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ORGANIC CULTIVATION OF TURMERIC RHIZOMES AND THEIR PROCESSING FOR IMMUNITY-BOOSTING TABLET FORMULATION

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ABSTRACT

Turmeric (Curcuma longa L.) is widely recognized for its potent therapeutic properties, primarily attributed to curcumin, a bioactive compound known for its anti-inflammatory and immune-boosting effects. This study aimed to develop a sustainable and organic approach for cultivating turmeric, extracting curcumin using eco-friendly methods, and formulating it into immunity-boosting tablets. Organic treatments, including vermicompost (10 t/ha), neem cake (500 kg/ha), and mulching, were applied under field conditions to evaluate their effects on rhizome yield and curcumin content. The highest yield (32.4 t/ha) and curcumin content (6.8%) were observed in plots treated with vermicompost + neem cake + mulch. Curcumin was extracted using Natural Deep Eutectic Solvents (NADES), yielding 3.6 g/100 g powder—30% higher than ethanol-based extraction. Tablets were formulated by incorporating piperine (5 mg) to enhance bioavailability. Physical parameters such as hardness, friability, and disintegration time met pharmacopeial standards. Dissolution tests showed that tablets with piperine released 85% of curcumin within 60 minutes, compared to 43% without piperine. Microbial testing confirmed the safety of the formulation, and stability studies *over six months demonstrated retention of quality and potency. Statistical analysis (ANOVA, Tukey's HSD) confirmed significant differences between treatments. This research supports the feasibility of developing effective, stable, and safe herbal nutraceuticals using organically grown turmeric and green processing techniques, providing a valuable model for eco-friendly immunity-boosting product development.*

Keywords: Turmeric, Organic cultivation, Curcumin, NADES extraction, Piperine, Immunity-boosting tablets, Sustainable agriculture, Herbal formulation, Bioavailability, Green chemistry.

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1. Introduction

Turmeric (*Curcuma longa* L.), a perennial herbaceous plant belonging to the Zingiberaceae family, has been revered for centuries in traditional medicine systems, particularly in South Asia. Its rhizomes are rich in curcumin, a bioactive compound known for its potent anti-inflammatory, antioxidant, and immunomodulatory properties (Jeliński, Przybyłek, & Cysewski, 2019). These properties make turmeric a highly promising candidate for developing immunity-boosting formulations in the form of dietary supplements and therapeutic agents. The increasing global demand for herbal remedies and natural immune enhancers has propelled the need for sustainable and organic cultivation of turmeric, especially with growing concerns over chemical residues and environmental degradation (Singh, Kumar, Passah, & Feroze, 2022).

Organic Cultivation of Turmeric Rhizomes

Organic farming practices emphasize ecological harmony and sustainability, avoiding synthetic inputs such as chemical fertilizers and pesticides. In the context of turmeric cultivation, this means selecting high-yielding, disease-resistant varieties and adopting sustainable practices like crop rotation, composting, and green manuring (Dayal, Singh, & Pahade, 2023). Organic manures such as farmyard manure, vermicompost, and neem cake are widely used to improve soil structure and nutrient content, supporting healthy rhizome development (Vikaspedia, n.d.).

The use of green leaf mulching is another integral practice in organic turmeric farming. It helps in conserving soil moisture, suppressing weed growth, and gradually enriching the soil organic matter. Mulching has shown to contribute significantly to rhizome yield and curcumin content (Dayal et al., 2023). Furthermore, effective organic pest and disease management is achieved by incorporating biocontrol agents such as *Trichoderma harzianum* and *Pseudomonas fluorescens*, which are effective against rhizome rot and fungal infestations. Neem oil and neem cake are commonly applied to deter shoot borers and aphids, maintaining crop health without synthetic interventions (Vikaspedia, n.d.).

Turmeric grows best in well-drained loamy or alluvial soils with a pH between 5.5 and 6.5, under warm and humid climatic conditions with 1500–2000 mm of annual rainfall. Certain regions like Lakadong in Meghalaya are renowned for cultivating turmeric with exceptionally high curcumin content, thanks to the region's specific microclimate and soil characteristics (Singh et al., 2022).

Processing of Turmeric Rhizomes

Post-harvest processing significantly impacts the therapeutic efficacy of turmeric products. The rhizomes are typically boiled or steamed soon after harvest to remove raw odor, deactivate enzymes, and gelatinize starch. This process also improves color and shelf-life. Once cured, the rhizomes are sun-dried for several days until moisture content drops below 10%, reducing microbial risks and enhancing storage stability (Dayal et al., 2023).

After drying, the rhizomes are polished and ground into powder for further use in formulations. Maintaining hygienic processing environments is essential to avoid contamination and preserve the bioactive content. Advanced research has explored the application of Natural Deep Eutectic Solvents (NADES) as green extraction solvents to enhance the solubility, stability, and bioavailability of curcumin. These solvents are non-toxic and biodegradable, making them suitable for organic processing methods (Jeliński et al., 2019).

Formulation of Immunity-Boosting Tablets

Despite its promising pharmacological properties, curcumin suffers from poor bioavailability due to low aqueous solubility and rapid metabolism. Hence, formulating it into effective health supplements requires addressing these challenges. Combining curcumin with piperine (a bioenhancer from black pepper) has been shown to increase its bioavailability by over 2000% by inhibiting hepatic and intestinal glucuronidation (Jeliński et al., 2019). Additionally, novel drug delivery systems like lipid-based nanoparticles, micelles, and phospholipid complexes have been developed to overcome curcumin's pharmacokinetic limitations.

The development of turmeric-based immunity-boosting tablets also demands strict quality control. Standardization of curcumin content, testing for microbial load, stability under various environmental conditions, and dissolution testing are all critical to ensuring the efficacy and safety of the product. Adherence to Good Manufacturing Practices (GMP) and compliance with organic certification standards are essential for market acceptance, especially in export-driven sectors (Singh et al., 2022).

Image.1. Immunity Booster Tablets

II. Materials and Methods

1. Site Selection and Experimental Design

The research was conducted over one complete cropping season (April–February) on organically certified farmland in [Tq. Gangapur Dist. Chh. Sambhaji Nagar], characterized by a loamy soil texture with a pH of 5.8 and annual rainfall of approximately 1800 mm. The site was selected based on agro-climatic suitability for *Curcuma longa* and its compliance with organic certification norms.

A **randomized block design (RBD)** was used with three replicates for each treatment. Treatments included:

- Different organic manures (farmyard manure, vermicompost, and neem cake),
- Various bio-control applications (*Trichoderma harzianum*, *Pseudomonas fluorescens*),
- Mulching types (green leaf mulch vs. no mulch).

2. Planting Material and Land Preparation

Certified disease-free seed rhizomes of the high-curcumin *Lakadong* variety were procured from a government-registered nursery. The rhizomes were pre-treated with a suspension of *Trichoderma harzianum* (5 g/L) for 30 minutes before sowing, a method known to prevent rhizome rot and enhance growth under organic systems (Dayal, Singh, & Pahade, 2023).The land was plowed thrice and raised beds were prepared with proper drainage channels. Each plot measured 3 m × 3 m, with a spacing of 30 cm between rows and 20 cm between plants.

3. Organic Inputs and Crop Management

Soil fertility was maintained through the application of the following organic manures:

- **FYM (Farmyard manure)**: 25 tons/ha
- **Vermicompost**: 10 tons/ha
- **Neem cake**: 500 kg/ha

Organic liquid formulations like Panchagavya (3%) were sprayed every 30 days to boost plant vigor and immunity (Singh *et al.*, 2022). Weeding was performed manually every 30–45 days.

4. Pest and Disease Management

Organic pest management included the use of:

• Neem oil (3%) sprayed biweekly to control shoot borers,

• *Pseudomonas fluorescens* (10 g/L) soil application every 60 days to control bacterial wilt and enhance soil microbial health (Vikaspedia, n.d.).

Crop health was monitored visually and via random destructive sampling of 10 plants per plot every 60 days to evaluate rhizome development and disease incidence.

5. Harvesting and Post-Harvest Processing

The turmeric crop was harvested 8–9 months after planting, once the leaves turned yellow and dried. Harvested rhizomes were cleaned and washed thoroughly.

Curing Process:

• Boiling: Rhizomes were boiled for 45 minutes at 80–90°C until the internal core turned yellow.

• Drying: Boiled rhizomes were sun-dried on clean drying platforms for 10–15 days, turning them regularly to ensure uniform drying to <10% moisture (Dayal *et al.,* 2023).

Polishing was done using manual polishing drums. The dried rhizomes were ground using a stainless steel grinder into fine powder and stored in airtight containers for further use.

6. Tablet Formulation

The formulation of immunity-boosting tablets from organically cultivated turmeric rhizomes involves a multi-step process to ensure the bioavailability, stability, and standardization of curcumin content.

6.1 Curcumin Extraction

After drying and powdering the turmeric rhizomes, curcumin was extracted using **Natural Deep Eutectic Solvents (NADES)**, a green alternative to conventional solvents. A eutectic mixture of **choline chloride and citric acid** in a 1:1 molar ratio was prepared by gentle heating and stirring at 60°C. Approximately 100 g of turmeric powder was mixed with 500 mL of NADES, and the solution was stirred at 60°C for 2 hours (Jeliński et al., 2019). The extract was then filtered and concentrated using a rotary evaporator under reduced pressure to obtain a dense, curcumin-rich paste.

This method improved the solubility and stability of curcumin while maintaining its chemical integrity and eliminating toxic solvent residues, which is crucial in organic product development.

6.2 Bioavailability Enhancement

To overcome curcumin’s inherent low bioavailability, **piperine** (5 mg per tablet) extracted from black pepper was incorporated into the formulation. Piperine inhibits hepatic and intestinal glucuronidation, enhancing curcumin absorption by up to 2000% (Jeliński et al., 2019).

6.3 Tablet Composition and Manufacturing

Each 500 mg tablet was formulated to contain:

- Curcumin extract (standardized to 95% curcumin) – 300 mg
- Piperine extract – 5 mg
- Microcrystalline cellulose – 160 mg (binder and bulking agent)
- Magnesium stearate – 5 mg (lubricant)
- Silicon dioxide – 5 mg (anti-caking agent)
- Natural vanilla flavor – 5 mg (organoleptic improvement)

The ingredients were thoroughly blended in a double-cone blender to ensure homogeneity and then compressed into tablets using a **rotary tablet press** fitted with 9 mm round concave punches. All operations were conducted under **GMP-compliant conditions** in a controlled cleanroom environment to minimize microbial contamination.

7. Quality Testing

Ensuring the safety, efficacy, and consistency of the formulated tablets required rigorous **phytochemical, microbiological, and pharmaceutical evaluations**.

7.1 Phytochemical Analysis

High-Performance Liquid Chromatography (HPLC) was employed to quantify the curcumin content in turmeric powder, extracts, and final tablets. Samples were analyzed using a C18 column with an acetonitrile–water (45:55) mobile phase containing 0.1% acetic acid, at a detection wavelength of 425 nm.

Results were expressed as milligrams of curcumin per gram of extract or per tablet, and the values were cross-referenced with standard curcumin for confirmation.

7.2 Microbial Load Testing

Microbiological assessments were carried out to determine the safety of the tablets as per **WHO and AYUSH guidelines** for herbal formulations:

- **Total Plate Count (TPC)** and **Yeast and Mold Count (YMC)** were performed using Nutrient Agar and Sabouraud Dextrose Agar, respectively.
- Pathogens such as *Escherichia coli*, *Salmonella spp.*, and *Staphylococcus aureus* were tested using selective media and confirmatory biochemical assays.

Acceptable limits adhered to were:

- TPC: $<10^4$ CFU/g
- YMC: $<10^2$ CFU/g
- Pathogens: Absent in 1 g

7.3 Physical and Pharmaceutical Evaluation

- **Disintegration Time**: Measured using a USP disintegration apparatus in distilled water at 37°C; tablets were required to disintegrate within 15 minutes.
- **Hardness and Friability**: Tablet mechanical strength was tested using a Monsanto hardness tester and Roche friabilator (<1% weight loss acceptable).
- **Dissolution Profile**: Dissolution was assessed in simulated gastric fluid (0.1 N HCl) using a USP paddle apparatus at 37°C and 50 rpm. Samples were collected at 15, 30, and 60 minutes and analyzed via UV-Vis spectroscopy.
- **Stability Testing**: Accelerated stability testing was carried out over 6 months at 40°C and 75% relative humidity (ICH Q1A-R2 guidelines). Samples were evaluated at 0, 3, and 6 months for color, odor, curcumin content, and microbial load.

8. Statistical Analysis

The experimental data were subjected to appropriate statistical techniques to determine the significance of various treatments on rhizome yield, curcumin content, and tablet quality parameters.

8.1 Software and Model

All data were analyzed using **SPSS version 25.0**. Analysis of variance (ANOVA) was performed to determine statistically significant differences among treatments.

8.2 Post-Hoc Analysis

When ANOVA indicated significant differences ($p < 0.05$), **Tukey's Honestly Significant Difference (HSD) test** was employed for multiple comparisons between treatment means.

8.3 Data Representation

- Quantitative results were expressed as **mean ± standard deviation (SD)** for three replicates.
- Graphs and figures were plotted using **Microsoft Excel 2019**, representing trends in curcumin yield, microbial load reduction, and tablet dissolution.

This statistical approach ensured robust evaluation of:

- Effects of different organic inputs on turmeric yield and curcumin concentration,
- Efficacy of the NADES method for extraction,
- Impact of piperine on tablet dissolution and bioavailability,
- Stability and safety of the final product.

Results and Discussion

1. Rhizome Yield and Quality

The application of organic inputs significantly influenced the rhizome yield and curcumin content. Among the treatments, plots receiving a combination of **vermicompost (10 tons/ha)**

and neem cake (500 kg/ha) with green leaf mulch recorded the highest fresh rhizome yield at **32.4 tons/ha**, which was **18% higher** than the farmyard manure (FYM) alone treatment ($p < 0.05$).

This enhanced performance can be attributed to the synergistic effect of vermicompost in improving soil structure and microbial activity, while neem cake likely acted as both a nutrient source and a biopesticide. These results align with Dayal, Singh, and Pahade (2023), who found that integrated organic inputs and mulching enhance turmeric productivity by improving soil aeration and moisture retention. The **curcumin content** analyzed using HPLC showed the highest values in turmeric grown with vermicompost + neem cake + mulching (**6.8%**), compared to FYM-treated plots (**5.1%**). This supports previous findings by Singh et al. (2022), who noted that organic practices in the North East Indian hill states favor higher curcumin accumulation due to enhanced soil microbial interactions and reduced chemical stress.

Table 1: Effect of Organic Treatments on Rhizome Yield and Curcumin Content

Treatment	Rhizome Yield (tons/ha)	Curcumin Content (%)
FYM (25 t/ha)	27.5 ± 1.2	5.1 ± 0.3
Vermicompost (10 t/ha)	30.1 ± 0.9	6.1 ± 0.2
Neem cake (500 kg/ha)	28.3 ± 1.1	5.7 ± 0.2
Vermicompost + Neem Cake	31.2 ± 1.0	6.5 ± 0.2
Vermicompost + Neem Cake + Mulch	**32.4 ± 1.3**	**6.8 ± 0.3**

2. Curcumin Extraction Efficiency

The use of **Natural Deep Eutectic Solvents (NADES)** significantly enhanced the curcumin yield during extraction. From 100 g of turmeric powder, the NADES-based method yielded **3.6 g of curcumin-rich extract**, which was approximately **30% higher** than ethanol extraction under similar conditions.

This improvement is due to the unique physicochemical properties of NADES (high polarity, hydrogen bonding capability, and thermal stability), which dissolve hydrophobic compounds like curcumin more effectively (Jeliński, Przybyłek, & Cysewski, 2019). Furthermore, the non-toxic, biodegradable nature of NADES supports its use in organic-certified formulations.

Table 2: Curcumin Extraction Yield Using Different Solvents

Extraction Method	Curcumin Extract Yield (g/100 g powder)	Solvent Used
Ethanol (95%)	2.7 ± 0.2	Ethanol
NADES (Choline Chloride + Citric Acid)	**3.6 ± 0.1**	Green solvent (NADES)

3. Tablet Evaluation

3.1 Physical Parameters

The formulated tablets had an average weight of **505 ± 5 mg**, hardness of **6.2 ± 0.4 kg/cm²**, and friability of **0.62%**, indicating adequate mechanical strength and handling characteristics. The **disintegration time** was recorded at **9.2 ± 1.1 minutes**, well within pharmacopeial limits (<15 minutes), which suggests good dissolution potential in gastric conditions.

3.2 Dissolution Profile and Bioavailability

Dissolution studies in simulated gastric fluid showed that **85% of curcumin was released within 60 minutes** in tablets containing piperine, whereas control tablets without piperine released only 43% curcumin. These findings confirm the bioavailability-enhancing role of piperine through inhibition of hepatic metabolism, in line with the work by Jeliński et al. (2019).

3.3 Microbial and Stability Testing

Microbial load was within acceptable limits:

- Total Plate Count: **320 CFU/g**
- Yeast and Mold Count: **<100 CFU/g**
- Pathogens: **Absent** in all samples

No significant changes in color, odor, curcumin content, or microbial status were observed after **6 months of accelerated storage** (40°C, 75% RH), indicating good **shelf stability** of the formulation.

These results validate the effectiveness of hygienic processing and GMP protocols in maintaining the microbial safety and quality of herbal tablets, as emphasized in WHO and AYUSH guidelines.

Table 3: Physical Properties of Formulated Tablets

Parameter	Observed Value (mean ± SD)	Pharmacopeial Limit
Tablet weight (mg)	505 ± 5	±5% variation allowed
Hardness (kg/cm²)	6.2 ± 0.4	4–8 kg/cm²
Friability (%)	0.62	<1%
Disintegration Time (min)	9.2 ± 1.1	<15 min

4. Statistical Significance

ANOVA revealed statistically significant differences ($p < 0.05$) between treatments for:

- Rhizome yield,
- Curcumin content,
- Extraction efficiency,
- Tablet dissolution rate.

Table 4: Dissolution Profile of Tablets With and Without Piperine

Time (minutes)	% Curcumin Released (With Piperine)	% Curcumin Released (Without Piperine)
15	52.3 ± 1.5	24.1 ± 1.8
30	73.8 ± 1.9	36.5 ± 1.7
60	**85.4 ± 1.3**	**43.1 ± 2.0**

Table 5: Microbial Load of Final Tablet Formulation

Microbial Parameter	Observed Value (CFU/g)	WHO/AYUSH Acceptable Limit
Total Plate Count	320	$<10^4$
Yeast and Mold Count	<100	$<10^2$
E. coli	Absent	Absent in 1 g
Salmonella spp.	Absent	Absent in 1 g
Staphylococcus aureus	Absent	Absent in 1 g

Table 6: Stability Testing (Accelerated, 40°C/75% RH)

Parameter	0 Month	3 Months	6 Months
Color/Odor	Normal	Normal	Normal
Curcumin Content (mg)	300 ± 2.4	295 ± 2.9	291 ± 3.2
Disintegration Time (min)	9.2 ± 1.1	9.4 ± 1.0	9.5 ± 1.2
Microbial Load	Within Limits	Within Limits	Within Limits

No significant degradation or microbial growth observed over 6 months.

Conclusion

This study demonstrates that organic cultivation using vermicompost, neem cake, and mulching significantly enhances turmeric yield and curcumin content. The use of green solvents like NADES for extraction and piperine for bioavailability successfully led to the formulation of safe, effective, and stable immunity-boosting tablets. These findings support the potential for sustainable, organic-based nutraceutical development that aligns with health, ecological, and economic goals.

References

[1] Dayal, G., Singh, S., & Pahade, E. (2023). Organic cultivation of turmeric by Good Agricultural Practices (GAP) in Bundelkhand region. Indian Farming, 73(4), 39–41. Retrieved from https://ebook.icar.gov.in/index.php/IndFarm/article/view/130732

[2] Jeliński, T., Przybyłek, M., & Cysewski, P. (2019). Natural deep eutectic solvents as agents for improving solubility, stability and delivery of curcumin. arXiv preprint, arXiv:1906.02105. https://arxiv.org/abs/1906.02105

[3] Singh, R., Kumar, S., Passah, S., & Feroze, S. M. (2022). Determinants of organic turmeric (Curcuma longa) cultivation in hill states of India: A logit approach. The Indian Journal of Agricultural Sciences, 92(2), 240–244. https://doi.org/10.56093/ijas.v92i2.122229

[4] Vikaspedia. (n.d.). Turmeric cultivation practices. Retrieved from https://en.vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric

[5] Dayal, G., Singh, S., & Pahade, E. (2023). Organic cultivation of turmeric by Good Agricultural Practices (GAP) in Bundelkhand region. Indian Farming, 73(4), 39–41. Retrieved from https://ebook.icar.gov.in/index.php/IndFarm/article/view/130732

[6] Jeliński, T., Przybyłek, M., & Cysewski, P. (2019). Natural deep eutectic solvents as agents for improving solubility, stability and delivery of curcumin. arXiv preprint, arXiv:1906.02105. https://arxiv.org/abs/1906.02105

[7] Singh, R., Kumar, S., Passah, S., & Feroze, S. M. (2022). Determinants of organic turmeric (Curcuma longa) cultivation in hill states of India: A logit approach. The Indian Journal of Agricultural Sciences, 92(2), 240–244. https://doi.org/10.56093/ijas.v92i2.122229

[8] Vikaspedia. (n.d.). Turmeric cultivation practices. Retrieved from https://en.vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric

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