Chalcones: Compounds Possessing a Diversity in Applications

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ABSTRACT

Chalcones are a class of α, β-unsaturated carbonyl compounds that form the central core for a variety of naturally occurring biologically active compounds. They exhibit tremendous potential to act as a pharmacological agent. They have been incessantly examined for their antioxidant, antifungal, antibacterial, antidepressant, anticancer & anti-inflammatory and many more activities. Besides their various pharmacological activities, chalcones have been explored for different optical applications including second harmonic generation materials in non-linear optics, fluorescent probe for sensing different molecules.

Key words: Chalcones, pharmacological agent, optical properties, fluorescent probe.

INTRODUCTION

Substituted chalcones are of particular interest for various studies because of their vital role as precursor in the biosynthesis of flavanoids abundantly available in plant kingdom. These bichromophoric molecules separated by a keto-vinyl chain are very useful as substrate for the synthesis of biologically very important heterocyclic compounds like cyclohexenone derivatives and pyrazoline derivatives. The scope of introducing variations in the structure of chalcones by changing various substituents has created an interest of scientists of different fields. Besides the different traditional methods used for synthesizing these molecules such as base catalyzed (NaOH, KOH, Ba(OH)₂) and acid catalyzed (including Lewis acids) condensation processes in the presence of suitable solvent, many new eco-friendly methods like use of ultrasonic radiations [1], microwave assisted [2], solvent free synthesis by grinding [3] etc. have been developed. The crucial interest of scientists in studying these molecules lies in their vast diversity in applications. Besides being important as starting material for synthetic purpose, they are being explored as a new class of non-azo dyes [4], as a pharmacological agent exhibiting a large number of activities out of which antioxidant [5, 6], antibacterial [7, 8, 9], antifungal [10, 11, 12], anticancer & anti-inflammatory [13, 14, 15] and antidepressant [16, 17] activities have been reported here. In addition, some photo physical properties of these substances such as non-linear optical properties [18, 19] and their use as fluorescent probe [20] have also been mentioned.

Pharmacological Activities

Antioxidant Activity

Antioxidants are the compounds that prevent the oxidative damage, induced by free radicals and reactive oxygen species, which is responsible for many pharmacological events such cancer and ageing etc. Chalcones, in many cases, serve as active participant in plant defense mechanisms to counteract the reactive oxygen species to reduce the destruction at molecular level and the damage caused by microorganisms, insects and herbivores [5]. The antioxidant activity of these compounds is related with various mechanisms like metal ion chelation, free radical consumption, transfer of an electron or hydrogen atom, singlet oxygen quenching and acting as substrate for radicals like hydroxide and superoxides [5].

A lot of research has been carried out to study the free radical scavenging by synthetic chalcones. On the same path, Tan Nhut Doan et al synthesized a series of allylicchalcones and pyrazolicchalcones. They examined these chalcones and related compounds for their antioxidant properties by using 1,1-biphenyl-2-picrylhydrazyl (DPPH) radical scavenging method. Vitamin C was chosen as reference compound (97.92%). Out of the eight tested samples, the two 2-(5-(3,4-Dimethoxyphenyl)-4,5-dihydro-1H-pyrazol-3-yl)-5-methoxyphenol, [1, 1] and N,N-Dimethyl-4-(3-(4-nitrophenyl)-4,5-dihydro-1H-pyrazol-5-yl)-benzamine, [1, 2] exhibited the highest DPPH scavenging activity (89.64% and 89.27% respectively) whereas the chalcones which were the precursor for these compounds did not show any activity. These results reflect that the presence of pyrazole ring was playing a role to exhibit this activity.

Nurettin Yayli et al studied the three simple methoxy chalcones for their superoxide radical scavenging activities by using a very common method in which xanthine as the substrate of xanthine oxidase was utilized to produce the superoxide radicals which were then consumed in the presence of antioxidants. The rest of the radicals were then determined by the reaction with NBT (nitroblue tetrazolium salt) spectrometrically. The results expressed as the concentration of test sample giving 50% reduction in the absorbance of control at 560 nm clearly reflected the effect of position of methoxy group on their potential to scavenge superoxide radicals. One of these chalcones having methoxy group at ortho-position was found to be most active antioxidant (IC₅₀ 0.623 mg/mL) even more active than the reference compound (Butylated hydroxytoluene IC₅₀ 1.839 mg/mL).
The order of the superoxide radical scavenging activity of these three chalcones followed the order o-methoxy chalcone (IC\textsubscript{50} 0.623 mg/mL) > m-methoxy (IC\textsubscript{50} 2.708 mg/mL) > p-methoxy (IC\textsubscript{50} 4.343 mg/mL). These results offer interesting synthetic possibilities to synthesize more potent antioxidants.

In order to explore the effect of various substituents present in two aromatic rings of chalcone molecules on their antioxidant activities, Ruby John Anto[9] et al examined about thirty three chalcones and chalcone related compounds. They tested these compounds for superoxide radical scavenging activity and lipid peroxidation inhibition. Most of the chalcones except those substituted with –Cl was found to scavenge superoxide radicals. The compound 1-(2’-Hydroxy-5’-methylphenyl)-3-phenylprop-2-en-1-one (IC\textsubscript{50} 10.5 µg/mL) was found to be most active superoxide radical scavenger. The dihydroxy chalcones (1-(2’-hydroxyphenyl)-3-(2-hydroxyphenyl) prop-2-en-1-one, (zone of inhibition 31 & 34 mm), its hydroxyl and methoxy substituted chalcones showed moderate activity. The hydroxyl and methoxy substituted chalcones showed moderate activity. The dihydroxy chalcones (1-(2’-hydroxyphenyl)-3-(2-hydroxyphenyl) prop-2-en-1-one, IC\textsubscript{50} 4.0 µg/mL) exhibited the highest lipid peroxidation inhibiting activity. One another chalcone substituted with 2’-OH and 4’-OCH\textsubscript{3} (IC\textsubscript{50} 8.8 µg/mL) proved to be very efficient in inhibition of lipid peroxidation. The compounds which were structurally similar to the chalcones, only those having methyl group were active superoxide scavengers while as lipid peroxidation inhibitor, only unsubstituted compounds and their dimethyl derivatives were found active. From the study, it reveals that the o- and p- substitution by electron donating groups may increase the antioxidant activities of chalcones which can open up a way to the more active and efficient synthetic antioxidants.

**Antibacterial Activity**

Synthesis of various noval chalcones and their corresponding flavones containing naphthyl moiety was carried out by Sainath B. Zangade[10] et al. The chalcones were synthesized by using the conventional Claisen–Schmidt condensation method. All the compounds were subjected to antibacterial activity test against Pseudomonas aeruginosa (Pa) and Staphylococcus aureus (Sa) using cup-plate agar diffusion method. They used antibiotic Cefixime as a standard antibacterial agent. Three bacterial strains Bacillus pumilus was performed by Y. Rajendra Prasad[12] et al. They used DMSO as solvent and Ampicillin as standard antibacterial agent. Three descriptors used to generate QSAR model were ADME weight, HOMO energy and Kappa 2 index. Results of the study suggested that high value of HOMO energy decreases the activity. Electron donating groups provide electrons which can delocalize in the π-space of benzene thus increasing energy of HOMO whereas electron withdrawing groups like halogens will increase bactericidal potential. On other hand, high values of ADME weight and Kappa 2 index showed a positive effect on inhibition of bacterial growth. Designing the chalcone derivatives bearing electron withdrawing substituents on the ring and with high degree of binding linearity with groups those results in high molecular weights increases antibacterial activity against Bacillus pumilus.

To explore the antibacterial activity of differentially substituted chalcones, Farzana Latif Ansari[11] et al synthesized two sets of chalcones using conventional and microwave assisted synthesis methods. The set-I chalcones were having two phenyl rings substituted with a variety of groups like hydroxyl, methoxy, halogens, nitro etc. at different positions whereas the set-II chalcones were containing one heterocyclic ring such as pyridinium, pyrrol, furanil, thienyl and indolyl. They tested all these compounds for their in vitro bactericidal action against six bacterial stains i.e. B. bronchiseptica, M. leuteus, P. picketti, E. coli, E. aerogenes and S. Setubal following agar well-diffusion method. Cefixime was used as a standard drug (zone of inhibition 31 & 34 mm respectively). The study revealed that all the tested compounds were active only against B. bronchiseptica with a zone of inhibition ranging from 9.5-18.5 mm in diameter. The findings suggested that chalcones bearing electron withdrawing halogen groups like bromo- & chloro- groups {3-(3-bromophenyl)-1-(3’-hydroxyphenyl)prop-2-en-1-one, [1.6] and 3-(3-chlorophenyl)-1-(3’-hydroxyphenyl)prop-2-en-1-one, [1.7]} showed the greatest antibacterial activity (zone of inhibition 18.5 and MIC values 0.2 & 0.3 mg/mL respectively) whereas compounds with more polar and electron withdrawing nitro- groups were least active. The hydroxyl and methoxy substituted chalcones showed moderate activity. From the analysis, order of bactericidal activity for various chalcones had been found X > OH > OCH\textsubscript{3} > NO\textsubscript{2}. Most active bactericidal chalcones were also found to have high value of hydrophobicity constant, octanol-water partition coefficient and molar volumes with exception of –OCH\textsubscript{3} substituted chalcones. The influence of heterocyclic ring on antibacterial activity was reflected by the results obtained for set-II chalcones. Only compounds with thiophene moiety were found active bactericidal except nitro substituted chalcones. These studies also strengthened their earlier hypothesis that nitro group attenuates the bactericidal effect. The results could prove fruitful in designing the synthesis of various chalcones possessing high antibacterial activity.

**Antifungal Activity**

V. Tomar[8] et al synthesized some noval chalcones containing piperazine or 2,5-dichlorothiophene moiety and evaluated their antimicrobial activities. All these compounds were screened for their antibacterial as well as antifungal potential against various bacterial strains and particularly three fungi Candida albicans, Candida kursei and Candida glabrata H0. Comparing the results as zone of inhibition and MIC values of tested chalcones with the standard drug Fluconazole (29 mm & 50 µg/mL for each), most of the compounds were showing significant activity against all the three chosen fungi. One chalcone carrying 2,5-dichlorothiophene moiety and unsubstituted phenyl ring [1.8] was found to be most potent antifungal agent with zone of...
were found showing even higher cell cycle arrest in G2/M phase than the thiophene moiety or a part of side chain group i.e. thiomethyl group. The second half part of the compounds was a phenyl ring having various substitutions. All the compounds were screened against fungal growth inhibitor (IC50). One with thiophene moiety and other with phenyl ring substituted with thiomethyl group. The second half part of the compounds was a phenyl ring having various substitutions. All the compounds were screened against both Fluconazole resistant as well as Fluconazole sensitive strains of Candida albicans (NCIM 3446 & ATCC 10231 respectively). The rigorous analysis of results of two series samples confirmed the perception as the chalcone having both unsubstituted thiophene moiety and p-thiomethyl substituted phenyl ring in the same molecule [1.9] was found to be the most active fungal growth inhibitor (IC50 0.5 µg/mL for both strains) when compared to the standard Fluconazole (IC50 100 & 20 µg/mL respectively). Bromo group on thiophene moiety reflected a negative effect in activity. Amongst first series compounds, maximum activity was reported for p-fluoro substitution (IC50 8 & 05 µg/mL respectively). Antifungal activity decreased with increase in bulk of halogen attached. Also the presence of heavier phenyl group or nitro reduced the activity of chalcones. On the other hand, introducing methoxy group on p-position or hydroxyl on any position proved helpful in enhancing the antifungal activity.

Presence of sulphur in chalcones either as a part of heteroaromatic ring (thiophene moiety) or a part of side chain group i.e. thiomethyl group influences the antifungal activity of chalcones was analysed by Seema Bag[14] group by synthesizing two series of α, β-unsaturated compounds, one with thiophene moiety and other with phenyl ring substituted with thiomethyl group. The second half part of the compounds was a phenyl ring having various substitutions. All the compounds were screened against both Fluconazole resistant as well as Fluconazole sensitive strains of Candida albicans (NCIM 3446 & ATCC 10231 respectively). The rigorous analysis of results of two series samples confirmed the perception as the chalcone having both unsubstituted thiophene moiety and p-thiomethyl substituted phenyl ring in the same molecule [1.9] was found to be the most active fungal growth inhibitor (IC50 0.5 µg/mL for both strains) when compared to the standard Fluconazole (IC50 100 & 20 µg/mL respectively). Bromo group on thiophene moiety reflected a negative effect in activity. Amongst first series compounds, maximum activity was reported for p-fluoro substitution (IC50 8 & 05 µg/mL respectively). Antifungal activity decreased with increase in bulk of halogen attached. Also the presence of heavier phenyl group or nitro reduced the activity of chalcones. On the other hand, introducing methoxy group on p-position or hydroxyl on any position proved helpful in enhancing the antifungal activity.

P. M. Gurubasavaraza Swamy[13] et al synthesized and then analysed a group of chalcones & their derivatives bearing hydroxyl benzofuran moiety for their antifungal activity against Candida albicans and Asperagillus flavus according to cup plate method using DMF as solvent control and Griseofulvin as standard drug for comparison. Amongst the series of eleven compounds examined, 1-(3-hydroxybenzofuran-2-yl)-3-(4-methoxyphenyl)prop-2-en-1-one was found to exhibit highest activity almost equal to standard chosen [zone of inhibition at 100 µg/mL 22 mm (tested chalcone) and 24 mm (Griseofulvin) for the two strains each]. Comparative study of results reflected that the improvement in antifungal activities of chalcones may be achieved by incorporating hydroxyl and other electron releasing groups at proper positions in the aromatic rings and avoiding nitro group substitution.

Anticancer and Anti-Inflammatory Activity
Ahcene Boumendjel[16] et al developed a set of fifty nine chalcones (especially methoxylated and some hydroxylated derivatives) by Claisen-Schmidt condensation of required acetophenone with various substituted benzaldehydes. The prepared chalcone series was subjected to test their in vitro antimitotic activities against K562 leukemia cells stained with propidium iodide at a concentration of 10 µM for 24 h. The distribution of the total population in various phases (G0/G1, S, and G2/M) was determined by flow cytometry. Vincristine (VCR) was selected as reference compound. Amongst the screened chalcones, four compounds, [1.10-1.13] were found showing even higher cell cycle arrest in G2/M phase than the standard one whereas the other two, [1.14 & 1.15] were showing equal potential than reference chosen. Using MTT assay, a set of eleven different human and murine cell lines (like MCF7, N2A, NIH3T3, SW48, HNO150, HCT116, Messa, CEM, K562, RL, L1210) representing various solid tumors and hematological malignancies was exposed to the selected chalcones 1.11, 1.12 & 1.13 for further analyzing their cell growth inhibition tendency. The IC50 concentration values in µM (drug concentration required to induce 50% loss of cell viability with reference to untreated cell after 24 h incubation) reflected compound, [1.12] as the most potent against almost all type of cell lines. The thorough analysis of data for in vitro antimitotic activities revealed that optimum value of lipophilic character (C log P) to show significant inhibition of cell growth was around 4 (as in the case of most effective chalcones found in test). As this character changed, by replacing methoxy group on ring A by ethoxy or methyl groups, activity was found to be reduced (might influencing the cell permeation required for cell growth inhibition). Also the dimethoxylation and trimethoxylation of the two phenyl rings proved significant for antimitotic behavior of various chalcones although the substitution pattern on ring B influenced the activity less than ring A. One of the highly active chalcones, [1.12] was further subjected to in vivo studies to test toxicity level in healthy animals and was found to be nontoxic up to the maximum tested dose level (1 mg/Kg) thus representing a group of very good anticancer agents.

A new series of quinolinyl and chloroquinolinyl chalcones was synthesized by Vijay Kotra[17] et al to study the effect of quinoline moiety present in chalcones on their anticancer and anti-inflammatory activities (as evident from the literature, two entities i.e. quinoline and chalcone both exhibits anticancer activities alone). They screened selected chalcones for their in vitro anticancer potential on RAW cell lines using MTT assay which was based on the appearance of highly colored blue formazan product by MTT reduction. Using MTT assay, a set of eleven different human and murine cell lines (like MCF7, N2A, NIH3T3, SW48, HNO150, HCT116, Messa, CEM, K562, RL, L1210) representing various solid tumors and hematological malignancies was exposed to the selected chalcones 1.11, 1.12 & 1.13 for further analyzing their cell growth inhibition tendency. The IC50 concentration values in µM (drug concentration required to induce 50% loss of cell viability with reference to untreated cell after 24 h incubation) reflected compound, [1.12] as the most potent against almost all type of cell lines. The thorough analysis of data for in vitro antimitotic activities revealed that optimum value of lipophilic character (C log P) to show significant inhibition of cell growth was around 4 (as in the case of most effective chalcones found in test). As this character changed, by replacing methoxy group on ring A by ethoxy or methyl groups, activity was found to be reduced (might influencing the cell permeation required for cell growth inhibition). Also the dimethoxylation and trimethoxylation of the two phenyl rings proved significant for antimitotic behavior of various chalcones although the substitution pattern on ring B influenced the activity less than ring A. One of the highly active chalcones, [1.12] was further subjected to in vivo studies to test toxicity level in healthy animals and was found to be nontoxic up to the maximum tested dose level (1 mg/Kg) thus representing a group of very good anticancer agents.

Babasaheb P. Bandgar[18] et al synthesized a large number of chalcones by

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\begin{align*}
\text{G2/M arrest} & \quad \text{Clog P} \\
1.10 & \quad R_1 = R_2 = \text{CH}_3 & \quad 86 & \quad 3.87 \\
1.11 & \quad R_1 = R_2 = \text{OCH}_3 & \quad 78 & \quad 3.88 \\
1.12 & \quad R_1 = R_2 = \text{OCH}_3 & \quad 84 & \quad 3.87 \\
1.13 & \quad R_1 = R_2 = \text{OCH}_3 & \quad 86 & \quad 3.83 \\
1.14 & \quad R_1 = R_2 = \text{OCH}_3 & \quad 72 & \quad 3.52 \\
1.15 & \quad R_1 = \text{OCH}_3, R_2 = \text{NH}_2 & \quad 74 & \quad 2.95
\end{align*}
\]
reacting differentially substituted acetophenones with 2,4-
dimethoxybenzaldehyde and 3,4,5-trimethoxybenzaldehydes using Claisen-
Schmidt condensation and analyzed their anticancer and anti-inflammatory
tivities. Anticancer activity of the chalcones was determined against five
human cancer cell lines responsible for renal cell carcinoma, pancreatic
carcinoma, non-small cell lung carcinoma and colon carcinoma. Flavopiridol
(700 nM) and Gemcitabine (500 nM) were taken as standard. Results of
the anticancer activity of chalcones at 10 µM concentration revealed that
furo substitution at p-position of ring A increased the cell inhibition trendency
of chalcone up to 100 % as compared to the references chosen which
seemed surprising as some compounds containing nitro group are supposed to
exhibit carcinogetic and mutagenic behavior. The substitution in 3,4,5-
trimethoxychalcones on ring A affected their anticancer activity considerably
(ranging from 50-95 %) in the order of OCH > OH > Cl > Br. Also from the
study, it was found that increase in number of methoxy groups increased the
anticancer activity. These chalcones were also analysed for their anti-
inflammatory activities in terms of TNF-α and IL-6 inhibitory activity. All 3,4,5-trimethoxy chalcones showed 90-100 % inhibition at 10 µM
concentration as compared to reference dexamethasone (73 % inhibition of
TNF-α and 84 % of IL-6 at 1 µM concentration) and 2,4-
dimethoxychalcones. Many of the tested chalcones showing anti-
inflammatory activities were also possessing anticiancer activities.

Antidepressant activity

Drugs available for curing depression, a very serious behavioral problem
related with brain which may even induce suicidal characteristics, are
associated with several undesirable side effects. So there is an urgent
unavoidable need for more efficient antidepressants with minimum
intolerable side effects. Inspired from the fact that a hydroxyl chalcone
obtained by central ring opening of naturally existing flavonoid, Apigenin[19]
(bearing antidepressant activity) was found to possess antidepressant activity, Xin Sui[20] et al synthesized a series of 2′, 4′, 6′-trihydroxy
chalcones and evaluated them for their antidepressant activity in male
Kunning mice (20-24 g, local breed) by using forced swimming test (FST)
and tail suspension test (TST). Fluoxetine was taken as reference for
comparing the results. One of the tested compound, 3-(2-bromophenyl)-1-
(2′, 4′, 6′-trihydroxyphenyl)prop-2-en-1-one [1.16] (10 mg/Kg) was found
to be most active antidepressant with a significant decrease in duration of
immobility (period of immobility = 69.4 s and for reference it was 57.4 s at
same dose level). Results revealed the effect of nature of various substituents
and their position in ring B on antidepressant activity of different chalcones.

Various chalcones {1-(2-Thienyl)-3-phenyl(2-thienyl)prop-2-en-1-ones} were used by Zuhal Ozdemir[21] et al to prepare a set of 3-(2-thienyl)
pyrazoline derivatives in order to study their antidepressant effects on
local breed albino mice using Porsolt’s behavioral despair test i.e. forced
swimming test (FST). They compared the results with tranylcypromine
sulfate, an antidepressant drug. Among the analyzed, compounds with 2-
thienyl moiety at 5-position of pyrazoline ring except one were found to
decrease the duration of immobility up to appreciable extent. Two derivatives,
1-N-methylthiocarbamoyl-3,5-di-(2-thienyl)-2-pyrazoline [1.17] and 1-N-
phenylthiocarbamoyl-3,5-di-(2-thienyl)-2-pyrazoline [1.18] exhibited
highest activity as antidepressant with duration of immobility 43 sec and
48 sec (for standard drug chosen, observed immobility period was of 57 sec
at same dose level of 10 mg/Kg). Data reflected that the introduction of a
thienyl moiety at 5-position of pyrazoline ring improved the antidepressant
activity of chalcones.

As fluorescent probe

The substances which exhibit variation in the fluorescence characteristics
under influence of external environment at molecular level and also nontoxic
to human body can act as fluorescent probe. Chalcones have been found to
be biologically active species. They also show absorbance and fluorescence
behavior in UV-Vis region which might be more pronounced when both
electron donating and electron withdrawing substituent present in the
molecule results in effective intramolecular charge transfer (ICT) process.
The effect of polarity of solvent on absorbance and emission characteristics
of a particular chalcone named 4′-dimethyl-2,5-dihydroxycalcone [1.19]
was studied by Zhicheng Xu[22] et al by using steady-state absorption and
fluorescent spectrum in various non-polar and polar solvents like carbon
tetrachloride, diethyl ether, tetrahydrofuran, acetone, dimethyl formamide,
dimethyl sulfoxide, ethanol and methanol. They analyzed the fluorescence
quantum yields and also the difference in dipole moment values of the
molecule in ground and excited state by plotting a curve between Stokes
shifts versus the orientation polarizability. Larger difference in dipole
moment values(Δμ = 6.5 D) revealed that atomic charges were redistributed
in higher energy state due to the charge transfer from dimethyl amino group
(electron donating) to carbonyl moiety (electron withdrawing species).
Minor changes in the absorbance pattern of the target molecule were observed
in different solvent environment whereas a significant bathochromic shift
was found for fluorescence. That was attributed to large extent of solvation
of molecule in excited state than in ground state. As the polarity of the
solvent was increased, the emission maximum shifted to higher wavelength
(solvents from CC14 to DMSO, values from 488 nm to 533nm). But in
protic solvents although with higher polarity, smaller λt values (529 nm
& 530 nm for ethanol and methanol respectively) were noted due to
intermolecular H-bonding between the solvent and -N(CH3), that decreased
the availability of lone pair of electrons for charge transfer process.

As non-linear optical material

The crystals of compounds exhibiting non-linear optical behavior can be
used in wide range of optical applications like optical parametric generation
and amplification (OPG, OPA), laser harmonic generation, frequency
conversion (SFG, DFG), eye and sensor protection etc. The inorganic
crystalline substances like potassium di deuterium phosphate (KDP), lithium
iodate (LiIO3), lithium triborate (LBO), beta barium borate (BBO), potassium
titanyl phosphate (KTP) etc. have been utilized for this purpose extensively.
But recently a large no of organic crystals have also been found to be
capable of showing second and third order non-linear optical properties.
Chalcones being very easy to be synthesized, easy crystal growth, excellent non-linear optical behavior created an interest of J. Indra et al to synthesize a chalcone molecule 1-(4-methoxophenyl)-3-(phenyl)-2-propen-1-one [1.20], cream white solid with molecular formula C19H18O2, molecular weight 238 and melting point 109 °C using Claisen-Schmidt condensation process. The maximum absorption wave length for the target was found to be 326 nm from the absorption spectra in UV region of electromagnetic spectrum. The power technique using neodymium-doped yttrium-aluminum-garnet (Nd: YAG) laser with 13 mJ/s power was used to determine the second harmonic generation conversion efficiency of the sample which was found to be comparable with that of urea.

John Kiran et al synthesized two chalcone compounds named p-methoxy dibenzylidene acetone (PDBA) [1.21] and p-chlorodibenzylidene acetone (CDBA) [1.22] by the familiar method. The PDBA pale yellow crystal with superior surface quality having maximum dimension of 12x 7 x 1.3mm and the CDBA crystal with somewhat lower surface quality & 13 x 8 x 2 mm3 size were grown by using slow evaporation solution technique. Both crystals (with cutoff wavelengths of 440 & 450 nm) did not exhibit any absorbance in visible and IR regions of electromagnetic spectrum.

As the second harmonic generation capacity of PDBA and CDBA were found to be significantly high than the standard chosen i.e. urea (15.5 and 4.5 times), these compounds were further examined for their second harmonic generation capability and can be explored as non-linear optical materials.

CONCLUSION

From this review, it can be revealed that chalcones and their analogs exhibit a variety of pharmacological activities and they can be further studied for their efficient use as an active biological agent. Chalcones also show a very good second harmonic generation capability and can be explored as non-linear optical material.

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