and after that the solid bed or feed is again treated with solvent like

acetone, methanol etc. for extracting the solute or curcumin present in it. By doing so solute extracted does not contain any oleoresin, volatile oils and there is no washing to be done for the solute obtained by this way because all impurities or volatile oils, oleoresin are extracted before by treating with hexane.

The product or curcumin obtained in this way is similar to curcumin obtained in other ways. For Hexane boiling point, cost, and weight of curcumin extracted for 1hour see table-2.

Solvent	**Boiling point(^{0}C)**	**Cost (Rs for 500ml)**	**Weight of curcumin extracted for 1 hour (gm)**
Hexane	98.4	850	0.24(with acetone)

Table 2: Hexane boiling point, cost, and weight of curcumin extracted for 1hour

This process is uneconomical because hexane is having high cost and single bed of solid is treated two times (more than 1hour) with solvent for extracting curcumin.

***Acetone**:*

This is having low boiling point and also low cost when compared with other solvents. The weight of curcumin obtained is little less than high . Table.3 indicates the weight of curcumin extracted with respect to time.

Time (hr)	**Weight of Curcumin (gm)**
1	0.24
2	0.35
3	0.41
4	0.41

Table 3: weight of curcumin extracted with respect to time

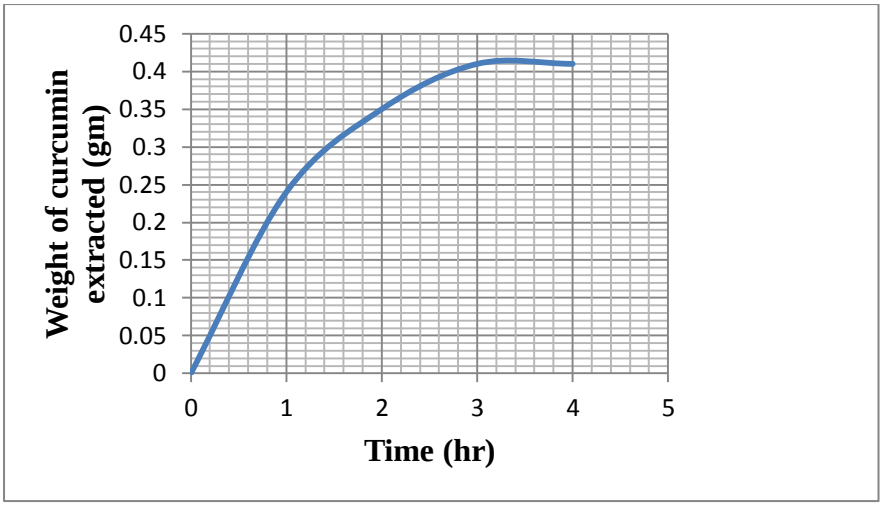

Figure 4: Weight of curcumin extracted Vs time

Graphical representation is also showed in **fig.4**.The graph shows the weight of curcumin extracted with respect to time. Intially the weight of curcumin extracted is zero at time zero and it increases linearly with time and gets saturated after 3hours i.e, the weight of curcumin extracted with respect to time is constant. Hence we can say that 3hours is the optimum time for the curcumin extraction by using acetone.

4. Calculations:

Time: ***For 1Hour:***

Basis: 10gms

Before extraction:

Quantity of curcumin in feed bed = 6%

Weight of solid cake = 94%

After extraction:

quantity of curcumin in feed bed =3.6%

weight of solid cake = 96.4%

Quantity of dry solid cake = (94/96.4)*100

= 97.51%

Percentage of curcumin in cake = 97.51*0.036

= 3.51%

Percentage of curcumin extracted = ((6- 3.51)/6)*100

=41.494%

Similarly for 2hrs,3hrs,4hrs are calculated. The following table indicates the percentage of curcumin extracted with time.

Time (hr)	Percentage extracted(%)
1	41.5
2	59.834
3	69.67
4	69.67

Table 4 :Percentage of curcumin extracted with time

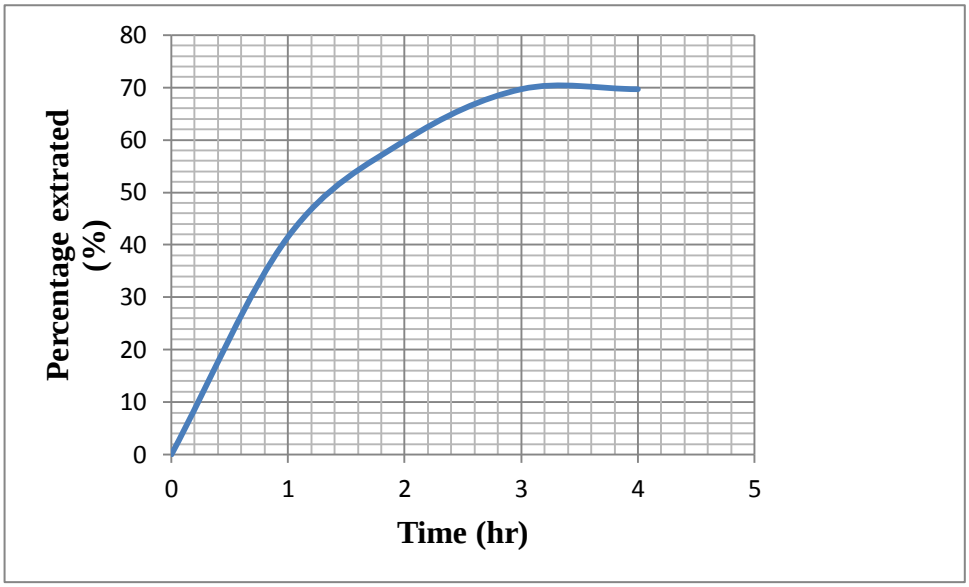

Figure 5 : percentage of curcumin extracted Vs time

Fig.5 also shows the percentage of curcumin extracted Vs time .By the results obtained for different times show that 3 hours of extraction time is considered as the optimun time or the maximum yield time for curcumin extraction from turmeric roots.

5. Conclusion:

The obtained results have shown that different solvents potential of extracting curcumin. Good yield is exhibited by the acetone. There is need for proper knowledge, documentation and assessment of curcumin yielding plants as well as the extraction techniques so as to increase the use of curcumin. There is a lot of scope to use the turmeric roots for extracting curcumin using safe solvents under eco-friendly.

Some of chemical based anti-oxident etc., have the potential to damage the nervous system and kidneys and can even stunt the physical and mental growth of children. Curcumin powder is mainly used in the food industry. They are also employed in other industrial products such as cosmetics, pharmaceuticals, and textiles[7].

In the curcumin extraction from turmeric roots we found that ethanol, methanol, ethyl acetate, isopropanol, hexane not satisfactory as solvents and a best extraction was carried out using acetone.

From the results obtained, we conclude that,

Optimum time : 3 hours

Optimum yield (%) : 69.67%

Optimum solvent : acetone

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