# To Enhance the Solubility of Turmeric

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***Abstract:*** **Turmeric is a strong-taste component of spices characteristic of Indian cuisine. It is obtained from the turmeric rhizome (Curcumae longae rhizoma) and has been used for thousands of years not only for culinary purposes, but also for medicinal purposes. It contains a group of organic compounds called curcuminoids. Curcumin is the main representative of this group of compounds which is also most frequently studied. In recent years, bioactive curcuminoids (including curcumin in the first place) have become more and more popular due to a wide spectrum of their biological activity. The anticancer, antibacterial, anti-inflammatory, and antiaging effects of curcumin have been confirmed by numerous in vitro and in vivo studies, as well as in clinical trials. However, an obstacle to simple, clinical application of curcumin is its poor bioavailability (which is due to its hydrophobic nature) and its very weak water solubility. Therefore, many scientists are working on improving the solubility of curcumin in water, which is the topic of the present article. Attempts have been made to combine curcumin with nanoparticles (polysaccharide or silica). Nanosuspensions or complexes with cyclodextrins are also considered. A promising direction is the search for new polymorphic varieties as well as obtaining cocrystals with curcumin which are characterized by better water solubility.**

***Keywords:*** **curcumin; solubility; bioavailability; nanoparticles; cocrystals**

## INTRODUCTION

Curcumin (CUR) [1, 7-bis (4-hydroxy-3-methoxyphenyl)-1, 6-heptadiene-3, 5-dione] is a naturally occurring hydrophobic polyphenol extracted from the plants of the Curcuma longa, its structure was showed.

It has variety of biological activities and pharmacological actions, such as anticancer, antiviral, antiarthritic, antiamyloid, antioxidant and anti-inflammatory properties. In spite of these wide span of activities of CUR, its therapeutic efficiency has been highly limited due to poor solubility in water (the maximum solubility was reported to be 11 ng/ml in plain aqueous buffer pH 5.0). Low bioavailability of CUR after oral delivery in addition to poor aqueous solubility, is attributed to high pre-systemic metabolism in gastrointestinal tract (GIT), degradation in GIT at neutral and alkaline pH, rapid systemic metabolism to sulfate and glucuronide conjugates.

Leading to short half-life.

Curcuminoids are a group of organic compounds which are responsible for the yellow color of curcumin—a spice characteristic of Indian cuisine and obtained from the turmeric rhizome (Curcumae longae rhizoma). Curcumin is the main and at the same time best known and studied compound of this group. Curcumin is a dimeric derivative of ferulic acid (Figure 1). Some of its effects include the choleretic and anti-inflammatory effects.

1.1.8 Chemical constituents –

Medicinal plants have provided a reliable source for preparation of new drugs as well as combating diseases, from the dawn of civilization. The extensive survey of the literature revealed that Curcuma turmeric is highly regarded as universal panacea in the herbal medicine with a wide spectrum of pharmacological acidities.

| | |
|---|---|
| Curcumin | 3.1-3.4 % |
| Anthocyannins | 18.9-37.0 g/g |
| Phenols | 0.15-0.62 % |
| Tannins | 0.32- 0.76 % |
| Protein content | 3.6-6.8 % |
| Sugars | 20.5-43.4 % |
| Oil | 3.7-5.3 % |
| Ash | 6.9-9.8 % |
| Moisture | 90.2-91.3 % |

Table1: Biochemical content in dried turmeric rhizomes.

Alzheimer's disease and other chronic and hard curable diseases. Several studies have shown the antioxidant and antimicrobial properties of Turmeric essential oils. Since ancient times, turmeric has been used as a traditional medicine and for beauty care.

1.1.10 Medicinal uses of turmeric –

1.1.10.1 Cancer –

There has been a great deal of research on turmeric's anticancer properties, but results are still very early.

Cancer should be treated with conventional medications. A lot of studies have shown that curcumin can be very beneficial in the treatment of cancer using herbs. It can influence the growth, development and spread of cancer cells at a molecular level. Cucumin acts as a potent anticarcinogenic compound. , induction of apoptosis plays an Important role in its anticarcinogenic effects. Curcumininduces Apoptosis and inhibits cell-cycle progression, both of which are instrumental in preventing cancerous cell growth in rat Aortic smooth muscle cells. Colon Carcinoma is also prevented by curcumin through arrest of Cell-cycle progression independent of inhibition of Prostaglandin synthesis. Curcumin suppresses human breast Carcinoma through multiple pathways. Curcumin also Produces nonselective inhibition of proliferation in several Leukaemia, nontransformed haematopoietic progenitor cells and fibroblast cell lines.

1.1.10.2 Increase the antioxidants in body –

Oxidative damage is one of the mechanisms which are responsible for aging and many kind of disease. The free radicals involved in this mechanism react highly with organic substance in our body which can couse harm.

Curcumin doesn't only block the free radicals: it also stimulates the Antioxidant mechanism in our body. This is probably one of the best benefits of turmeric for our body. The antioxidant activity of cucurmin was reported as Early as 1975. It acts as a scavenger of oxygen free radicals. It can protect haemoglobin from oxidation. Curcumin also lowers the production of ROS in Vivo.

This is brought about by maintaining the activities of Antioxidant enzymes like superoxide dismutase, catalase and Glutathione peroxidise.

1.1.10.3 Heart Disease -

Keeping healthy cholesterol level is essential to pevent cardiovascular isssues and other serious health problem.

High Cholesterol level can very detrimental to one's health, so people are always looking for ways to lower them. Studies have shown and proven that the simple act of adding turmeric to season your food can significantly lower blood cholesterol levels. Early studies suggested that turmeric may help prevent Atherosclerosis, the build up of plaque that can block arteries and lead to heart attack or stroke. In animal studies, an extract of turmeric lowered cholesterol levels and kept LDL "bad" cholesterol from building up in blood vessels.

1.1.10.4 Indigestion –

Curcumin stimulates the gallbladder to produce bile, which Some people think may help improve digestion. The German Commission E, which determines which herbs can be safely prescribed in Germany, has approved turmeric for digestive problems. And one double-blind, placebo-controlled study found that turmeric reduced symptoms of bloating and gas in people suffering from indigestion. Turmeric powder has beneficial effect on the stomach. It increases mucin secretion in rabbits and may thus act as gastro protectant against irritants. However, controversy exists regarding antiulcer activity of curcumin. Both antiulcer and ulcerogeniceffects of Curcumin have been reported but detailed studies are still lacking.

1.1.10.5 Liver Diseases–

Turmeric is beneficial for its influence on the liver. In spring more consumption of herbs and Foods can strengthen the liver. Turmeric shares similar liver protectant compounds that milk Thistle and artichoke leaves contain. It is said to shrink engorged hepatic ducts, so it can be useful To treat liver conditions such as hepatitis, cirrhosis, and jaundice.

1.1.10.6 Osteoarthritis –

Turmeric may help relieve the symptoms of osteoarthritis because of its ability to reduce pain And disability.

1.1.11 Application –

1.1.11.1 Application of turmeric in dental problem –

Turmeric can be used in following ways offer relief from dental problems: Rinsing the mouth with turmeric water (boil 5 g of turmeric powder, two cloves, and two dried Leaves of guava in 200 g water) gives instant relief. Massaging the aching teeth with roasted, ground turmeric eliminates pain and swelling. Applying the powder of burnt turmeric

pieces and bishop's weed seed on teeth and cleaning.Them makes the gums and teeth strong.

1.1.11.2 Food Additive –
Turmeric is a mild aromatic stimulant used in the manufacture of curry powders. Turmeric is used in products that are packaged to protect them from sunlight. The oleoresin component of turmeric is used for oilcontaining products. The curcumin solution or curcumin powder dissolved in alcohol is used for water. Containing products. Sometimes in pickles and mustard, turmeric is used to compensate for fading. Turmeric is also used for coloring cheeses, salad dressings, margarine, yogurts, cakes, Biscuits, popcorn, cereals, sauces, etc. Turmeric also forms a substitute for mustard in the cattle feed.

1.1.11.3 Cosmetics -
The juice of raw turmeric is applied to the skin as a paste, kept for around thirty minutes and then washed off. It adds glow to the skin. It is an essential ingredient of the traditional bathing ritual of Indian marriages where it is Applied along with sandal wood paste before the bath.

1.1.12 Side effects –
If you are currently being treated with any of the following medications, you should not use Turmeric or curcumin in medicinal forms without first talking to your health care provider.
1.1.12.1 Antiplatelet and anticoagulant drugs (bloodthinners) –
Turmeric may affect the blood's ability to clot, and could interfere with any blood-thinning drugs you are taking, including:

- Warfarin (Coumadin)
- Clopidogrel (Plavix)
- Aspirin

1.1.12.2 Drugs that reduce stomach acid –
Turmeric may interfere with the action of these drugs, Increasing the production of stomach acid:

- Cimetidine (Tagamet)
- Famotidine (Pepcid)

1.1.12.3 Drugs for diabetes (that lower blood sugar) –
Turmeric may increase the effects of these drugs, Increasing the risk of hypoglycemia (low blood sugar).
1.2 Thymol:
Thymol (2-isopropyl-5-methylphenol) belongs to the phenolic monoterpenes and mostly occurs in thyme species. It is one of the main compounds of thyme essential oil. Both thymol and Thyme essential oil have long been used in traditional medicine as expectorant, anti-inflammatory, antiviral, antibacterial, and antiseptic agents, mainly in the treatment of the upper respiratory system.
1.2.1 Synonyms - Thyme camphor, phenol.
1.2.2 Biological Source - Thymol is a naturally occurring phenol monoterpene derivative of cymene and isomer of carvacrol.

1.2.3 Family - Lamiaceae.
The current search for new directions of biological or therapeutic activities of natural plant substances With known structures includes thyme essential oil and thymol. Novel studies have demonstrated Their antibiofilm, antifungal, antileishmanial, antiviral, and anticancer properties. Also, their new Therapeutic formulations, such as nanocapsules containing these constituents, can be beneficial in Medicinal practice and create opportunities for their extensive use. Extensive application of thymol And thyme essential oil in the healthcare sector is very promising but requires further research And analysis. The genus Thymus from the Lamiaceae family contains many representatives. These plants, Originating from the Mediterranean area, are commonly used for food, cosmetic, and medicinal Purposes. A thyme herb obtained from Thymus vulgaris L. And Thymus zygis L. Is the most well-known Herbal substance in the pharmaceutical industry. Nowadays, only standardized preparations of thyme Herb and essential oil that meet the requirements of national pharmacopeias or European Pharmacopoeia X (Ph. Eur. X) are used for the production of medicines. Thyme EO compounds belong to various chemical groups including monoterpenes, monoterpene Alcohols, phenol derivatives, ketones, aldehydes, ethers, and esters. There are also numerous Chemotypes within the T. Vulgaris species, differing in the main component of EO, but only "thymol Type" with thymol as the main constituent is listed in the European Pharmacopoeia. The main Components of thyme EO are the isomeric phenolic monoterpenes thymol (2-isopropyl-5methylphenol) And carvacrol (2-methyl-5-(propan-2yl) phenol). Both these monoterpenes are biosynthesized by the Hydroxylation of p-cymene after the aromatization of γ-terpinene to p-cymene. The scheme of the Biosynthesis pathway is shown in Figure 1. Thymol is a colorless, crystalline compound with Characteristics including strong odor and solubility

in alcohol and other organic solvents, but it is only slightly soluble in water.

1.2.4 Activity against Microbiological Biofilms
Antibiotic resistance to currently used and frequently overused antibiotics is a growing problem In the pharmacotherapy of bacterial infections. Therefore, it is very important to search for new Substances, including those of natural origin, that can be used to combat pathogens. Bacterial And fungal resistance to antibiotics and disinfectants is related to their ability of bio film production
That prevents the penetration of the antibacterial agent into the site of infection. Bio film is defined as a Group of microorganisms connected by a cell-free polymer matrix composed mainly of polysaccharides, Protein, and DNA.

1.2.5 Antifungal activity:
Cryptococcosis is a systemic mycosis caused by fungi of the genus Cryptococcus, most often byThe species C. Neoformans. In the last decade, the percentage of C. Gattii infections has increased, while infections with Albidus and C. Laurentii species are rare. This pathogen mainly attacks the Respiratory and nervous systems, causing pneumonia or meningitis. This disease mainly affects Immuno compromised patients, especially those with AIDS. Over 223,000 cryptococcal meningitis Cases occur worldwide each year, of which approximately 181,000 are fatal. This infection is Often associated with patient catheterization, artificial heart valves, or dialysis.

1.2.6 Antileishmanial Properties –
Parasitic infections are still a serious health problem, especially in less developed countries, where Poor hygiene, overpopulation, and migration of people from neighboring countries are common Problems.
The development of parasites is also favored by a humid and hot tropical climate. Leishmaniasis is caused by flagellate protozoa of the genus Leishmania. According to the WHO, there are Between seven hundred thousand and one million new cases of this disease annually.

1.2.7 Applications –
1.2.7.1 Antiseptic and disinfectant-
Thymol possesses antimicrobial properties and is commonly used as an ingredient in mouthwashes, toothpastes, and hand sanitizers. It helps to kill bacteria, fungi, and viruses, making it useful for maintaining oral hygiene and preventing the spread of infections.
1.2.7.2 Preservative-
Thymol has been used as a natural preservative for food and beverages. It can inhibit the growth of bacteria and fungi, helping to extend the shelf life of perishable products.

1.2.7.3 Pest control-
Thymol is an active ingredient in some insecticides and pesticides. It can repel and kill insects, including mosquitoes, ants, and ticks. It is also used in beehives to control varroa mites, a common pest of honeybees.

1.2.8 Side effects –
1.2.8.1 Skin irritation-
Thymol can cause skin irritation, especially when applied in high concentrations or on sensitive skin. It may cause redness, itching, or a burning sensation.
If you experience any skin reactions, it is recommended to discontinue use and consult a healthcare professional.
1.2.8.2 Mucous membrane irritation-
Thymol can also irritate mucous membranes, such as the mouth, throat, and eyes. In some cases, it may cause a burning or stinging sensation. If you are using products containing thymol, such as mouthwashes or gargles, and you experience discomfort or irritation, it is advisable to discontinue use and seek medical advice.
1.2.8.3 Allergic reactions-
Although rare, some individuals may be allergic to thymol. Allergic reactions can vary in severity and may include symptoms such as rash, hives, itching, swelling, or difficulty breathing. If you experience any signs of an allergic reaction after using products containing thymol, it is crucial to seek immediate medical attention.
1.2.8.4 Gastrointestinal issues- Ingesting large amounts of thymol can potentially lead to gastrointestinal problems such as nausea, vomiting, diarrhea, or stomach pain. It is important to follow the recommended dosage and use of thymol-containing products to avoid such issues.

## LITERATURE OF REVIEW

Development and validation of UV SpectrophotometricMethod For the estimation of Curcumin in cream formulation- We have taken calibration curve from this paper.
Turmeric - A Herbal and Traditional Medicine – from this paper we taken the biological source of turmeric

and chemical constituents present in turmeric. We also taken cultivation, microscopy and characteristics of turmeric.

Medicinal properties of turmeric (Curcuma longa L.) from this paper we taken the medicinal properties and uses of turmeric. We taken the various applications of turmeric, side effects and health benefits of turmeric in daily life.

Thymol and Thyme Essential Oil—

New Insights into Selected Therapeutic Applications From this paper we taken the information about the thymol. Information about The biological source, it's properties and various applications of thyomol. We also taken the various uses of Thymol form this paper.

## NEED OF WORK

- To over the solubility problem of turmeric.
- It's worth noting that the choice of method for enhancing solubility depends on the specific requirements and applications of turmeric or curcumin.

## AIM & OBJECTIVES

Aim –

• Enhance the solubility of Turmeric.

Objectives –

- To increase the solubility of turmeric.
- Identify suitable solvents or solvent systems that can effectively solubilize turmeric and its active compounds.
- Enabling the development of more effective formulations and delivery systems for various applications, including pharmaceuticals,
- nutraceuticals, and functional foods.

| Author Name of Publication | Year of Publication | Abstract Of Publication |
|---|---|---|
| .Govindarajan, V.S | 13 September 2010 | Turmeric is a minor spice in the West, but a major one in the East. It is valued by Westerners mainly, on account of its colour, but to the Asians both colour and aroma are equally important. |
| Venkata Subba Rao Kotra, Laishram Satyabhanta And Tridib Kumar Goswami. | 05 Augast 2019 | Turmeric (Curcuma longa) is one of the most important ingredients in Indian and Chinese cuisine. Curcuminoids and volatile oils present in turmeric are known for their functional and nutraceutical properties. |
| Rahul Kumar Verma, PreetiKumari, Rohit Kumar, maurya , vijay Kumar. | 28 June 2018 | Turmeric is an herbaceous evergreen plant in the Zingiberaceae (ginger) family. Turmeric (Curcuma longa) is extensively used as a spice, food preservative and colouring material in India, China and South East Asia. |
| R. Poudle, N.P. Neupane, I. H. Mukeri, S. Alok and A. Verm. | 1 June 2020 | Ageratina adenophora, often known as Crofton Weed, is one of the common invasive weeds which first originated from Mexico and Central America and gradually invaded numerous parts of the world. |
| S Guo, W Jiang, L Shen, G Zhang, Y Gao, Y Yang… | 07 May 2020 | In recent years, attempts to improve the mechanical properties of composites have increased remarkably owing to the inadequate utilization of matrices in demanding technological systems where efficiency, durability, and environmental compatibility are the key requirements. |

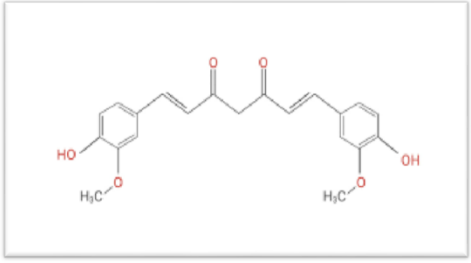
Table 2: Literature of Review Chart

- 5.1Curcumin –

It is a Diarylheptanoid. It is the principal curcumanoid of turmeric, which is a member of the ginger family (Zingeberaceae.).

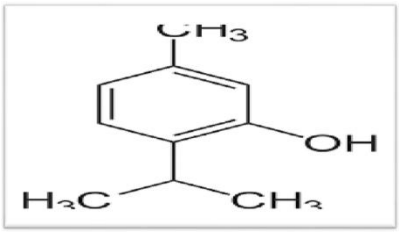
- 5.1.2 Synonyms - Indian saffron
- 5.1.3 Chemical name –
- 1,7-Bis(4-hydroxy-3-methoxyphenyl)-l,6-heptadiene-
- 3,5-dione,

5.1.4 Molecular Structure –



- 5.1.5 Molecular Formula - C21H200g
- 5.1.6 Molecular Weight - 368.39
- 5.1.7 Melting point - 183 ◦C (361 F;456 K)
- 5.1.8 Solubility profile - Curcumin is soluble in oil, and alkali, practically insoluble in water, acidic and neutral pH.

5.2.2 Synonyms – Thyme camphor, phenol. 5.2.3 Chemical name – 2-isopropyl-5-methylphenol
5.2.4 Molecular Structure –




5.2.5 Molecular Formula – C10H14O
5.2.6 Molecular Weight – 150.22 g/mol
5.2.7 Melting point – 232 °C
5.2.8 Solubility profile - From other reliable sources & authoritative databases it is concluded that water solubility of thymol is 980 mg/L at temperature 25 Deg C & 1000 mg/L which indicates that chemical is moderately soluble in water.

## MATERIALS AND INSTRUMENTS

Materials -
Curcumin (purity 90%) was purchased from Signet Pvt. Ltd. India. Thymol crystals and Methanol was purchased from Research Lab Fine Chem Industries. India. Starch was obtained from Research Lab Fine Chem. India,
Silicon dioxide was obtained from Research Lab Fine Chem. India, Magneium stearate was obtained from Research Lab Fine'. Instruments :

- ➢ UV Spectrophotometer
- ➢ Weighing balance
- ➢ Centrifugation machine
- ➢ Vertex
- ➢ Ultrasonicator

## EXPERIMENTAL WORK

7.1 Solubility Enhancement –
7.1.1 Without Thymol
1] Experimental procedure - Taking 10 ml methanol in 10 mg of turmeric, then make the dilutions of 1000ppm and
100ppm of above mixture. Analyse under UV Spectroscopy.
2] After that we check the absorbance in UV. The absorbance of 1000ppm solution is 1.733'
3] Then from the above solution we took 1ml solution and diluted it up to 10ml with methanol which makes 100ppm solution.
4] The absorbance of 100ppm solution at 420 nm is 0.259. 5] After that we carry out the calibration curve by using equation y=0.166x-0.010.
6] Then we put the values in equation then we got concentration (x) 0.156 mg .

7.1.2 With Thymol
1] We take 100 mg thymol in 100mg turmeric and then we heat it until thyomol get melt ,then cool it .
2] Then we dilute the resulting solution with 10ml methanol.
3] Then make the dilutions of 1000ppm and 100ppm.
4] After that we check the absorbance in uv.
5] The absorbance of 1000ppm solution at 420nm is 1.5

7.2 Formulation of Capsule:

| Sr. No. | Name Of The Ingredient | Quantity Taken | Role |
|---|---|---|---|
| 1 | Turmeric | 500mg | Drug |
| 2 | Thymol | 500mg | Excipient |
| 3 | Starch | 1000mg | Binder |
| 4 | Silicon dioxide | 25mg | Glident |
| 5 | Magnesium stearate | 25mg | Lubricant |

Table 3 –Formula of capsule.

Step 1: Dry mixing :
Weigh and mix Turmeric,, Thymol & Starch for 10 minute.
1. Add Silicon dioxide in 1 and mix for 2 min.
2. Add Magnesium Stearate in 2 and mix for 2 minute.
3. Then we carried out evaluation test of powder.
4. Then we check the bulk density, tap density, carr's index & hausner ratio.

| Sr .no | Weight of capsule after filling | Sr no | Weight of capsule after Filling |
|---|---|---|---|
| 1. | 546 | 11. | 553 |
| 2. | 550 | 12. | 540 |
| 3. | 554 | 13. | 546 |
| 4. | 552 | 14. | 554 |
| 5. | 546 | 15. | 546 |
| 6. | 549 | 16. | 552 |
| 7. | 550 | 17. | 546 |
| 8. | 549 | 18. | 552 |
| 9. | 548 | 19. | 549 |
| 10. | 556 | 20. | 550 |

Table 4: Weight of 20 Capsule

Step 2: Capsule filling:

Then we perform Evaluation test for capsule such as uniformity of weight, uniformity of content dissolution & standard deviation. Capsule size: 00. Average weight of Empty Capsule: 126.6 mgAverage weight of Filled Capsule: 550 mg

7.2.1 Uniformity of Weight:

1. Weigh an intact capsule. Open the capsule without losing any part of the shell anremove the contents as completely as possible.
2. To remove the contents of a soft capsule the shell may be washed with ether or other suitable solvent and the shell allowed to stand until the odour of the solvent is no longer detectable.
3. Weigh the shell, the weight of the contents is the difference between the weighings. Repeat the procedure with a further 19 capsules. Determine the average weight of capsule contents.
4. Not more than two of the individual weights deviate from the average weight by more than the percentage deviation.

Average Weight of Capsule after filling

$$= \frac{\text{Total weight of capsule}}{\text{No. of capsules}}$$

$$= \frac{11000}{20}$$

$$= 550 \text{ mg}$$

Average weight of a capsule contents is more than 300 mg so the percentage deviation is allowed as per Indian pharmacopeia is 7.5 %

Therefore 7.5 % of 550 mg is 550 * 7 /100 = 38.5 mg So the capsule weight 550 ± 38.5 mg is accepted. All 20 capsules have weight in the range of 511.5mg – 588.5mg. 7.2.2 Content uniformity :

| No. of Capsule | Absorbance | % Yield |
|---|---|---|
| 1 | 0.137 | 88.55 |
| 2 | 0.156 | 100 |
| 3 | 0.18 | 114.45 |
| 4 | 0.143 | 92.16 |
| 5 | 0.173 | 110.24 |
| 6 | 0.165 | 105,42 |
| 7 | 0.147 | 94.57 |
| 8 | 0.139 | 89.75 |
| 9 | 0.155 | 99.39 |
| 10 | 0.142 | 91.56 |

Table 5 – Content Uniformity test readings.

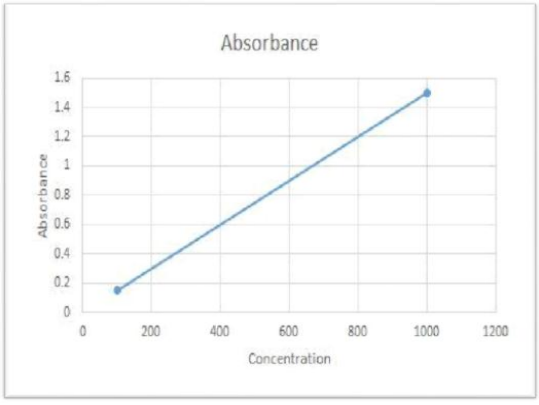
## RESULTS & DISCUSSION

8.1 Result -

I. Calibration curve :

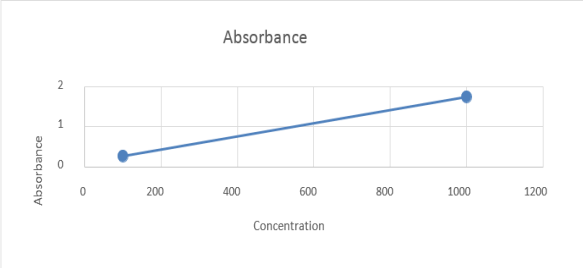
$y = 0.166x - 0.010$

$R^2 = 0.999$



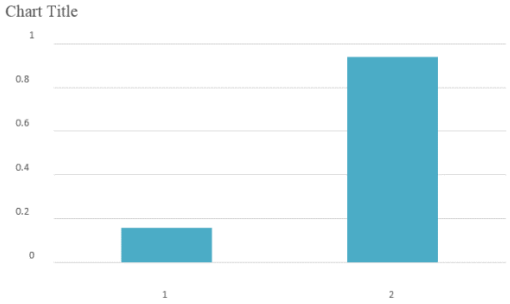

Graph 1 - Calibration Curve of curcumin with thymol

$y = 0.166x-0.010$, $R^2 = 0.010$




Graph 2 - Calibration Curve of curcumin without tymol

II. Solubility Graph:




Graph 3 - The solubility of Turmeric with thymol is increased by 6 folds.

III. Evaluation Test Of Powder blend

| Sr.No. | Evaluation Test | Obervation | Result | Inference |
|---|---|---|---|---|
| 1 | Bulk Density | 0.48 g/ml | Good | Pass |
| 2 | Tapped Density | 0.54 g/ml | Good | Pass |
| 3 | Carrs index | 15.79 | Good Compressibility | Pass |
| 4 | Hausner Ratio | 1.18 | Good Flow | Pass |

Table 6 - Evaluation Test of Powder blend

IV. Evaluation Test for Capsule

| Evaluation Test | Result | Inference |
|---|---|---|
| Uniformity of Weight | All 20 capsules have weight in the range of 511.5mg – 588.5mg. | PASS |
| Uniformity of Content | None of Capsule is outside 75–125 % range & not less than 27 of 30 are with in 85–115 % range. | PASS |

Table 7 - Evaluation Test for Capsule

8.2 Discussion –

- when we perform the experiment the problem arises about the solubility of turmeric in aqueous solution.
- The problems about flow property of turmeric powder.
- We check the solubility of turmeric with and without Thymol. We found that the solubility of turmeric is increased by the use of Thymol.
- After that, we performed the evaluation test of the powder. The bulk density of powder is found to be 0.462 g/ml and tapped density is found to be 0.549 g/ml. Hausner's ratio found to be 1.18 and Carr's index found to be 15.69 show' s the good flow of powder.
- The chemical constituents of Turmeric contains yellow coloring matter called as curcuminoids (5%) and essential oil (6%).The chief constituent of the coloring matter is curcumin I (60%) in addition with small quantities of curcumin III, curcumin II and dihydro curcumin.
- Thymol react with these constituents and increases the solubility of turmeric.

## SUMMERY & CONCLUSION

In conclusion, the experiment aimed to enhance the solubility of turmeric by using thymol as a solubilizing agent. The results of the experiment demonstrated that thymol effectively increased the solubility of turmeric.

Throughout the experimental process, various concentrations of thymol were tested to identify the optimal solubility enhancement. The solubility of turmeric was measured using quantitative techniques such as UV-Vis spectrophotometry, and the results consistently showed a significant improvement in solubility when thymol was added.

Thymol, known for its solubilizing properties, acted as a co-solvent, promoting the dispersion of turmeric particles within the solvent and increasing their solubility. The increased solubility of turmeric is highly beneficial as it enhances its bioavailability and ensures a more efficient delivery of its therapeutic compounds.

Furthermore, the experiment demonstrated that the solubility enhancement achieved with thymol was dependent on its concentration. Higher concentrations of thymol led to greater improvements in solubility, up to a certain point where further increases in concentration yielded diminishing returns. Therefore, an optimal concentration range was identified for achieving the desired solubility enhancement.

In summary,

The experiment successfully demonstrated that the addition of thymol significantly enhanced the solubility of turmeric. This finding has important implications for various applications, including pharmaceutical formulations, nutraceutical products, and food industry uses.

The improved solubility of turmeric facilitated by thymol can enhance its bioavailability and potentially enhance its therapeutic or functional properties, making it a valuable approach for harnessing the benefits of turmeric. Further studies and optimization of the concentration range can be explored to maximize the solubility enhancement and its practical applications.

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