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## Updates on Ethnomedicinal Uses and Biological Activities of *Genus Ruellia*

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### ABSTRACT

*Ruellia* is the genus of flowering plant comprising about 250 species, commonly called as wild petunias. Some of the members of this genus are medicinally important and are being used traditionally to cure several ailments by tribals and local peoples. Present article deals with the discussion of various traditional uses and biological activities of members of genus *Ruellia*, reported by several scientists. These plants showed diuretic, anti-diabetic, antipyretic, analgesic, antioxidant, gastroprotective, antimicrobial, antifertility, anti-inflammatory, antioceptive, antiulcer, cytotoxic and anticancer properties. Several members of genus *Ruellia* have traditional medicinal values and most of them are explored for their biological properties. However, the bioactive molecules of these plants are yet to be investigated fully. Some of these plants could prove significant source of medicinal potential molecules as drug candidate.

**Keywords:** *Ruellia*, ethnomedicinal uses, biological activities.

### INTRODUCTION

Since civilization, humans are using plants and plant products for their various needs includes routine healthcare. As plants possess healing properties, they are being used as traditional medicinal plants across the globe, especially by different tribes. Due to its unique phylogenetic and environmental conditions, Indian subcontinent supports the growth and development of over 20,000 flowering plants, of which about 7000 plants are reported to have medicinal potential and are being used by local medicine men in different native communities.

Now, it's a known fact that the properties of medicinal plants are due to their active secondary metabolites. The herbal era was started after the isolation of active compounds like digitoxin, quinine, cocaine and codeine from different medicinal plants. The genus *Ruellia* belongs to family Acanthaceae (Acanthus family). The members of this genus are commonly known as wild petunias<sup>1-2</sup>. This genus consists of over 250 species, distributed in tropical and temperate regions of both the hemispheres including Indian subcontinent. *Ruellia* is represented by 10 species from India off which two were recorded from Maharashtra State<sup>3-6</sup>. Present review article is an update on the information related to folk medicinal uses, ethnobiology and phytochemical constituents from different members of genus *Ruellia* having medicinal potential.

### MATERIAL AND METHODS

We conducted an online survey of literature in different online databases and professional websites with the key

words related to our study. Initially we have searched for the ethnomedicinal uses of different members of *Ruellia* recorded by various ethno-botanists across the globe. Later we search for experimentally proven biological activities of various species of *Ruellia*. Then the data collected was interpreted in the light of recent researchers and compiled to prepare this review.

### RESULTS AND DISCUSSION

#### Ethnomedicinal uses of members of Genus *Ruellia*

*Ruellia* is one of the most under rated medicinal plant genus of Acanthaceae. Some species of *Ruellia* are being used in traditional medicine preparations by different communities and also been part of Ayurveda and Ayush systems in India. The fresh leaves of the plant *Ruellia patula* is been use in earache<sup>7</sup>. One of the species, *R. tuberosa* has been extensively used as diuretic, anti-diabetic, antipyretic, analgesic, antioxidant<sup>8</sup>, to treat gonorrhoea, anti-hypertensive and gastroprotective<sup>9-10</sup>. Most of the plant species of *Ruellia* has been widely used as anti-diabetic, antipyretic, gastroprotective, antimicrobial, analgesic, anti-oxidant and anticancer against the epidermis of nasopharynx region<sup>11</sup>. *Ruellia asperula* is used in bronchitis, asthma, flu, fever and uterus inflammation<sup>12</sup>. The leaves of *R. prostrata* are being used in the treatment of chronic rheumatism, eczema, facial paralysis, cephalgia and hemiplegia; its leaf juice is an efficient remedy on colic infection in children<sup>13</sup>. *R. brittoniana* is being used for cardiovascular screening and also as antioxidant plant<sup>14</sup>. Choudhary<sup>15</sup> has documented the use of *R. patula* to cure bone fracture (stem decoction with cow milk),

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## Synthesis of new heterocyclic N'-(2-hydroxy-3-methoxybenzylidene)-4-oxopiperidine-1-carbohydrazide and its mononuclear metal (II) complexes: Spectroscopic characterization, fluorescence, DFT, thermo-kinetic, and antimicrobial studies

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### ABSTRACT

New hydrazone Schiff base N'-(2-hydroxy-3-methoxybenzylidene)-4-oxopiperidine-1-carbohydrazide (H<sub>2</sub>L), synthesized by the condensation reaction of 2-hydroxy-3-methoxybenzaldehyde (HMB) and 4-oxopiperidine-1-carbohydrazide (CPH), form mononuclear complexes, [Mn(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Co(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Ni(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>] and [Cu(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>]. The formation of ligand was confirmed by elemental analysis, melting point, IR, <sup>1</sup>H and <sup>13</sup>C NMR, and ESI-Mass spectroscopy. Cu(II) complex was further examined by ESR spectroscopy. Other properties, like, molar conductance, IR, electronic spectra, magnetic susceptibility, DFT, powder X-ray diffractometer, fluorescence and thermal analysis have also been studied. Powder X-ray diffraction patterns inferred that compounds are nanocrystalline nature. Surface morphology further support this observation. All compounds show good absorption properties and in excited state at (λ<sub>320nm</sub>), the fluorochromes of the ligand and its metal (II) complexes emitted a good fluorescence emission with the resonance of 0.2 nm in (λ<sub>527-545 nm</sub>) region. The DFT B3LYP/6-311G+(d,p) calculations were carried out for the determination of the optimized structure of ligand (H<sub>2</sub>L) and its metal complexes. The frontier MOs energies data indicated good charge transfer (CT) from HOMO to LUMO. Thermal study of complexes monitored under nitrogen atmosphere led us to determine the activation parameters of various decomposition steps. On the basis of activation energy evaluated by Coats-Redfern relation, thermal stability order was found to be Ni(II) < Cu(II) < Mn(II) < Co(II). The ligand and complexes have also been screened for their antibacterial and antifungal potency and metal complexes showed higher activity against multi-stranded microorganisms viz. gram -ve bacteria (*Escherichia coli* and *Salmonella typhi*), gram + ve bacteria (*Staphylococcus aureus*, *Bacillus subtilis*) and fungal species (*Candida albicans*, *Aspergillus niger*).

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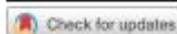
### 1. Introduction

Heterocyclic moiety involving hydrazones have gained wide applications, and proven to be a very promising, versatile motif in the medicinal chemistry and drug design. Hydrazone based Schiff bases offer an adaptable series of ligands proficient to tie with different metal ions to give edifices for their various applications. Hydrazone based Schiff bases can be considered to be one of the most researched group of chemical molecules by researchers, the reasons being their versatility, selectivity, sensitivity, stability, and ease of synthesis, just to mention a few, which resulted in their

wide applications. It has been reported that the azomethine functional group containing molecules contribute to their bioactivity by interacting and forming intramolecular hydrogen bonding with some responding sites within the cell structure, and thus affects the regular cell processes and signifies their biological significance. Similarly, the lone pair of electrons on the sp<sup>2</sup> hybridized orbital of the azomethine nitrogen is another reason for their chemical reactivity. The compounds of hydrazone Schiff base are not only synthons for the synthesis of new metal complexes but also exhibit interesting coordination mode [1–6]. The chemistry of hydrazones containing piperidine ring and their metal complexes is fascinating due to their importance in pharmacological, clinical, analytical and biological applications such as antimalarial, antibacterial, antifungal, and antiviral activities antioxidant, anti-inflammatory, anticonvulsant, analgesic, antimicrobial, anticancer, antiprotozoal,

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## A heterocyclic *N'*-(4-(diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazone Schiff base ligand and its metal complexes: Synthesis, structural characterization, thermal behavior, fluorescence properties, and biological activities

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### ABSTRACT

A new heterocyclic hydrazone Schiff base ligand, *N'*-(4-(diethylamino)-2-hydroxybenzylidene)-4-oxopiperidine-1-carbohydrazone, (HL) was derived by a condensation reaction of 4-oxopiperidine-1-carbohydrazone with 4-(diethylamino)-2-hydroxybenzaldehyde. The ligand reacts with chloride salts of chromium(III), manganese(II), iron(III), cobalt(II), nickel(II), copper(II) and zinc(II) to form metal complexes of [Cr(L)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Mn(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Fe(L)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Co(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Ni(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Cu(HL)(Cl)(H<sub>2</sub>O)<sub>2</sub>], [Zn(L)(H<sub>2</sub>O)<sub>2</sub>], respectively. The structure of the hydrazone ligand was confirmed by elemental analysis and spectroscopic techniques, viz., FT-IR, <sup>1</sup>H NMR, <sup>13</sup>C NMR, and LC-MS spectroscopy. The newly synthesized ligand behaves as a tridentate ONO donor towards Cr, Mn, Fe, Co, Ni, Cu, and Zn metal ions. The spectral, magnetic moment, and thermal data indicate the octahedral geometry for all metal complexes except for Zn, which has tetrahedral geometry with 1:1 stoichiometry (M:L). ESR study revealed that π-bonding covalency is much stronger than the σ-bonding with axial distortion in the structure. The molar conductivity data suggested the nonelectrolytic nature of the complexes. The powder X-ray diffraction patterns suggest the nanocrystalline nature of the compounds. The SEM micrograph of the ligand significantly differs from its Ni(II) complex indicating coordination of Ni(II) ion to the ligand. The intense fluorescence emitted in the region of λ<sub>max</sub> 521 to 524 nm due to the functional fluorophores of the ligand and its manganese (II), chromium(III), cobalt(II), and zinc(II) complexes. Various kinetic parameters such as E<sub>a</sub>, ΔS, ΔH, and ΔG of various decomposition steps were calculated from TGA diagrams using Coats-Redfern method and the thermal stability order was found to be Cr < Fe < Co < Mn < Cu < Zn < Ni. The antibacterial and antifungal activities of the ligand and its divalent and trivalent metal complexes were performed against the various pathogens viz. *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus*, *Bacillus subtilis*, *Candida albicans*, and *Aspergillus niger* with reference to standard antibiotics viz. ofloxacin, azithromycin, and fluconazole. All metal complexes showed promising biological activity as compared with their parent ligand and may be used as a potential antimicrobial candidate in biological science.

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### 1. Introduction

The heterocyclic hydrazone Schiff base ligand plays a significant role in the coordination chemistry, as they easily form more stable complexes with most of the transition metal ions and found extensive applications in the various fields comprising organic synthesis, medicinal chemistry, non-linearity, and superb optical (i.e., absorbance and emission properties) to the supramolecular chemistry [1-4]. The hydrazone Schiff base containing the tridentate moiety of ONO active donor sites displayed a versatile class of ligands which have been studied for a long time as potential multifunctional properties due to their structural diversity, tautomerism, reaction conditions, and with good yield. The heterocyclic tridentate hydrazone contains the flexible ONO donor atoms in

the carbonyl 'O' and the azomethine 'N', and phenolic 'O' active donor sites. Aryl hydrazones are having to possess paramount importance due to their molecular modularity, structural flexibility, straightforward synthesis, and thermal stability have been explored as a reason for their diversified potential application [5,6].

The transition metal complexes derived from aryl hydrazones exhibit very good enzymatic activity and are found very important in organometallic synthesis, analytical chemistry, and medicinal chemistry [6,7]. Furthermore, the tridentate moieties of the Schiff base of hydrazones and their complexes gained more recognition due to their broad-ranging biological properties, antinociceptive, and anti-inflammatory activities [8-10]. Hydrazone compounds containing the azomethine group have shown a significant role in the medicinal

## ७. भारतीय अभिजात संगीतामध्ये पं. वि. ना. भातखंडे यांचे अतुलनीय योगदान

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### प्रस्तावना

भारतीय अभिजात संगीताचे शिक्षण, घराण्यांमधून पूर्वापार चालत आलेल्या पारंपरिक गुरुकुल पद्धतीने दिल्या जात होते. घराण्यांतून दिले जाणारे हे संगीत हस्तगत करणे सर्वसामान्यांच्या आवाक्यातली बाब नव्हती. भारतात स्थापन झालेल्या संस्थागत शिक्षण पद्धतीतूनही संगीत शिकविल्या जाण्याची कोणतीच सोय अद्याप केल्या गेली नव्हती. त्यामुळे संगीत शिक्षणाच्या नावावर केवळ घराण्यांचेच वर्चस्व राहिले होते. संगीत शिक्षण म्हटले, तर घराण्यांविना दुसरा कोणताच इलाज उरलेला नव्हता. इतकेच काय, तर घराण्यांतील गायकांचे गाने ऐकणेही बहुसंख्यकांसाठी जवळ जवळ दुर्लभच होते. अशा परिस्थितीत, भारतीय अभिजात संगीताची धारा सर्वसामान्यांसाठी उपलब्ध करून देण्याच्या दृष्टीने, तसेच संगीत कलेचे प्रत्यक्ष सादरीकरण व या कलेच्या तात्त्विक बाजूमध्ये असलेली विसंगती दूर करून, संगीताचा सर्वमान्य सैद्धांतिक पक्ष पुनर्स्थापित करण्याच्या दृष्टीने अभूतपूर्व कामगिरी करणाऱ्याचे महान कार्य पंडित विष्णू नारायण भातखंडे यांनी केले.

पं. भातखंडेंचे पूर्ण नाव विष्णू नारायण भातखंडे उर्फ विष्णू शर्मा असे होते. त्यांचा जन्म १० ऑगस्ट १८६० साली झाला. संगीताप्रती ओढ त्यांना लहानपणापासूनच होती. त्यामुळे त्यांना संगीताचा छंद जडला होता. त्यांच्या वडिलांनीही त्यांच्या या छंदाचा कधी विरोध केला नाही. आपल्या या संगीत छंदाची जोपासना करता आल्यामुळेच त्यांना शालेय जीवनात गायनासंबंधीची अनेक पारितोषिके मिळविता आली. बासरी आणि सितार वादनातही प्रगती साध्य करता आली. सन १८८० साली ते मॅट्रिकची परीक्षा पास झालेत. त्यांच्या सांगीतिक वाटचालीच्या दृष्टीने, भावी आयुष्यात जे महान कार्य त्यांच्या हातून घडणार होते त्याला प्रेरक होईल अशी घटना, सन १८८४ च्या तेव्हापात घडली. या काळात त्यांचा संपर्क मुंबई मधील 'गायनोत्सव मंडळी' नावाच्या संस्थेशी झाला. हे मंडळ मुंबईतील धनाढ्य अशा पारशी लोकांच्या पुढाकाराने चालविले जात असे. या मंडळाद्वारे घराणा पारंपरेतील गायक- वादकांची मासिक वेतनावर नेमणूक केली जात असे. त्यामुळे आपल्या सांगीतिक जिज्ञासू प्रवृत्तीला वाट मोकळी करून देण्याच्या दृष्टीने हे मंडळ भातखंडेंना उपयुक्त वाटले. या दृष्टीने ते या संस्थेचे सदस्य झालेत. त्यावेळी दक्षिण हिंदूवादाच्या झेंड्याखाली ख्याचे शिष्य असलेले, श्री. रावजीबुवा बेलगावकर हे सुविख्यात धूपद गायक या मंडळात नोकरीला होते. रावजीबुवांच्या शिष्यत्वात राहून, भातखंडेंनी त्यांच्याकडून जवळ- जवळ तीनशे धूपद शिकून घेतले होते. पुढे सन १८८७ साली

## Synthesis, Characterization and Antimicrobial Activity of Copper Oxide Nanoparticles Using Sol-Gel Method

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### Abstract

This study investigates a novel way for producing copper oxide (CuO) nanoparticles using the sol-gel process and citric acid as a surfactant. In this technique, water is used as a potent solvent. Because of its low cost, ease of preparation, and commercial practicality, the synthetic approach is environmentally beneficial. X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FE-SEM), Energy-Dispersive X-ray spectroscopy (EDX), Fourier Transform Infra-Red spectroscopy (FTIR), and Ultra-Violet visible spectroscopy (UV-Vis) were used to examine the antimicrobial activity of bacterial, fungal, as well as Pneumonia activity. Copper oxide NPs synthesized demonstrates highly scattered characterization and application findings. The green method is a practical, eco-friendly, simple, and valuable method for producing copper oxide nanoparticles.

**Keywords:** Copper oxide; sol-gel method; nanomaterial; antimicrobial; antifungal

### Introduction

The unique properties of nanomaterials, as well as their high surface-to-volume ratio, have made them a viable and new tool in many scientific disciplines. This flexible material has numerous applications, including antimicrobial activities, photovoltaics, sensors, storage devices, medicine administration, photocatalytic training, and so on. Copper oxide nanoparticles most used because they are cheap, common, have low toxicity, and are easy to manufacture. Because of their high catalytic activity and durability, photo-catalysts constructed of single metal oxides are becoming increasingly popular [1-2].

A multitude of procedures can be used to create single metal oxide nanoparticles. Solid-state synthesis, the hydrothermal method, the electrochemical approach, the sol-gel technique, co-precipitation, microwave-assisted synthesis, the thermal decomposition method, and others are examples[3-4]. We choose the sol-gel process due to worries about overheating and hazardous solvents in other procedures. The sol-gel

method is the most environmentally friendly and cutting-edge of these techniques because it does not require high pressure or high temperature, is inexpensive, and allows for easy monitoring of the crystalline size and structure of the nanomaterial through pH modification of the medium while preparing a large amount of sample. This paper describes a simple sol-gel method for producing copper oxide (CuO) nanoparticles with citric acid as a suitable surfactant. Synthesized Copper oxide nanoparticles were screened for biological activity of antibacterial, antifungal, and antimalarial activity which showed better to excellent results.

### Experimental

#### Characterization

Copper chloride, citric acid, hydrochloric acid, and ammonium hydroxide were purchased from SD-Fine Chemical Company and used without further purification. The X-ray diffraction (XRD) pattern was recorded by the Rigaku X-ray Diffractometer with a Cu

## Synthesis of Some New 1-Hepta-O-benzoyl- $\beta$ -D-lactosyl-3-(1-sulfanilamido-3-arylthiocarbamide) thiocarbamides

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**ABSTRACT** We report the synthesis of a series of 1-hepta-O-benzoyl- $\beta$ -D-lactosyl-3-(1-sulfanilamido-3-arylthiocarbamide) thiocarbamides. These were prepared by reacting 1-hepta-O-benzoyl- $\beta$ -D-lactosyl-3-sulfanilamido thiocarbamide with various aryl isothiocyanates. The required 1-hepta-O-benzoyl- $\beta$ -D-lactosyl-3-sulfanilamido thiocarbamide was prepared in good yield through the reaction of hepta-O-benzoyl- $\beta$ -D-lactosyl isothiocyanate with sulfanilamide.

**KEY WORDS:** Aryl isothiocyanates, Lactosyl sulfanilamido thiocarbamide, Lactosylated thiocarbamides.

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### INTRODUCTION

The consciousness of the significance of carbohydrates in living organisms and in medicine is rising due to the increasing understanding of their biological and pharmacological applications and their contribution in a huge range of physiological processes with diseases.<sup>1-4</sup> Carbohydrates are everywhere in nature as one of main groups of biomolecules. Although it has long been clear that sugars are both important foodstuff and structurally important compounds. An exciting development in carbohydrates since over the past 20 years has initiated to divulge that they are concerned in huge variety of very specific and sophisticated procedures. Similarly, there is a rising trend in carbohydrates derivative drugs<sup>5</sup> for therapeutic use.

Naturally, carbohydrates are broken down in the body to produce energy for various biological activities. It is well known that antibiotics have served mankind more than any other class of therapeutics. A number of medically important antibiotics, such as streptomycin, are carbohydrate derivatives.<sup>6</sup> Carbohydrate-based or-customized therapeutics are utilized widely in cardiovascular and hematological healing from provocative virus and

anti-thrombolytic treatments to helping in wound healing.<sup>7</sup> Most of the carbohydrate-based drugs belong to the groups of antibiotics and cytostatics. Carbohydrate containing antibiotics, nucleosides, glycolipids, glycopeptides, glycoproteins, glycosaminoglycans, and glycosides of steroids which have been found to have therapeutic application.<sup>8</sup> A recent development in the laboratory synthesis of carbohydrates<sup>9-13</sup> makes it possible to produce complex, pure, and structurally defined carbohydrates for drug discovery and development. Several derivatives of thiocarbamides are used as pharmaceuticals, preservatives, rodenticides, and insecticides.<sup>14-17</sup> Thiocarbamides have valuable uses in organic synthesis and are used as intermediates in several organic synthetic reactions.<sup>18</sup> Bacterial resistance remains a significant threat and a leading cause of death worldwide, despite massive attempts to control infections. Sulfanilamide is a sulfonamide antibacterial drug. In an effort to develop biologically active antibacterial and antifungal agents, a novel substituted sulfanilamido thiocarbamides linked with carbohydrate units were synthesized through interaction of 1-hepta-O-benzoyl- $\beta$ -D-lactosyl-3-sulfanilamido thiocarbamide with various aryl isothiocyanates. Therefore, their broad spectrum

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## Induced physical and chemical mutagenic studies in M<sub>1</sub> generation of Chickpea (*Cicer arietinum* L.)

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### ABSTRACT:

The seeds of chickpea (*Cicer arietinum* L.) varieties -Vishal and JAKI-9218 were treated with mutagens EMS, Sodium azide (SA), and Gamma-rays. M<sub>1</sub> generation was raised and studied with respect to different morphological parameters such as germination percentage, plant survival percentage at maturity, plant sterility percentage, and fertility percentage. Germination Percentage was found lesser in both populations treated with chemical mutagens as compared to physical mutagen gamma radiation and control. High sterility is recorded in M<sub>1</sub> plants of both Chickpea varieties treated with EMS and Sodium azide. However, the plant germination, survival and fertility percentage were highest in the gamma-ray-treated M<sub>1</sub> population of both varieties. An increasing trend with an increase in mutagenic concentrations/doses is recorded for the percentage of sterility while germination percentage and plant survival percentage at maturity revealed a decreasing trend with increasing mutagenic concentrations/doses.

**KEYWORDS:** Chickpea, EMS, Gamma Rays, Germination, mutagens, M<sub>1</sub> generation.

### INTRODUCTION:

Chickpea botanically described as *Cicer arietinum* L. belongs to the family Fabaceae. It is popularly grown for its edible mature seeds. It is a cheap plant protein, carbohydrates, and minerals source in the human diet, especially in the Indian arena (Jukanti *et al.*, 2012). This crop plant also plays a key role in the enrichment of soil fertility by fixing atmospheric nitrogen through symbiotic nitrogen fixation. It's a popular grain among people, but the average yield of chickpeas reported in India is far below its potential (Choudhary *et al.*, 2013).

Induced mutation breeding has become an established tool in plant breeding to supplement existing germplasm and improve cultivars in certain traits. Mutagenesis has been widely used as a potent method of enhancing variability for crop improvement. This is a highly effective method in enhancing natural genetic resources and have been used in developing improved cultivars of crops (Gaul *et al.*, 1972; Lee *et al.*, 2002; Jagadeesan and Punniamorthy, 2023).

Therefore, it was planned to initiate the work of induced mutation breeding in Chickpea. The present paper deals with the details of the effects of physical mutagen gamma rays and chemical mutagens EMS and SA on different parameters of the M<sub>1</sub> generation of Chickpea varieties Vishal and JAKI. Variety Jaki has its specialized role in the high productivity of the chickpea crop throughout the state while Vishal is an old Desi variety bearing a large pod size. The parameters considered in this work are the percentage of germination, percentage of survival, percentage of sterility, and percentage of fertile mutants.



## Designing and Segmentation of Devanagari Script Based Captcha for Security of Web Based Applications

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**Abstract:** The paper aims to design Devanagari Script Based Captcha in Marathi. It also focuses on Segmentation of Captcha image. CAPTCHA is widely used as a security tool in web application. It is sometime referred as reverse Turing test as it is administered by machine and the target is user. In the state of Maharashtra all the official work is in Marathi. The CAPTCHA is used on website in mostly in English. The people from rural area are not comfortable with English CAPTCHA. Hence this work is proposed. For designing this CAPTCHA, the dataset is created using Devanagari Marathi Numerals, Consonants and Vowels. The dataset of 1200 images are created and considered for this study. From this dataset the Captcha image of length 6 character is generated and distorted using some transformation like scaling and rotation. Also, noise is added to this image. Using bounding box method, the image is segmented into characters. The performance of this segmentation method is approximately 100%.

**Keywords:** CAPTCHA, Devanagari script, Segmentation, Turing-Test

### 1. Introduction

In the era of digital world, we are using internet for all the activities. After COVID everything is available on net and all are becoming familiar with online services. To enjoy the benefits of online services one has to register herself/himself by filling online form. CAPTCHA (Completely Automated Public Turing Test to tell Computers and Humans Apart) is used as a security tool by all the websites to prevent it from malicious program called bots, Bots are the automated programs which run over the internet and consume web space as well as network traffic. In state of Maharashtra, a lot of people are from rural background. Now a day they are also using these online services if it is in their regional language. The Maharashtra state Govt. also uses Devanagari script as the language of communication. So, there is a need of Devanagari CAPTCHA which will be easy for these peoples who are not comfortable with English. For Developing Devanagari CAPTCHA, the steps required are Pre-processing, Segmentation, Feature extraction and Classification. Segmentation is the first most important and crucial phase from these. As the success of recognition phase depends on accuracy of segmentation. Hence the focus of this paper is basically on character segmentation of Devanagari CAPTCHA image.

Section-1 gives introduction and need for Devanagari Script based Captcha. Section 2 explains the related work on character segmentation. Section-3 explains the features of Devanagari Script. Phases of Devanagari Character Recognition System are given in Section-4. Proposed method for Devanagari Script Based Captcha along with dataset preparation is given in Section-5. An algorithm is explained in section-6. In Section-7, result and discussion is given.

### 2. Related Work

There are ample techniques for character segmentation. It is broadly classified in three types: Classical approach of segmentation, Recognition based approach of segmentation and holistic approach also referred as hybrid approach. The following table shows these types, criteria and techniques used for character segmentation [1].

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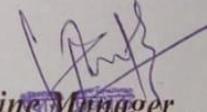
Ref NO. Trd/Exp./23-24/141

DATE - 20.04.2023

**TO WHOMSOEVER IT MAY CONCERN**

*This is to certify that Mr Ajinkya S/o Shyam Wanjare Form A. No. 0995 has Undergone his Unpaid Internship/Industrial Training in **Geology** (Tirodi Mine) Form 04.04.2023 To 19.04.2023 (15 days) During his training period, he was engaged in Various **Geological** work at **Tirodi Mine**.*

*His Performance and conduct was found good during the training period. I wish him all the best for his future Endeavors.*

  
**Mine Manager**  
मॉयल लिमिटेड तिरोडी खान  
**Tirodi Mine**  
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Date 23.01.2023

To,  
**The Moil Manager,**  
**Manganese Ore India Ltd.**  
**Tirodi Mines**  
**Madhya Pradesh.**

**Subject:** Permission for Mining Training to our B.Sc. Geology Part III students in your reputed organization from 15th Feb 2023 to 22th Feb 2023.

Sir,

The Shri Shivaji College of Arts, Commerce and Science, Akola is affiliated to Sant Gadge Baba Amravati University, Amravati and NAAC reaccredited with "A++" grade with CGPA 3.58 (Fourth cycle) The college also recognized as a lead college by S.G.B., Amravati University, Amravati and UGC awarded "College with Potential for Excellence". Our college has been also supported by funds from Department of Science Technology, Government of India under DST-FIST program.

Geological field work associated with mining and its application in various Geological sectors is a part of the B.Sc. Geology curriculum. The following enlisted students are bonafied students of our college, studying in B.Sc. Geology Part-III wish to participate in training programme in your institute.

1. Ms. Vaishnavi Prashant Patil.
2. Mr. Ajinkya Shyam Wanjare.

o/c  
Kindly allow them to participate in the training programme from 15th Feb 2023 to 22th Feb 2023 as per your convenience in your reputed organization.

Thanking you in anticipation.

Yours faithfully,

**Principal**  
**PRINCIPAL**  
Shri Shivaji College of Arts,  
Commerce & Science Akola.  
A++ Grade CGPA.3.58 by NAAC

**Head**  
Department of Geology  
Shri Shivaji College of Arts  
Commerce & Science, Akola