

Ensino,  
pesquisa e  
inovação em  
botânica 2

Jesus Rodrigues Lemos  
(Organizador)

Ensino,  
pesquisa e  
inovação em  
botânica 2

Jesus Rodrigues Lemos  
(Organizador)

**Editora chefe**

Profª Drª Antonella Carvalho de Oliveira

**Editora executiva**

Natalia Oliveira

**Assistente editorial**

Flávia Roberta Barão

**Bibliotecária**

Janaina Ramos

**Projeto gráfico**

Bruno Oliveira

Camila Alves de Cremo

Daphynny Pamplona

Luiza Alves Batista

Natália Sandrini de Azevedo

**Imagens da capa**

iStock

**Edição de arte**

Luiza Alves Batista

2022 by Atena Editora

Copyright © Atena Editora

Copyright do texto © 2022 Os autores

Copyright da edição © 2022 Atena Editora

Direitos para esta edição cedidos à Atena Editora pelos autores.

Open access publication by Atena Editora



Todo o conteúdo deste livro está licenciado sob uma Licença de Atribuição Creative Commons. Atribuição-Não-Comercial-NãoDerivativos 4.0 Internacional (CC BY-NC-ND 4.0).

O conteúdo dos artigos e seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva dos autores, inclusive não representam necessariamente a posição oficial da Atena Editora. Permitido o *download* da obra e o compartilhamento desde que sejam atribuídos créditos aos autores, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

Todos os manuscritos foram previamente submetidos à avaliação cega pelos pares, membros do Conselho Editorial desta Editora, tendo sido aprovados para a publicação com base em critérios de neutralidade e imparcialidade acadêmica.

A Atena Editora é comprometida em garantir a integridade editorial em todas as etapas do processo de publicação, evitando plágio, dados ou resultados fraudulentos e impedindo que interesses financeiros comprometam os padrões éticos da publicação. Situações suspeitas de má conduta científica serão investigadas sob o mais alto padrão de rigor acadêmico e ético.

**Conselho Editorial****Ciências Biológicas e da Saúde**

Profª Drª Aline Silva da Fonte Santa Rosa de Oliveira – Hospital Federal de Bonsucesso

Profª Drª Ana Beatriz Duarte Vieira – Universidade de Brasília

Profª Drª Ana Paula Peron – Universidade Tecnológica Federal do Paraná

Prof. Dr. André Ribeiro da Silva – Universidade de Brasília

Profª Drª Anelise Levay Murari – Universidade Federal de Pelotas

Prof. Dr. Benedito Rodrigues da Silva Neto – Universidade Federal de Goiás



Prof. Dr. Cirênio de Almeida Barbosa – Universidade Federal de Ouro Preto  
Profª Drª Daniela Reis Joaquim de Freitas – Universidade Federal do Piauí  
Profª Drª Débora Luana Ribeiro Pessoa – Universidade Federal do Maranhão  
Prof. Dr. Douglas Siqueira de Almeida Chaves – Universidade Federal Rural do Rio de Janeiro  
Prof. Dr. Edson da Silva – Universidade Federal dos Vales do Jequitinhonha e Mucuri  
Profª Drª Elizabeth Cordeiro Fernandes – Faculdade Integrada Medicina  
Profª Drª Eleuza Rodrigues Machado – Faculdade Anhanguera de Brasília  
Profª Drª Elane Schwinden Prudêncio – Universidade Federal de Santa Catarina  
Profª Drª Eysler Gonçalves Maia Brasil – Universidade da Integração Internacional da Lusofonia Afro-Brasileira  
Prof. Dr. Ferlando Lima Santos – Universidade Federal do Recôncavo da Bahia  
Profª Drª Fernanda Miguel de Andrade – Universidade Federal de Pernambuco  
Prof. Dr. Fernando Mendes – Instituto Politécnico de Coimbra – Escola Superior de Saúde de Coimbra  
Profª Drª Gabriela Vieira do Amaral – Universidade de Vassouras  
Prof. Dr. Gianfábio Pimentel Franco – Universidade Federal de Santa Maria  
Prof. Dr. Helio Franklin Rodrigues de Almeida – Universidade Federal de Rondônia  
Profª Drª Iara Lúcia Tescarollo – Universidade São Francisco  
Prof. Dr. Igor Luiz Vieira de Lima Santos – Universidade Federal de Campina Grande  
Prof. Dr. Jefferson Thiago Souza – Universidade Estadual do Ceará  
Prof. Dr. Jesus Rodrigues Lemos – Universidade Federal do Piauí  
Prof. Dr. Jônatas de França Barros – Universidade Federal do Rio Grande do Norte  
Prof. Dr. José Aderval Aragão – Universidade Federal de Sergipe  
Prof. Dr. José Max Barbosa de Oliveira Junior – Universidade Federal do Oeste do Pará  
Profª Drª Juliana Santana de Curcio – Universidade Federal de Goiás  
Profª Drª Lívia do Carmo Silva – Universidade Federal de Goiás  
Prof. Dr. Luís Paulo Souza e Souza – Universidade Federal do Amazonas  
Profª Drª Magnólia de Araújo Campos – Universidade Federal de Campina Grande  
Prof. Dr. Marcus Fernando da Silva Praxedes – Universidade Federal do Recôncavo da Bahia  
Profª Drª Maria Tatiane Gonçalves Sá – Universidade do Estado do Pará  
Prof. Dr. Maurilio Antonio Varavallo – Universidade Federal do Tocantins  
Profª Drª Mylena Andréa Oliveira Torres – Universidade Ceuma  
Profª Drª Natiéli Piovesan – Instituto Federaci do Rio Grande do Norte  
Prof. Dr. Paulo Inada – Universidade Estadual de Maringá  
Prof. Dr. Rafael Henrique Silva – Hospital Universitário da Universidade Federal da Grande Dourados  
Profª Drª Regiane Luz Carvalho – Centro Universitário das Faculdades Associadas de Ensino  
Profª Drª Renata Mendes de Freitas – Universidade Federal de Juiz de Fora  
Profª Drª Sheyla Mara Silva de Oliveira – Universidade do Estado do Pará  
Profª Drª Suely Lopes de Azevedo – Universidade Federal Fluminense  
Profª Drª Vanessa da Fontoura Custódio Monteiro – Universidade do Vale do Sapucaí  
Profª Drª Vanessa Lima Gonçalves – Universidade Estadual de Ponta Grossa  
Profª Drª Vanessa Bordin Viera – Universidade Federal de Campina Grande  
Profª Drª Welma Emídio da Silva – Universidade Federal Rural de Pernambuco



## Ensino, pesquisa e inovação em botânica 2

**Diagramação:** Daphynny Pamplona  
**Correção:** Yaidy Paola Martinez  
**Indexação:** Amanda Kelly da Costa Veiga  
**Revisão:** Os autores  
**Organizador:** Jesus Rodrigues Lemos

### Dados Internacionais de Catalogação na Publicação (CIP)

E59 Ensino, pesquisa e inovação em botânica 2 / Organizador Jesus Rodrigues Lemos. – Ponta Grossa - PR: Atena, 2022.

Formato: PDF  
Requisitos de sistema: Adobe Acrobat Reader  
Modo de acesso: World Wide Web  
Inclui bibliografia  
ISBN 978-65-258-0258-9  
DOI: <https://doi.org/10.22533/at.ed.589222405>

1. Botânica. I. Lemos, Jesus Rodrigues (Organizador). II. Título.

CDD 580

Elaborado por Bibliotecária Janaina Ramos – CRB-8/9166

**Atena Editora**  
Ponta Grossa – Paraná – Brasil  
Telefone: +55 (42) 3323-5493  
[www.atenaeditora.com.br](http://www.atenaeditora.com.br)  
contato@atenaeditora.com.br



## DECLARAÇÃO DOS AUTORES

Os autores desta obra: 1. Atestam não possuir qualquer interesse comercial que constitua um conflito de interesses em relação ao artigo científico publicado; 2. Declaram que participaram ativamente da construção dos respectivos manuscritos, preferencialmente na: a) Concepção do estudo, e/ou aquisição de dados, e/ou análise e interpretação de dados; b) Elaboração do artigo ou revisão com vistas a tornar o material intelectualmente relevante; c) Aprovação final do manuscrito para submissão.; 3. Certificam que os artigos científicos publicados estão completamente isentos de dados e/ou resultados fraudulentos; 4. Confirmam a citação e a referência correta de todos os dados e de interpretações de dados de outras pesquisas; 5. Reconhecem terem informado todas as fontes de financiamento recebidas para a consecução da pesquisa; 6. Autorizam a edição da obra, que incluem os registros de ficha catalográfica, ISBN, DOI e demais indexadores, projeto visual e criação de capa, diagramação de miolo, assim como lançamento e divulgação da mesma conforme critérios da Atena Editora.



## DECLARAÇÃO DA EDITORA

A Atena Editora declara, para os devidos fins de direito, que: 1. A presente publicação constitui apenas transferência temporária dos direitos autorais, direito sobre a publicação, inclusive não constitui responsabilidade solidária na criação dos manuscritos publicados, nos termos previstos na Lei sobre direitos autorais (Lei 9610/98), no art. 184 do Código Penal e no art. 927 do Código Civil; 2. Autoriza e incentiva os autores a assinarem contratos com repositórios institucionais, com fins exclusivos de divulgação da obra, desde que com o devido reconhecimento de autoria e edição e sem qualquer finalidade comercial; 3. Todos os e-book são *open access*, *desta forma* não os comercializa em seu site, sites parceiros, plataformas de *e-commerce*, ou qualquer outro meio virtual ou físico, portanto, está isenta de repasses de direitos autorais aos autores; 4. Todos os membros do conselho editorial são doutores e vinculados a instituições de ensino superior públicas, conforme recomendação da CAPES para obtenção do Qualis livro; 5. Não cede, comercializa ou autoriza a utilização dos nomes e e-mails dos autores, bem como nenhum outro dado dos mesmos, para qualquer finalidade que não o escopo da divulgação desta obra.



## APRESENTAÇÃO

A obra “Ensino, Pesquisa e Inovação em Botânica 2”, seguindo o foco do primeiro volume, continua transitando por esferas que permitem a possibilidade de percepção do quão ampla e abrangente é esta grande área das Ciências Biológicas, esta, por sua vez, um grande campo do conhecimento.

Este segundo volume também traz a oportunidade ao leitor de enveredar por caminhos nos quais verificará uma amplitude de pensamento acerca do que pode ser explorado, e, ainda, provocando neste leitor o alargamento das suas perspectivas de realização de investigações envolvendo as plantas, organismos sobre os quais tem-se percebido e constatado, cada vez mais, sua fundamental importância na manutenção salutar da vida no planeta.

Somente por questões de uma fluência sequenciada deste título, os capítulos foram trazidos concebendo seus perfis principais dentro da proposta geral, assim, primeiramente são trazidos estudos com enfoque direcionados especificamente ao ensino formal e não-formal de Botânica, seguidos de pesquisa básica com subáreas mais tecnicistas, entretanto, todas desembocando em vieses nitidamente inovadores.

Assim, objetivamente, desejo aos leitores que aproveitem ao máximo das informações aqui contidas, reproduzindo-as, aplicando-as e expandido seus horizontes.

Jesus Rodrigues Lemos



## SUMÁRIO

### **CAPÍTULO 1..... 1**

PRODUÇÃO DE MATERIAL DIDÁTICO DIGITAL PARA USO E APLICAÇÃO NO ENSINO FORMAL E NÃO FORMAL DE BOTÂNICA COM PLANTAS DA ARBORIZAÇÃO URBANA DE PARNAÍBA, NORTE DO PIAUÍ

Andrislene Costa da Conceição

Lucas dos Santos Araújo

Jéssica Lira Viana

Ivanilza Moreira de Andrade

Jesus Rodrigues Lemos

 <https://doi.org/10.22533/at.ed.5892224051>

### **CAPÍTULO 2..... 22**

JOGO DIDÁTICO COMO COMPLEMENTO DAS AULAS SOBRE O TEMA MORFOLOGIA DAS FLORES E INFLORESCÊNCIAS

Igor da Silva dos Santos

Malena Gomes da Costa


Tamirys de Souza Rosa

Doralice Silva Neves

Gislene Ferreira da Silva

Patrícia Carneiro da Silva

Claudia Scareli-Santos

 <https://doi.org/10.22533/at.ed.5892224052>

### **CAPÍTULO 3..... 35**


ANÁLISE DAS CONCEPÇÕES ALTERNATIVAS DOS ESTUDANTES DO CURSO CIÊNCIAS DA NATUREZA SOBRE FISIOLOGIA VEGETAL

Samara Pacheco Rocha

Francisco Igor Ribeiro dos Santos

Maria Jaislanny Lacerda e Medeiros

Clarissa Gomes Reis Lopes

 <https://doi.org/10.22533/at.ed.5892224053>

### **CAPÍTULO 4..... 48**

OPTIMIZATION OF MICROWAVE -ASSISTED EXTRACTION OF ANTI-CANCEROUS CONSTITUENTS OF TURMERIC (*Curcuma longa L.*) BY RESPONSE SURFACE METHDOLOGY

Mariam Liaqat

Naila Mukhtar

Asma saleem

Gulnaz parveen

Maria Naqve

Athar Mahmood

Faiza Jamil

Zunaira Hashmi

Arshad Kamran

 <https://doi.org/10.22533/at.ed.5892224054>

<b>SOBRE O ORGANIZADOR.....</b>	<b>58</b>
<b>ÍNDICE REMISSIVO.....</b>	<b>59</b>

# CAPÍTULO 4

## OPTIMIZATION OF MICROWAVE -ASSISTED EXTRACTION OF ANTI-CANCEROUS CONSTITUENTS OF TURMERIC (*CURCUMA LONGA L.*) BY RESPONSE SURFACE METHDODOLOGY

Data de aceite: 01/05/2022

### **Mariam Liaqat**

Department of Computational Physics  
University of Okara,

### **Naila Mukhtar**

Department of botany  
University of okara,

### **Asma saleem**

Department of botany  
University of okara,

### **Gulnaz parveen**

Department of botany  
Women University swabi

### **Maria Naqve**

Department of botany  
University of Agriculture, Faisalabad

### **Athar Mahmood**

Department of Agronomy  
University of Agriculture, Faisalabad

### **Faiza Jamil**

Department of Botany  
University of Okara

### **Zunaira Hashmi**

Department of Physics  
University of Okara

### **Arshad Kamran**

Department of Physics  
University of Okara

Pakistan. It belongs to a ginger family (Zingiberaceae).Turmeric has been used as anti-oxidant and anti-cancerous and anti-inflammatory properties containing herb all over the world. The most active constituents of turmeric are curcumin and its derivatives demethoxycurcumin (DMC) and bisdemethoxycurcumin (BDMC) collectively called curcuminoids. The present work reports on extraction of curcuminoids through Microwave-assisted technique optimized by Response Surface methodology (RSM).Three independent variables ethanol concentration (10-95%), extraction time (2-4minutes) , extraction temperature(250-400°C) were selected. Total 27% yield of curcuminoids was calculated after crystallization of curcuminoids. The higher yield calculated at (95% ethanol), at time of (4minutes) and at (400°C) temperature. The presence of curcuminoids was confirmed by UV-visible spectroscopy and curcumin showed maximum absorbance at 430nm to 465nm wavelength in ethanol solvent. Separation of curcuminoids was carried out by thin layer chromatography (TLC) analysis and results showed retention factor (RF) value at 0.78, 0.55, and 0.48 as curcumin, demethoxycurcumin, bis-demethoxycurcumin respectively. It is concluded that theoretical yield calculated by RSM was comparatively very close to experimental yield and Microwave-assisted extraction technique optimized by RSM was easiest and advanced way to obtain pure curcuminoids.

## 1 | INTRODUCTION

There is some truth to the old age that cancer is as old as the human race, but paleo

ABSTRACT: Turmeric (*Curcuma longa L.*) is a significant plant among cultivated spice crop in

pathologic findings indicate that tumors existed in animals in prehistoric times, long before men appeared on Earth (Hajdu, 2011). The Egyptians attempted to treat tumors and cancers with cauterization, knives, and salts, and introduced arsenic paste that remained in use as “Egyptian ointment” until the 19th century (Kim et al. 2014). The Sumerians, Chinese, Indians, Persians, and Hebrews of the same epoch were partial to herbal remedies such as tea, fruit juices, figs, and boiled cabbage, but in advanced cases, they did not hesitate to resort to solutions and pastes of iron, copper, sulfur, and mercury (Castiglioni, 2011). They believed that cancer was initiated by natural causes. They rationalized that excess or deprivation of blood, mucus, bile, and other body secretions, particularly at old age, may induce cancer. Remedies for cancer were compiled by Pliny the Roman (AD 23-79), in his *Materia Medica* (Jasvir et al. 2018). He recommended compound herbal and other remedies for internal use in advanced cancer before or after attempted surgery. His most highly praised prescription was a boiled mixture of ash of sea crabs, egg white, honey, and powdered feces of falcons (Talmadge and Fidler, 2010). Tumor is a mass composed of a group of abnormal cells. There are approximately 200 types of cancer (Jiang et al. 2013).

The consumption of herbal medicines is increasing steadily throughout the world as an alternative treatment for a number of health problems including heart diseases, diabetes, high blood pressure and even certain types of cancer (Jasvir et al. 2018). Herbs and spices can modify micro biota which can stimulate growth within organisms that protect against cancer as well as within microorganisms that may serve to increase cancer risk (Chirstine et al. 2008). Culinary herbs and spices generally serve as antioxidants but may also serve as pro-oxidants at higher exposures. Inflammation, tumorigenesis, and carcinogen bio activation influence cancer risk and tumor behavior, but interventions which inhibit these processes can contribute to cancer (Schmidt and Weber, 2006).

Turmeric (*Curcuma longa* L.) is a spice that has received much interest from both the medical/scientific worlds as well as from the culinary world. Turmeric is a rhizomatous herbaceous perennial plant (*Curcuma longa* L.) of the ginger family zingiberaceae (Priyadarsini, 2014). Turmeric is known to possess antibacterial, anticancer, antifungal, Antioxidant and anti-inflammatory properties (Susan et al. 2017). The major component, curcumin, is a polyphenolic compound classified as generally recognized as safe (GRAS) by the U.S. Food and Drug Administration (An et al. 2011). Curcumin is available in various formulations: capsules, tablets, ointments, energy drinks, soaps and cosmetics (Gupta et al. 2013). Curcumin is the main component of turmeric; it is also known as diferuloylmethane and is a yellow-orange crystalline solid (Zhu et al. 2017).

Recently it has been shown that phenolic compounds have an inhibitory effect on cancer and its ability to metastasize (Zhang et al. 2013). Curcuminoids, the principal pigment and bioactive compounds in turmeric, are composed of curcumin (1,7-bis-(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) and its derivatives desmethoxycurcumin (DMC) and bisdesmethoxycurcumin (BDMC), which have been widely studied for antioxidant,

anticancer, ant mutagenic, and antibacterial functions(Hu et al. 2016). Curcuminoids are used in cosmetics as ingredients in skincare products due to their antioxidant, anti-inflammatory, and anti-aging activities (Arct et al. 2014). Curcuminoids are yellow pigments whose main compounds are curcumin (70–75%), demethoxycurcumin (10–20%) and bisdesmethoxycurcumin (5–10%) and represent 2–9% of the active components in turmeric (Sahne et al. 2017).

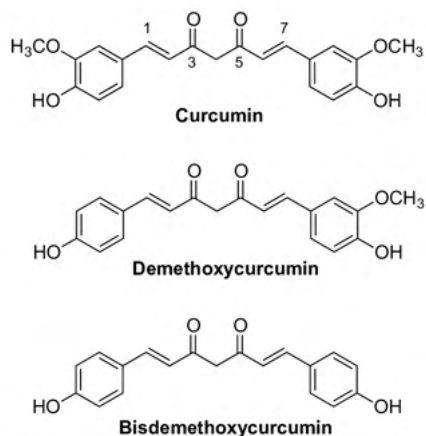


Fig: 1.1 Chemical structures of Curcuminoids.

In this research we are using microwave-assisted extraction technique optimized by response surface methodology. In the present time, the application of computer software technology in the research process has brought about remarkable results, gradually replacing traditional methods. One of the methods used to optimize the conditions that affect the extraction of plants is the response surface methodology. Response surface methodology (RSM) is a method used to simultaneously optimize two or more factors affecting the experiment process (Chandrap et al. 2018). Response Surface Method used to find the interaction of different affecting factors. Response surface methodology explores the relationship between different explanatory variables or different response variables. This method was first introduced by George E. P. Box and K. B. Wilson in 1951. Experiments is conducted at experimental designs and output is recorded (Chelladurai et al. 2021).

RSM is also capable of designing experiments. The designed experiments will consists of 12 or 20 experiments for optimization of 2 and 3 factors affecting the extraction process, respectively. In addition, RSM also facilitates the experiment detection and manipulation. Finally, with the simultaneous optimization of multiple factors, RSM results in the equations for prediction, and 3D models that describe the interaction of conditions on the response factor (Bahl et al. 2018). In the current stage, green technology has always been the subject of many studies Desai et al. 2014). A particular attraction in this field is microwave extraction because of its ability to transfer energy to the material, its environmental-friendliness and

most importantly, the ability to improve the quality (Abdurrahman et al. 2012) .

However, to improve the yield in the extraction of turmeric extract not only does the choice of extraction method matter, but it is also necessary to consider the optimization of the influencing conditions through response surface methodology (Bach et al. 2017). Microwave extraction and response surface methodology are used to extract turmeric extract and optimize the factors that influence the extraction process. (Tran et al. 2019). The requirement for the advancement of high performance in the extraction method is essential (Barzegar et al. 2019).

The aims and objectives of the present study were as follow; Optimization of extraction process by response surface methodology (RSM). To find a maximum yield of turmeric extract by Microwave-Assisted Extraction Technique and to characterize the Anti-Cancerous compounds of turmeric by different analytical techniques.

## 2 | MATERIALS AND METHODS

Turmeric (*Curcuma longa* L.) plant is used in this research. It belongs to (zingiberaceae) family. The main compound (Curcumin) present in turmeric is an important bio-active Constituent of turmeric. Yellow color of turmeric is due to this curcumin compound. There are lots of benefits we obtain from turmeric. It is used as spice, food coloring, and dyes. It has anti-cancer, anti-oxidant, anti-inflammatory effects that help in cure of cancer, inflammation, oxidative stress, joints pain and other diseases. The main focus of this research was to highlight the anti-cancer compounds of turmeric. For this purpose different techniques were used for the optimization of extraction process of turmeric and characterization of its anti-cancerous compounds were used.

Following techniques were used: Response Surface Methodology (RSM) for the theoretical prediction of the values, Microwave Assisted Extraction Technique (MAE)

1. Filtration
2. Ultra-Violet Visible Spectroscopy
3. Thin Layer Chromatography (TLC)

### 2.1 Response Surface Methodology (RSM)

Response surface methodology (RSM) was introduced by Wilson and Box. Response surface methodology is a collection of mathematical and statistical techniques based on a polynomial equation to the experimental data. It is an optimization tool that can identify interrelationship between variables as being adopted by experiment in food and herbal plants extraction. In this research Response surface methodology was applied for the optimization of extraction conditions. It is performed by using design expert software 8.0.7.1.

In Response surface methodology different steps were followed as

### 1. Central composite design (CCD)

- Analysis, Fit summary, ANOVA, Model graphs , Predicted vs. actual yield
- 3D Graphs

### 2. Final equation

## 2.2 Central Composite Design (CCD)

Before applying the Response Surface methodology (RSM), it is first necessary to choose an experimental design that will define which experiments should be carried out in the experimental region being studied. RSM helps to determine the best experimental design in order to identify the relationship between variables. Three independent variables Extraction time (X1), Extraction temperature (X2), Ethanol concentration (X3) were selected. After selecting variables in design expert it provided us 17 run at different ethanol concentration, extraction time, extraction temperature. CCD Model is presented in Table 1.

Factors	Code	Levels	
		Low level	High level
Ethanol concentration (%)	X1	10	95
Extraction time (Minutes)	X2	2	4
Extraction temperature (°C)	X3	250	400

Table1: 3.3.1 Central composite Design (CCD) for the extraction of Turmeric (*Curcuma longa L.*)

## 2.3 Microwave Assisted Extraction

### 2.3.1 Principal of working

Microwave-assisted extraction (MAE) is an automated green extraction technique that offers many advantages such as the reduction of the extraction time and solvent consumption. MAE largely complies with the minimum criteria required for modern sample preparation techniques, and provides a very attractive alternative to conventional approaches for the extraction of organic compounds from a wide variety of matrices. MAE is a conventional technique for the extraction of active components from medicinal plants, using microwave energy to heat solvents containing samples, thereby partitioning analytes from a sample matrix into the solvent. The main advantage of MAE is its ability to rapidly heat the sample solvent mixture, resulting in its wide applicability for the rapid extraction of analytes, including thermally unstable substances. MAE can reduce the extraction time to < 20 min and solvent consumption below 20 ml. Furthermore, the recoveries obtained are usually higher than the conventional methods.

### 3 I EXTRACTION EXPERIMENTS

Fifteen experiments were performed by ultrasonic extraction method given by design Expert software

Runs	Ethanol Concentration (%)	Extraction Time (Min)	Extraction temperature	Solvent to drug ratio(g/ml)	Solution
1	10.00	2.00	250.00	1:10	20ml
2	10.00	2.00	400.00	1:10	20ml
3	52.50	1.32	325.00	1:10	20ml
4	52.50	4.68	325.00	1:10	20ml
5	52.50	3.00	325.00	1:10	20ml
6	95.00	2.00	250.00	1:10	20ml
7	95.00	4.00	250.00	1:10	20ml
8	52.50	3.00	325.00	1:10	20ml
10	95.00	2.00	400.00	1:10	20ml
11	10.00	4.00	250.00	1:10	20ml
12	52.50	3.00	198.87	1:10	20ml
13	10.00	4.00	400.00	1:10	20ml
14	52.50	3.00	325.00	1:10	20ml
15	52.50	3.00	451.13	1:10	20ml
17	95.00	4.00	400.0	1:10	20ml

Table1: 3.3.1 Central composite Design (CCD) for the extraction of Turmeric (*Curcuma longa L.*).

### YIELD ESTIMATION

After crystallization of curcuminoids yield was calculated by dividing total dry weight of total extract by total weight of dry powder.

Yields of extracts obtained were calculated as follows :



$$\text{Yield (\%)} = \frac{\text{Total weight of recovered extract}}{\text{Total weight of dry powder}} \times 100$$

## 4 | ANALYTICAL TECHNIQUES ( FOR CHARACTERIZATION OF SAMPLES )

### Results of Extraction of Curcuminoids

We performed fifteen experiments given by design expert software. During first experiment ethanol concentration was 10% and extraction time 2 minutes and temperature was 250°C. So total curcuminoids yield we calculated from this extracted solution was 5.810mg/2g. We see that due to lower concentration of ethanol and lower temperature curcuminoids contents lead to less in yield. After this second experiment was carried out and we used 10% ethanol concentration and extraction time was 2 minutes and extraction temperature was 400°C so yield we calculated was 6.621mg/2g. After third experiment was carried out and we used 52% ethanol concentration and extraction time 1.32 minutes and extraction temperature was 325°C and calculated yield was 9.10 higher than above mentioned yield because of the higher concentration of ethanol and temperature than these experiments. After this during 4<sup>th</sup> experiment we used again 52% ethanol concentration extraction time was 4.68 and extraction temperature was 325 and we calculated the yield of 14.910mg/g due to the higher concentration of curcuminoids. During the fifth experiments we used 52% ethanol concentration and extraction time was 3 minutes and extraction temperature was 325. The calculated yield was 13.4mg due to the higher content of curcuminoids in the solution. During the 6<sup>th</sup> experiment we used 95% ethanol concentration and extraction time was 2 minutes and extraction temperature was 250°C and calculated yield was 15.601mg due to the higher content of curcuminoids.



Fig:4.2.1 Extracted samples after Micro-wave assisted extraction.

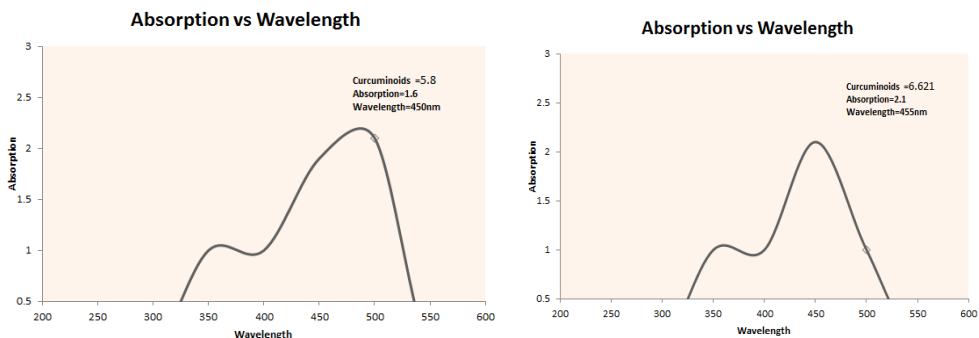
## TOTAL YIELD

Total yield was estimated as follows :

$$\begin{aligned}\text{Yield (\%)} &= \frac{\text{Total weight of recover extract}}{\text{Total weight of dry powder}} \times 100 \\ &= \frac{182.0561\text{mg}}{30\text{g}} \times 100\end{aligned}$$

Total yield = 27% total number of curcuminoids

## 5 | UV-VISIBLE SPECTROSCOPY RESULTS



These graphical explanation of uv results shows that higher number of curcuminoids containing solution shows peak near to the standard peak of curcumin which is 423nm. So when we see the graph Figure.(i) it shows peak at 455nm and its solution contains 5.810 number of curcuminoids content. In the next figure.(ii) it shows 465nm peak very far away from the standard peak of curcumin due to the less amount of curcuminoids. Furthermore, a solution containing 9.160 curcuminoids yielded shows a peak at 445nm and an absorbance of 1.7. After this, a solution containing 14.910mg curcuminoids yielded shows a peak at 440nm and an absorbance of 2.4. Next, a solution shows a wavelength peak at 445nm and an absorbance of 2.3. Furthermore, a solution containing 15.6mg curcumin yielded shows a peak at 435nm, which is slightly closer to the standard peak of curcumin. A solution containing 17.051 and 17.8 and 17.8 shows the most similar peaks to the standard peak of curcumin, so these are the best peaks we see. A solution containing 10.0, 4.8, 6.625mg yield of curcuminoids shows the lowest peak and is farthest from the standard peak because of the lower concentration of curcuminoids. So according to the results, we conclude that a solution containing a higher content of curcuminoids shows good peaks near 430-435 nm and a solution containing a lower number of curcuminoids shows the lowest peak at 44–465nm.

## REFERENCES

- Adiwidjaja J, McLachlan AJ, Boddy AVJEoodm, toxicology. 2017. Curcumin as a clinically-promising anti-cancer agent: Pharmacokinetics and drug interactions. 13(9):953-972.
- An Y-E, Ahn S-C, Yang D-C, Park S-J, Kim B-Y, Baik M-YJL-FS, Technology. 2011. Chemical conversion of ginsenosides in puffed red ginseng. 44(2):370-374.

- Arena A, Romeo MA, Benedetti R, Masuelli L, Bei R, Gilardini Montani MS, Cirone MJP. 2021. New insights into curcumin-and resveratrol-mediated anti-cancer effects. 14(11):1068.
- Barzegar F, Omid N, Kamankesh M, Mohammadi A, Ferdowsi R, Jazaeri SJAM. 2019. An advanced microwave-assisted extraction-low density solvent based on a sensitive microextraction method coupled with reverse phase high-performance liquid chromatography for the simultaneous determination of heterocyclic aromatic amines in fried chicken nuggets. 11(7):942-949.
- Batra H, Pawar S, Bahl DJPr. 2019. Curcumin in combination with anti-cancer drugs: A nanomedicine review. 139:91-105.
- Berger PD, Maurer RE, Celli GB. 2018. Introduction to response-surface methodology. Experimental design. Springer. p. 533-584.
- Castiglioni A. 1931. Histoire de la médecine: Édition française établie par les soins de l'auteur. Traduction par j. Bertrand... Et f. Gidon.(1. Tirage). Payot.
- Destandau E, Michel T, Elfakir CJNpep, applications. 2013. Microwave-assisted extraction. (21):113.
- Fidelis GK, Louis H, Tizhe TF, Onoshe SJJom, Sciences C. 2019. Curcumin and curcumin-based derivatives as anti-cancer agents: Recent nano-synthetic methodologies and anti-cancer therapeutic mechanisms. 2(2):59-63.
- H Lajis N, Abas F, Othman I, Naidu RJN. 2020. Mechanism of anti-cancer activity of curcumin on androgen-dependent and androgen-independent prostate cancer. 12(3):679.
- Hajdu SIJC. 2011. A note from history: Landmarks in history of cancer, part 1. 117(5):1097-1102.
- Hu S, Kim B-Y, Baik M-YJFC. 2016. Physicochemical properties and antioxidant capacity of raw, roasted and puffed cacao beans. 194:1089-1094.
- Hussein Y, Loutfy SA, Kamoun EA, El-Moslamy SH, Radwan EM, Elbehairi SEIJJoBM. 2021. Enhanced anti-cancer activity by localized delivery of curcumin form pva/cnacs hydrogel membranes: Preparation and in vitro bioevaluation. 170:107-122.
- Kanchanathawornviboon X, Monton C, Urairong HJJ. 2021. Microwave-assisted extraction of curcuminoids from organic curcuma longa l. In different oil types for cosmetic purpose: An optimization approach. 11(1):71-89.
- Kleijnen JP. 2015. Response surface methodology. Handbook of simulation optimization. Springer. p. 81-104.
- Liu P, Ying Q, Liu H, Yu SQ, Bu LP, Shao L, Li XYJOR. 2020. Curcumin enhances anti-cancer efficacy of either gemcitabine or docetaxel on pancreatic cancer cells. 44(4):1393-1402.
- Mirzaei H, Bagheri H, Ghasemi F, Khoi JM, Pourhanifeh MH, Heyden YV, Morteza pour E, Nikdasti A, Jeandet P, Khan HJA-CAiMC. 2021. Anti-cancer activity of curcumin on multiple myeloma. 21(5):575-586.

Nüchter M, Ondruschka B, Bonrath W, Gum AJGc. 2004. Microwave assisted synthesis—a critical technology overview. 6(3):128-141.

Okolie CL, Mason B, Mohan A, Pitts N, Udenigwe CCJFH. 2019. The comparative influence of novel extraction technologies on in vitro prebiotic-inducing chemical properties of fucoidan extracts from *ascophyllum nodosum*. 90:462-471.

Palve YP, Nayak PJIJoP, Sciences B. 2012. Curcumin: A wonder anticancer drug. 3(2):60-69.

Pandey VK, Ajmal G, Upadhyay SN, Mishra PKJIJoP. 2020. Nano-fibrous scaffold with curcumin for anti-scar wound healing. 589:119858.

Pandya N, Khan E, Jain N, Satham L, Singh R, Makde RD, Mishra A, Kumar AJB. 2021. Curcumin analogs exhibit anti-cancer activity by selectively targeting g-quadruplex forming c-myc promoter sequence.

## **SOBRE O ORGANIZADOR**

**JESUS RODRIGUES LEMOS** - Professor do Curso de Ciências Biológicas da Universidade Federal do Delta do Parnaíba-UFDPAr (anterior UFPI/*Campus* Ministro Reis Velloso), desde março de 2007. Possui Graduação em Ciências Biológicas pela Universidade Federal do Piauí, Mestrado em Biologia Vegetal pela Universidade Federal de Pernambuco, Doutorado em Ciências Biológicas (Botânica) pela Universidade de São Paulo e Pós-Doutorado no *Royal Botanic Gardens, Kew*, Londres. Desenvolve pesquisas na área de Botânica, com ênfase em Florística, Fitossociologia, Fitogeografia e Etnobotânica com a vegetação do semiárido brasileiro e Ensino de Botânica.

## ÍNDICE REMISSIVO

### A

Ambiente urbano 2  
Anti-cancerous 3, 48, 51  
Anti-oxidant 48, 51  
Aprendizagem 22, 23, 32, 33, 34, 35, 36, 37, 45, 46  
Arborização urbana 3, 1, 2, 3, 6, 20

### B

Botânica 1, 2, 3, 1, 21, 22, 23, 24, 29, 32, 33, 34, 35, 36, 44, 45, 46, 47, 58

### C

Curcuma 3, 48, 49, 51, 52, 53, 56  
Curcumin 48, 49, 50, 51, 55, 56, 57  
Curcuminoids 48, 49, 50, 53, 54, 55, 56

### E

Ensino 1, 2, 3, 1, 22, 23, 24, 28, 29, 33, 34, 35, 36, 37, 40, 43, 45, 46, 47, 58  
Estratégia de ensino 35

### F

Fisiologia vegetal 3, 35, 37, 38, 44, 45  
Flor 29, 33, 34, 42  
Flora 3, 4, 6, 7, 20  
Fotossíntese 35, 36, 38, 39, 40, 41, 42, 45, 46, 47

### I

Inflorescência 4, 24

### J

Jogos 23

### L

Levantamento florístico 4, 6  
Licenciatura 24, 35, 37

### M

Morfologia 3, 1, 20, 22, 23, 24, 32, 33, 34, 42

## **N**

Nutrição vegetal 35, 45

## **P**

Paisagismo 1

Praça 3, 4, 7

## **R**

Respiração vegetal 44


## **S**


Sítio eletrônico 4, 7


## **Z**


Zingiberaceae 32, 48, 49, 51

Ensino,  
pesquisa e  
inovação em  
botânica 2

[www.atenaeditora.com.br](http://www.atenaeditora.com.br) 

[contato@atenaeditora.com.br](mailto:contato@atenaeditora.com.br) 

@atenaeditora 

[www.facebook.com/atenaeditora.com.br](https://www.facebook.com/atenaeditora.com.br) 



Ensino,  
pesquisa e  
inovação em  
botânica 2

[www.atenaeditora.com.br](http://www.atenaeditora.com.br)   
[contato@atenaeditora.com.br](mailto:contato@atenaeditora.com.br)   
[@atenaeditora](https://www.instagram.com/atenaeditora)   
[www.facebook.com/atenaeditora.com.br](https://www.facebook.com/atenaeditora.com.br) 