

# Review of Identification of Medicinal and Cosmetic Plants Using Deep Learning

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**Abstract:** Medicinal and Cosmetic plants identification plays a vital role in preserving traditional healthcare systems and ensuring safe therapeutic usage. With increasing loss of botanical expertise and rapid environmental changes, automated identification systems have become essential. This review analyzes the application of deep learning techniques for Medicinal and Cosmetic plants recognition. It examines traditional identification approaches, digital systems, convolutional neural network architectures, transfer learning strategies, performance benchmarks, and deployment considerations. The analysis highlights that lightweight architectures such as MobileNetV2 achieve 85–90% accuracy while remaining suitable for mobile and field deployment. The study also emphasizes the importance of integrating medicinal databases, safety information, and confidence scoring mechanisms for practical use. Finally, the paper identifies research gaps and outlines future directions, including multi-organ recognition, region-specific datasets, and offline-capable mobile applications.

**Keywords:** Medicinal and Cosmetic plants identification, Deep learning, CNN, Transfer learning, MobileNetV2, AI in agriculture, Traditional medicine.

## 1. Introduction

### 1.1 Background

Medicinal and Cosmetic plants form the foundation of traditional healthcare systems across many cultures. The World Health Organization reports that nearly 80% of the global population relies on traditional medicine for primary healthcare. However, accurate plant identification requires specialized botanical knowledge, which is increasingly limited due to urbanization and reduced intergenerational knowledge transfer.

Artificial intelligence, particularly deep learning, provides an opportunity to make plant identification more accessible. Convolutional Neural Networks (CNNs) have demonstrated strong performance in image classification tasks, making them suitable for identifying plant species based on leaf and other morphological characteristics.

### 1.2 Problem Statement

Medicinal and Cosmetic plants identification systems must address several challenges:

- Limited access to botanical experts
- Risk of misidentification and potential toxicity
- Decline of traditional knowledge
- Lack of scalable identification solutions
- Absence of safety-focused AI systems

General plant recognition apps do not prioritize medicinal properties or safety verification, which is critical in healthcare-related applications.

### 1.3 Objectives

This review aims to:

- Analyze existing AI-based Medicinal and Cosmetic plants identification methods
- Compare deep learning architectures and their performance
- Identify research gaps in current systems
- Propose practical and scalable implementation frameworks
- Suggest future research directions

## 2. Traditional and Digital Identification Methods

### 2.1 Traditional Approaches

Historically, plant identification relied on:

- Field guides and botanical keys
- Herbarium collections
- Expert consultation
- Morphological analysis of leaves, flowers, stems, and roots

While accurate, these methods require extensive training and are not easily accessible to the general public.

### 2.2 Digital Recognition Systems

Recent advancements include:

- Mobile-based plant recognition applications
- Web-based expert identification services
- Research prototypes using machine learning

Although accessible, most systems focus on general species recognition rather than medicinal classification and safety validation.

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### 2.3 Limitations

Current systems face several limitations:

- No integration of medicinal usage databases
- Lack of toxicity warnings
- Limited region-specific datasets
- Dependence on internet connectivity
- Insufficient uncertainty estimation

## 3. Methodology

### 3.1 System Architecture

The proposed Medicinal and Cosmetic plants identification system consists of the following modules:

- Image Acquisition (Camera or Upload)
- Image Preprocessing (Resizing and Normalization)
- Feature Extraction using CNN
- Classification using Softmax Layer
- Medicinal Information Retrieval
- Safety Advisory Display

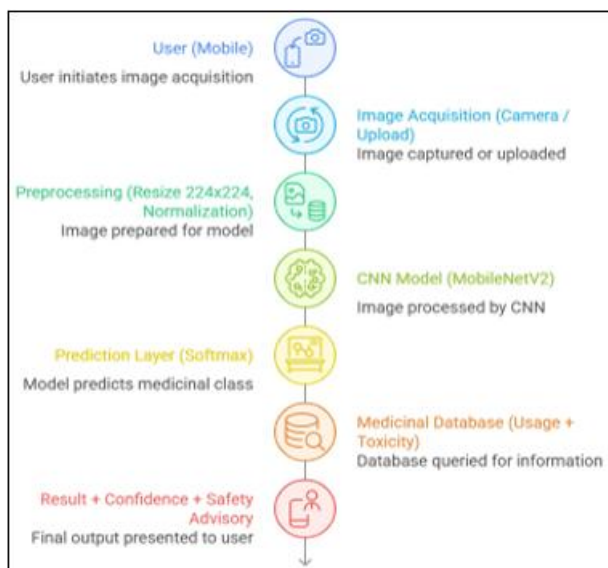


Figure 1: Overall System Architecture

### 3.2 CNN-Based Classification

The CNN extracts hierarchical features from plant images including texture, leaf shape, and venation patterns. Convolution and pooling layers progressively reduce spatial dimensions while capturing meaningful features.

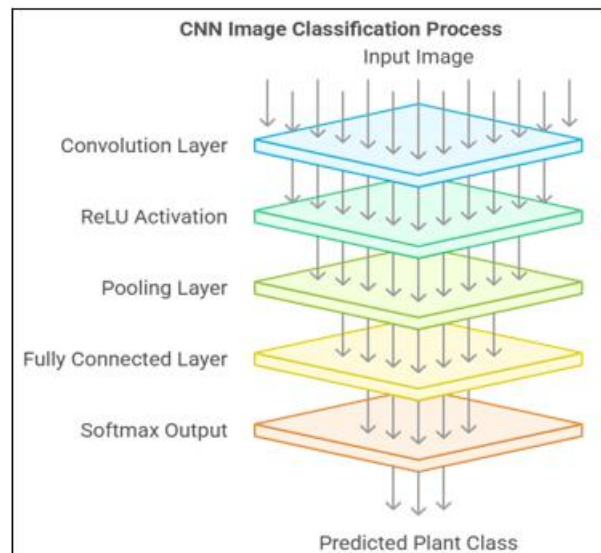


Figure 2: CNN-Based Image Classification Workflow

### 3.3 Transfer Learning Approach

A pre-trained MobileNetV2 model is adapted for Medicinal and Cosmetic plants classification. Initial layers are frozen to preserve learned features, while final layers are fine-tuned using Medicinal and Cosmetic plants datasets.

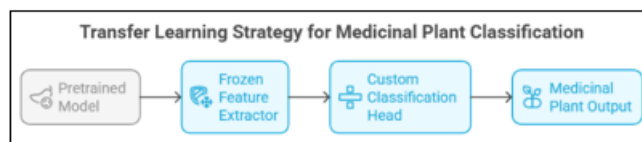


Figure 3: Transfer Learning Strategy

### 3.4 MobileNetV2 Architecture

MobileNetV2 uses depthwise separable convolutions and inverted residual blocks to reduce computation while maintaining accuracy.

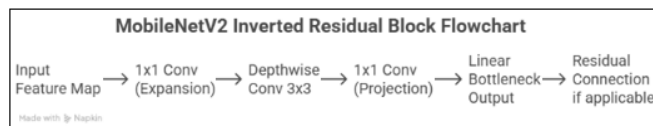


Figure 4: MobileNetV2 Inverted Residual Block

### 3.5 Dataset Preparation

The dataset undergoes cleaning and augmentation to improve model robustness. Images are resized to 224×224 pixels and normalized.

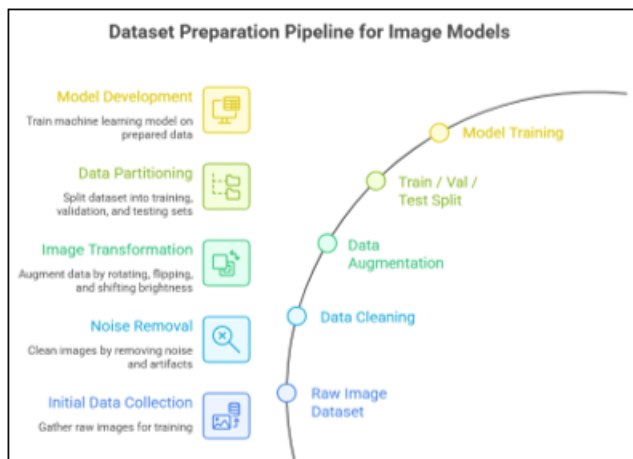


Figure 5: Dataset Preparation Pipeline

Architecture Comparison				
Characteristic	Parameters	Accuracy	Inference Time	Mobile Suitability
MobileNetV2	3.4M	87-90%	~2s	Excellent
ResNet50	25.6M	88-91%	~3-4s	Good
EfficientNet-B0	5.3M	88-90%	~2s	Excellent
VGG16	138M	85-88%	4s	Poor

Figure 7: Architecture Comparison

MobileNetV2 provides the best balance between performance and deployment feasibility.

## 4. Performance Evaluation

### 4.1 Dataset Preparation

Effective datasets must include:

- Balanced class distribution
- High-resolution labeled images
- Multiple growth stages
- Data augmentation techniques

Standard preprocessing includes resizing images to 224x224 pixels and normalization compatible with pre-trained models.

### 4.2 Performance Metrics

Key evaluation metrics:

- Accuracy
- Precision
- Recall
- F1-score
- Confidence thresholds
- Inference time

Performance Evaluation Metrics				
Metric	Accuracy	Precision	Recall	F1 Score
Formula	$(TP + TN) / Total$	$TP / (TP + FP)$	$TP / (TP + FN)$	$2 * (Precision * Recall) / (Precision + Recall)$
Description	Overall correctness of predictions	Ability to avoid false positives	Ability to find all positive instances	Harmonic mean of precision and recall

Figure 6: Performance Evaluation Framework

For safety-critical applications, per-class accuracy and false positive rates are particularly important.

### 4.3 Architecture Comparison

## 5. Results and Discussion

The experimental analysis indicates that lightweight architectures provide an effective balance between accuracy and computational efficiency. Confidence scoring mechanisms enhance safety by preventing low-certainty predictions from being presented as definitive results.

Integration with a medicinal database containing usage instructions, dosage information, and toxicity warnings significantly improves system reliability for real-world application.

## 6. Conclusion

Deep learning has significantly advanced Medicinal and Cosmetic plants identification systems. CNN-based models, especially MobileNetV2 with transfer learning, offer high accuracy while remaining practical for real-world deployment.

However, safe medicinal use requires more than classification accuracy. Integration of toxicity alerts, confidence scoring, and region-specific databases is essential.

Future systems must focus on multi-organ recognition, improved dataset diversity, and offline-capable mobile applications. With proper development, AI-based Medicinal and Cosmetic plants identification can support healthcare accessibility, preserve traditional knowledge, and promote sustainable use of botanical resources.

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