

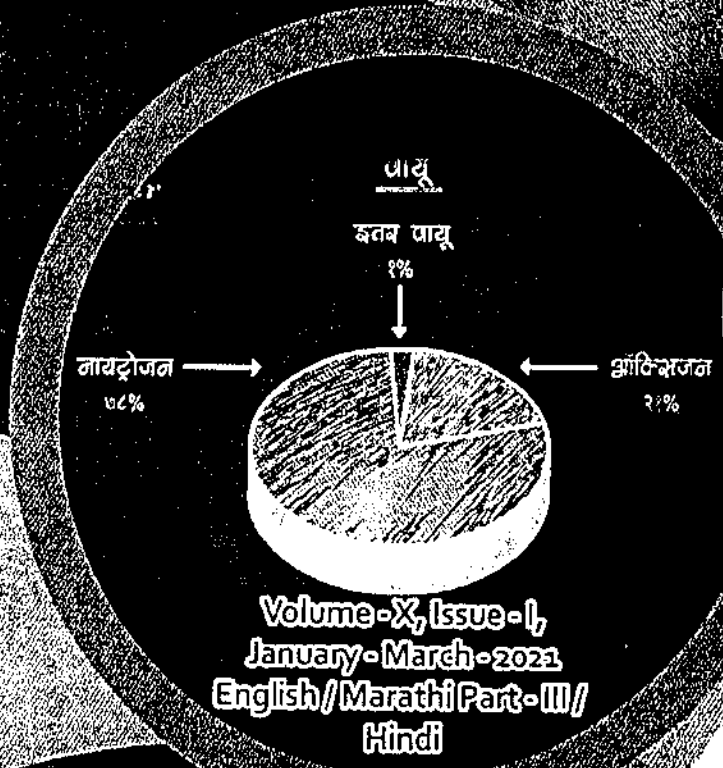


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M.Sc (Maths), M.B.A. (Mktg.), M.B.A. (H.R.),
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प्रा. धनंजय भाट

कला, वाणिज्य आणि विज्ञान महाविद्यालय, पलूस.

प्रस्तावना

महाराष्ट्राची संत परंपरा ही सामाजिक, सांस्कृतिक आणि आध्यात्मिक जडणघडणीमध्ये महत्वाची भूमिका असलेली आहे. पुरोगामी चळवळीची परंपरा लाभलेल्या या भूमीत संतांचे योगदान मोठे आहे. संतांनी भक्तीची चळवळ उभी केली. त्यामध्ये तत्कालीन समाजाला सांस्कृतिक पातळीवर नवदिशा देणाऱ्या आणि स्वतंत्र मूल्यविचार रुजविणाऱ्या संतसाहित्याचे कार्य अतुल्यच मानावे लागते. कारण विविध संप्रदायांनी महाराष्ट्रात परिवर्तन घडवून खऱ्या जीवनाचा अर्थ सांगण्याचा प्रयत्न केला. त्यामध्ये 'भक्ती संप्रदायाची' भूमिका अत्यंत मोलाची आहे. समाजप्रबोधनाच्या विचारधारेने वाटचाल करत भागवत धर्मातील तत्वांना भक्तीमार्गाची जोड देवून समतावादी, मुल्यवादी व मनुष्यत्वाचा गौरव करणाऱ्या तात्विक विचारसरणीचा पुरस्कार भक्ती संप्रदायाने केला. अभंग, कीर्तन, भजन, भारुडे या माध्यमातून तत्कालीन अज्ञानांच्या डोळ्यात वैचारिक अंजन घालून शिक्षित व जाणकार करण्याचा प्रयत्न केला. संत ज्ञानेश्वरांपासून ते निळोबा पर्यंतच्या सर्वच संतांच्या वाङ्मयाचा जीवितहेतू परमेश्वरप्राप्ती हाच होता. मात्र त्या खालोखाल आपल्याला जे बरोबर वाटते ते सांगून लोकांना शहाणे करून त्यांना आपल्या मार्गाला लावण्याचे ध्येयही दिसून येते. त्यायोगे संतांच्या शिकवणीचे आणि त्यांच्या भक्तीमार्गाने दिलेल्या शिक्षणाचे महत्त्व मध्ययुगीन कालखंडाप्रमाणेच आधुनिक काळातही मोलाचे वाटते.

संतांची उपदेशवाणी आणि तत्कालीन समाज

'काया काळाचे भातुके' हा संदेश देवून संत नामदेवांनी संसाराची असारता पटवून देण्याचा प्रयत्न केला आहे. असे असले तरी संत नामदेव, संत ज्ञानेश्वर, संत एकनाथ, संत तुकाराम, संत जनाबाई, सावतामाळी, नरहरी सोनार, चोखामेळा, मुक्ताबाई, कान्होपात्रा इत्यादी संतानी परमेश्वर प्राप्तीसाठी भक्ती महत्वाची मानून सर्वसामान्य लोकांना उपदेश केले आहेत. वास्तविक पाहता मध्ययुगीन काळात समृद्ध असणाऱ्या लोकांच्या कर्तृत्वहीन कमतरतेची आणि त्यांच्यातील शक्तिस्थळांची जाणीव करून देण्यासाठी बहुतांश संतानी आपली लेखणी वैचारिक आणि प्रबोधनाच्या पातळीवर चालविली होती. कारण मध्ययुगीन कालखंडात 'वारकरी संप्रदाय' हा जनमानसात आपला वेगळा आणि जवळीकतेचा ठसा उमटलेला संप्रदाय होता. त्यामुळेच तुकोबांनी कीर्तन, नाथानी भारुडे, ज्ञानेश्वर - नामदेवांनी अभंग, दासानी श्लोकांच्या माध्यमातून उपदेश करून जनजागृती करण्याचा प्रयत्न केला.

यादव काळात प्रचलित असणाऱ्या विविध संप्रदायामध्ये वारकरी संप्रदाय हा अधिक प्रभावी होता. मुक्ती आणि पुनर्जन्माच्या पलीकडे जावून जन्मोजन्मी भक्ती हाच पंचमपुरुषार्थ हवा. अशा अपेक्षा ठेवणाऱ्या

वारकऱ्यांच्या आयुष्यामध्ये परिवर्तन घडवून आणणाऱ्या संत साहित्याने ँका अर्थांने तत्कालीन लोकांच्या सामाजिक उन्नतीचे महत्त्वपूर्ण काम केले. तत्कालीन हिंदू संस्कृती आणि समाजावर होत असलेले आघात, समृद्धतेमुळे अंधश्रद्धेकडे झुकलेल्या, नाना व्रतवैकल्ये, यज्ञयाग करणाऱ्या, जुगारी आणि धर्मपरंपरा हेच धर्मनियम मानणाऱ्या समाजाला आपल्या साहित्यातून मार्गदर्शन आणि प्रबोधन करण्याचे काम संतानी केले. तत्कालीन ढोंगी आणि बुवाबाजी करत दांभिकता मिरविणाऱ्या साधू - बैरागी लोकांचाही समाचार संतानी आपल्या साहित्यातून घेतला आहे. संत नामदेवांनी तर

मांजराचे गेले डोळे | उंदीर देखोनी तळमळे

वेश्या झाली पाटाची राणी | तिला मागील करणी

अशाप्रकारे लोकव्यवहारातील मार्मिक दृष्टांत देवून अज्ञानांच्या अज्ञानावर बोट ठेवले आहे. समस्त संतांच्या वाणीतील उपदेशाचे आणि प्रबोधनांचे स्वरूप हे सामाजिक आहे. विविध कर्मकांड आणि विषमता याविषयी समाजाला योग्य व दिशादर्शक विचार हेच संत साहित्याचे शक्ती स्थळ मानावे लागेल. म्हणूनच भारतीय संस्कृतीचा आत्मा म्हणजे संतसाहित्य आहे. असे अभ्यासकांचे मत आहे. कधीकाळी पढिक पांडित्यामुळे गुदमरून गेलेल्या धर्माचे पुनुरुज्जीवन करण्याचे काम संत वाङ्मयाने केले. संत ज्ञानेश्वरांच्या उपदेशाची प्रेरणा प्रबळ असल्याने ते लोकांस सरळ उपदेश करतांना

चातकाचे जिवन घनु तरि तो सये ँकाधिनु

आला वेळ भुलावणु जैसा नळीनिसि नाही भानु

असे म्हणतानाच 'विठ्ठल न विसंबावा ँकु क्षणु' असेही म्हणतात. यातून भक्तीमध्ये परमेश्वराच्या नामस्मरणाचे महत्त्वही अनन्य साधारण असल्याचे स्पष्ट होते. समाजातील वैचारिक मतभेदांच्या युद्ध स्वरूपाला छेद देत अवघ्या मानव जातीस विश्वात्मक आवाहन करणाऱ्या ज्ञानेश्वरांच्या वाणीचे मूल्य त्यांच्या साहित्यामध्ये ठिकठिकाणी अधोरेखित होते. तर 'भलेची तरि देवू कासेची लंगोटी' असे म्हणणाऱ्या संत तुकारामांनी आपल्या अभंगातून केलेल्या समाजप्रबोधनामुळे आणि त्यांच्या लौकिक जीवनाभवांमुळे आध्यात्मिक काव्यपरंपरेला प्रतिष्ठा तरी मिळवून दिलीच शिवाय नवी दिशाही सुचविली. त्याचप्रमाणे तुकारामांनी पारंपारिक अनेक श्रद्धांवर हल्ला चढविल्याचे दिसून येते. वर्षानुवर्षे रुजलेल्या अनेक श्रद्धाना विद्रोहाने धक्के देत नव्या श्रद्धा रुजविण्याचे संतांचे कार्य संत साहित्यामध्ये मैलाचा दगड बनले आहे.

कथा करोनिया मोल ज्यापे घेती

ते ही दोघे जाती नरकामध्ये |.....

कष्टसाध्य आणि त्यागसिद्ध संतत्व असलेल्या संत तुकोबांनी संत परंपरेतील इतर संतांहून वेगळी आणि वास्तवदर्शी काव्य रचना केली आहे. त्यातूनही भक्ती संप्रदायातील इतर संतांप्रमाणेच समस्त समाजापुढे निवृत्त जीवनाचा आदर्श ठेवणे हीच त्यामागील प्रेरणा जाणवते. म्हणूनच

उपकारासाठी बोलो हे उपाय | येणेविण काय आम्हा चाड ||

बुडता हे जन न देखवे डोळा | येतो कळवळा म्हणउनि ||

असे तुकाराम म्हणतात.

सर्वसामान्य माणसांना संगतीचे महत्व सांगताना सर्वच संतानी संत संगतीचा आग्रह धरल्याचे दिसून येते. निःसंगाचा संग हा सतत अग्रस्थानी असावा याचे कारण सांगताना संत जनाबाई 'संतांचा तो संग नव्हे भलतैसा | पालटावी दशा तात्काळीक || या शब्दात संतांच्या संगतीचे परिणाम आणि शक्ती सांगतात. जीवन हे स्वप्नरजनात्मक असते. पर्यायाने ते दुःखी व क्षणजीवी असते. अशा लौकिक जीवनाला अलौकिक अध्यात्माची आणि योग्य संगतीची साथ असल्यास जीवनातील अधःपतन टळू शकते असा विश्वास त्यांना वाटतो.

समारोप

संतानी ईश्वराच्या नामसंगतीत सातत्याने येणारे अनुभव सामाजिक पातळीवर अभंग, श्लोक, भारुडे, कीर्तन या माध्यमातून सांगितले आहेत. ही संगत म्हणजे एक प्रकारची शिकवणच मानावी लागते कारण अग्नीजवळ काष्ठ गेले की, ते स्वतःच अग्नी होऊन जाते असेच काहीसे संत संगतीचे आहे. असे म्हटल्यास वावगे ठरणार नाही. संत परंपरेने आणि साहित्याने महाराष्ट्राच्या सांस्कृतिक आणि सामाजिक उन्नतीला चालना दिली. समाजाला पाप - पुण्य, सत्य - असत्य, कर्म - अकर्म, स्वर्ग - नरक इत्यादी बाबीमधला फरक दाखवून योग्य व विवेकनिष्ठ मार्गक्रमण करण्याचा सल्ला संतानी दिला आहे.

संदर्भ ग्रंथ

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विद्यया सर्वे विद्विरे एव शिलनीय विद्या...

दस्त ट्रेडर्स

बेदाणा मर्चंट्स अण्ड कॉर्पोरेशन एजेंट

विकास सोसायटी, गाळा नं. ७, मार्केट याई,

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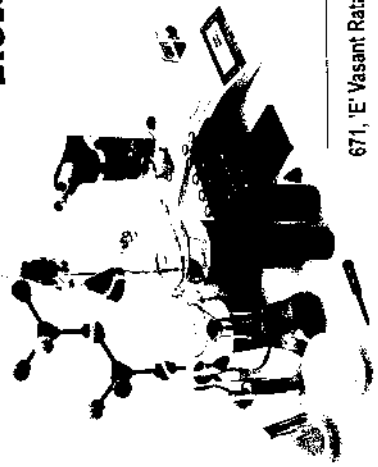
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Vinod S. P

Mo. 9422580305



671, 'E' Vasant Ratan Apt; 3rd Lane, Shahupuri, Kolhapur - 416 004

Ph: (0231)-2661216 (R)937095, E-mail : Vinoduniqu@yaho.com

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लोकसंस्कृतीची आविष्कार रूपे

● संपादक ●

प्रा. (डॉ.) शिवकुमार सोनाळकर

अध्यक्ष, शिवाजी विद्यापीठ मराठी शिक्षक संघ, कोल्हापूर

● अतिथी संपादक ●

डॉ. मिलिंद हुजरे

प्राचार्य, पद्मभूषण डॉ. वसंतरावदादा पाटील महाविद्यालय, तासागाव, जि. सांगली

डॉ. तातोबा बदासे

डॉ. शहाजी पाटील

● कार्यकारी संपादक ●

डॉ. नीला जोशी

● संपादक मंडळ ●

प्रा. (डॉ.) नंदकुमार मोरे डॉ. गोमटेश्वर पाटील डॉ. तातोबा बदासे डॉ. विनेश वाघुबारे

● सहाय्यार समिती ●

डॉ. राजन गवस डॉ. प्रकाश कुंभार डॉ. डी. ए. देसाई डॉ. अनिल गवळी

● प्रकाशक ●

अध्यक्ष, शिवाजी विद्यापीठ मराठी शिक्षक संघ, कोल्हापूर

अनुराज, ७/ब सूर्यवंशी कॉलनी, सामेगुल्ली वसाहत, कोल्हापूर - ४१५ ०११

मुद्रक

देशमाने ऑफसेट,

औद्योगिक वसाहत, पलूस, (जि. सांगली) ४१६ ३१०, मो. ९९७०७००७५८

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हे संशोधन पत्रिका प्रकाशक डॉ. शिवकुमार सोनाळकर, यांनी शिवाजी विद्यापीठ मराठी शिक्षक संघ, कोल्हापूर यांच्या अर्थसहाय्याने प्रकाशित केलेली पत्रिका आहे. या पत्रिकेच्या वसाहत, पलूस येथे छापून आणण्यात, ७/ब सूर्यवंशी कॉलनी, सामेगुल्ली वसाहत, कोल्हापूर - ४१५ ०११ येथे प्रकाशित केलेली पत्रिका प्रकाशित आहे. इंग्लिशा मताची संपादक, प्रकाशक, सहाय्यार व मुद्रक सहकृत अस्तित्वात आले आहे.

लोककला समाजपरिवर्तनाची प्रभावी साधने बनली आहेत. याची व्याप्ती वाढवणे आवश्यक आहे.

लोकसंस्कृतीतील काही समाजविघातक रूढी परंपरेला फाटा देण्याच्या घटना आज घडत आहेत. १४ जानेवारी, २०२१ रोजी मकरसंक्रांत या सणादिवशी पारंपरिकतेला बगल देऊन बीड जिल्ह्यातील चुंबळी या गावात एका शिक्षक असलेल्या भगिनीने 'विधवांसाठी हळदीकुंकू' समारंभाचे आयोजन केले. हे लोकसंस्कृतीमधील परिवर्तन क्रांतिकारी आणि मानवतेचा पुरस्कार करणारे आहे. आज बऱ्यापैकी शिक्षणप्रसार आणि औद्योगिकीकरण चालू आहे. विज्ञान तंत्रज्ञानामुळे मोबाईल, चित्रपट, विविध चॅनल्स इत्यादी मनोरंजनाची साधने आणि पिढ्याची गिरणी, वॉशिंग मशीन, सेतात आधुनिक यंत्रणा आली आहे. त्यामुळे बऱ्यापैकी लोकसाहित्य आणि लोककला दुर्मिळ होत आहेत, काळाच्या ओघात नष्ट होण्याची शक्यता आहे, तरीही बारसे, लग्न, विधी, जत्रा इत्यादी प्रसंगाने लोकसाहित्य व लोककला यांची गरज भासते. वर्षभरातील सण-समारंभाच्या निमित्ताने काही वयोवृद्ध लोककलावंतांकडून हे लोकसाहित्य व लोककला ऐकायला, पाहायला मिळतात. हे लक्षात ठेवले पाहिजे की, वैज्ञानिक क्षेत्रातील संशोधनासाठी पुढे जावे लागते, पण लोकसंस्कृती आणि लोकसाहित्याच्या संशोधनासाठी भूलकाळात जावे लागते. म्हणून अशा लोकसंस्कृतीचे, लोकसाहित्याचे इतिहास म्हणून संकलन संशोधन व जतन करावे. परंतु अंधश्रद्धा, देवभोळेपणा, नशीब, स्त्री-पुरुषभेद व वर्ण-जातीव्यवस्थेचा पुरस्कार करणाऱ्या लोकसंस्कृतीचे, लोकसाहित्याचे व लोककलांचे उदात्तीकरण करू नये. तर स्वातंत्र्य, समता, बंधुता, स्त्री - पुरुष समानता, सामाजिक न्याय, धर्मनिरपेक्षता इत्यादी मानवी मूल्यांचा पुरस्कार करणाऱ्या भारतीय संविधानाचा पुरस्कार करावा. या संविधानातून संविधानवादी संस्कृती निर्माण व्हावी आणि या संविधानवादी संस्कृतीतून उद्याची लोकसंस्कृती आणि लोकसाहित्य निर्माण होईल असा आशावाद व्यक्त करून मी या ठिकाणी थांबतो. धन्यवाद!

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डॉ. संपतराव पार्लेकर
कला, वाणिज्य व विज्ञान महाविद्यालय, पलूस

एकोणिसाव्या शतकाच्या उत्तरार्धात भेदिकापासून अलिप्त झालेला तमाशा स्थिरावला. त्यावेळी तमाशा शाहिरांनी भेदिक शाहिरीचे गुरुत्व स्वीकारले. आपल्या शाहिरी फडात छंदू आणि शृंगारिक लावण्यांचा समावेश केलेले उमाजी कांबळे सावळजकर आणि बाबाजी साठे पेढुकर हे सांगली जिल्ह्यातील तमाशा शाहीर आधुनिक लोकनाट्य तमाशाचे कर्ते ठरले. ४ असे नामदेव व्हटकर सांगतात. तर उमाजी - बाबाजी यांनी गावलेली 'मोहना बताव' ही अख्यानक लावणी तमाशातला पहिला वग मानला गेला असला तरी ती भेदिक फडातील ऐकिव आहे. ५ असे डॉ. विश्वनाथ शिंदे सांगतात. गण : महाराष्ट्रातल्या प्रचलित लोककला परंपरेचा प्रारंभच गणेशस्तुतीपर रचनेने व्हावा असा एक संकेत दिसतो. तमाशा या पारंपरिक लोकनाट्याची सुरुवात 'गण' सादरीकरणाने होते. गणेशाची स्तुती किंवा वंदन या अर्थाने 'गण' तमाशात रूढ झालेला दिसतो. गणेश हा बुद्धीचा दाता, तो अमंगलाचे निवारण करतो अशी जनमानसात त्याच्याविषयी असलेली समजूत विचारात घेता गणेश पूजनाला प्राधान्य दिले गेले ही वस्तुस्थिती आहे. गणेश हा समूहसंगचा देव असल्याने शाहिरांनी त्याचे सुरुवातीला स्मरण केले. भेदिक परंपरेतील शाहिरी आणि उत्तर पेशवाईतील शाहिरी येथून 'गण' परंपरा सुरू झाली. ६ असे विधान लक्ष्मणशास्त्री जोशी करतात. तर 'गण' निर्मितीच्या बाबतीत सर्वसमावेशक विचार डॉ. विश्वनाथ शिंदे यांनी मांडतात. भेदिक फडातून तमाशातला 'गण' आला असला तरी 'गण' गाण्याची धाटणी मात्र गोंधळातून तमाशागिरांनी उचलली असावी ७ असे ते ठामपणे सांगितले.

गौळण : तमाशात 'गण' सादरीकरणानंतर 'गौळण' हा कथाभागावर आधारित नाट्यमय प्रसंग सुरू होतो. गद्यरूप संवादाच्या आधारे कृष्णाला उद्देशून गाविलेली गीते या भागात सादर होतात. इथे कृष्ण व त्याचा सवंगडी पेंद्या (सोंगाड्या) राधा, चंद्रावळीसह इतर गवळणी, श्रीवेशधारी मावशी ही वृद्ध गवळण अशी पात्रे सहभागी होतात. यावेळी नाट्य आणि अभिनय यांना भरपूर वाव असतो. इतर लोकनाट्य प्रकारात देवदेवतांची स्तुतिपर गाणी म्हटली जातात, पण तमाशात कथाप्रसंगावर आधारित गद्य-पद्य स्वरूपातील सादरीकरण होते. इथे विनोदाला भरपूर संधी असते. कृष्ण-पेंद्या बरोबर गवळणीची होणारी प्रश्नोत्तरे यांतून मार्मिकता, मिस्किलता, हजरजबाबीपणा या गोष्टी निर्दर्शनास येतात. भाषा आणि तत्त्वज्ञान यांचा सुरेख संगम या भागात पहावयास मिळतो. काळानुरूप या गौळण घटकात नावीन्य आणण्याचा प्रयत्न केला जातो. त्यामुळे रागदादा प्रसंग म्हणून या गौळण प्रकाराकडे घटकाकडे पाहिले जाते.

तमाशातल्या 'गौळण' या कथानाट्याला सुरुवात केव्हापासून झाली याबाबत निश्चित पुरावा मिळत नाही, पण हा कथाभाग कुठून आला असावा याबाबत तमाशा अभ्यास डॉ. विश्वनाथ शिंदे, ८ या गौळण कथा प्रसंगाचे मूळ बंगालमध्ये प्रचलित

असणाऱ्या 'बारामासा' या कथात्मक लोकधर्मी नाट्यपरंपरेत शोधून त्याचा परिणाम कर्नाटकातील 'राधाआटा' या लोकपरंपरेतील नाट्यावर होऊन महाराष्ट्रात होळीच्या सणानिमित्त होणाऱ्या 'राधानाच' या प्रकारात समाविष्ट होऊन त्याचे अनुकरण तमाशाने केले असावे असे सांगतात.

मावशीच्या परंपरेचा शोध घेतना डॉ. विश्वनाथ शिंदे ९ यांनी, बंगालमधील 'बारामासा' या लोकगीतांचा प्रभाव असणाऱ्या 'श्रीकृष्णकिर्तन' या ग्रथातील बढाई नावाचे पात्र मावशीस साधर्म्य दाखवणारे आहे. ही बढाई कर्नाटकातील 'राधाआटा' या लोकधर्मी नाट्यात आणि तिथून मराठी तमाशा आली असावी असे अनुमान काढले आहे. तर डॉ. रां. चिं. हेरे १० सांगतात की, तमाशा ज्या राधेच्या नावातून उदकांत झाला तो 'राधानाच' आजही मूळ न्यात अस्तित्वात आहे आणि तमाशातली बाई ज्या वेशधारी पुरुषाची जागा घेण्यासाठी आणि तो पुरुषही आपले स्त्रीमुलभ हावभाव टिकवून आजही तमाशात मावशीच्या रूपाने आहे यावरून मावशीचा इतिहास समजतो. तमाशातील गौळण हा कथाप्रसंग यशस्वी ठरलेला दिसतो. उत्स्फूर्त मार्मिक संवाद हे या घटकाचे अंगभूत वैशिष्ट्य असलेले दिसते.

लावणी : तमाशात गणगौळण यः भागानंतर 'लावणी' सादरीकरणाला विशेष महत्त्व दिले जाते. ही लावणी भेदिक, गाहिरी परंपरेतून आणि पेशवेकालीन शाहिरी वाडू मयातून आलेली दिसते. ढोलकीच्या साथीन सादर होणाऱ्या या लावणीतून शृंगारिक भाव व्यक्त होतो. स्त्रीमानातील विरह भावना हा तमाशातील लावणीचा विषय ठरला त्यामुळे लावणीला लोकप्रियता मिळाली. तर काही प्रमाणात ती मुक्त होऊन बैठकीत सादर होऊ लागली. लावणीची रचना मूळातच लोकजनासाठी झालेली आहे. पूर्व पेशवाईत मराठी साम्राज्यात ऐशआरामी जीवन विलासी असल्याने करमणूकप्रधान गोष्टींना विशेष प्राधान्य दिले गेले. तेव्हा या काळात लोकशाहिरांनी विविध स्वरूपाच्या रचना केल्या. त्यांना काही काळानंतर लावणीचे स्वरूप प्राप्त झाले. उत्तर पेशवाईत ही लावणी बहरास आली. सुरुवातीला तिचे रूप आध्यात्मिक असले तरी तिची नंतरची बाजू शृंगारिक होती. विरह, शारीरिक सौंदर्य, प्रेम, कामोत्सुक भावना या भावनिक अवस्थांचे चित्र तिच्यातून होताना दिसते. ही लावणी नर्तिकांच्या नृत्य, अभिनयासहित सादर केली गेली. सन १८५० नंतरच्या तमाशात तिला प्रतिष्ठा मिळाली हे लक्षात घ्यावयास हवे.

बतावणी : मराठी तमाशात 'बतावणी' या घटकास महत्त्वाचे स्थान आहे. या बतावणी शब्दाबाबत अभ्यासकांनी वेगवेगळ्या बाजूने आपली मते मांडलेली दिसतात. नामदेव हटकरांनी ११ गोंधळ या लोकनाट्याशी बतावणीचा संबंध दाखविताना, गोंधळी बारा बलुयाप्रमाणे शेतकऱ्यांच्या खड्यावर धान्य वसुलीसाठी जात तेव्हा तिथे आजमासाने बोलायच्या संवादाला 'तपातनी', 'बतावणी' म्हणण्याची रीत आहे. 'सपातनी' हा शब्द 'संपादणी' शब्दापासून बनला आहे. तर बतावणी हा शब्द उर्दूतील 'बताना' म्हणजे साणणे या क्रियापदापासून तयार झाला आहे. असे स्पष्टीकरण दिले आहे. बतावणी हा शब्द तमाशात रूढ झाला हे मात्र निश्चितपणे सांगता येईल. दुसऱ्या बाजूने विचार करता वि. कृ. जोशी १२ यांनी बतावणीम रंगबाजी असे म्हटले आणि आशुक-माशुकांच्या

डॉ. बाळासाहेब संतू चव्हाण
डी.पी. भोसले कॉलेज, कोरगाव

प्रस्तावना-

भारतातील आदिवासी जमातीत व जनजीवनात लोकनृत्यांतची प्रदीर्घ परंपरा आढळते. आसाममधील वैष्णव पंथाचे 'अकिया नाट' हे धर्मविधीपर नृत्य आहे. मणिपुरी रासलीला नृत्यातून जनजीवनातील उत्कृष्टीय त आनंदमय आविष्कृत होते. लायहरोबा हा पुरातन लोकनृत्यप्रकार असून त्यात शिवपार्वतीची नृत्यमय उपासना केली जाते. 'संकीर्तन' ह्या धार्मिक लोकनृत्यासतून युंग- चोलम व करताल. चोलम् हे प्रकार निर्माण झाले आहेत. बंगाली लोकनृत्यात कीर्तन (कीर्तनीयाट) हा प्रकार रुढ आहे. रस्याह शिवरुन धार्मिक आशयाचे नृत्योगान करीत नर्तकांचा संघ जात असतो. हे नागर कीर्तन होय. बाउल गाणी खंडोपाडी गायिली जातात त्या-वर आधारित लोकनृत्यग असतात. बंगाली जात्रा हा पारंपरिक नृत्यनाट्यप्रकार असून त्याचे अनेक उपप्रकार आहेत. बिहारमधील आदिवासी मथाळ जमातीची लोकनृत्ये प्रसिद्ध आहेत. स्त्रीव-पुरुषांच्या समूहनृत्यांत त्यांचे कृषिजीवन व शिकार हयांचे प्रतीकात्मक दर्शन घडते. 'करमा नृत्य' आदिवासीमध्नी विंजण प्रचलित आहे. सेराईकेला लोकांची 'छाऊ' (मुखवटा) नृत्ये सांस्कृतिक दृश्या महत्वाची आहेत. उत्तर प्रदेशात रासलीलांप्रमाणेच नोटकी हा पारंपरिक नृत्यनाट्यप्रकार लोकप्रिय आहे. उत्तर प्रदेशातील लोकनृत्यांवर मुस्लिम संस्कृतीचा पगडा दिसून येतो. पंजाबमधील शेतक-यांचे भांगडा नृत्य साऱ्या भाषात अत्यंत लोकप्रिय आहे. हिमाचल प्रदेशात गद्दी जमातीची नृत्ये व महाराष्ट्रातील धनगरांची गजीनृत्ये ही फार आकर्षक असतात. दिल्ली येथे प्रतिवर्षी भरणाऱ्या लोकनृत्य महोत्सवात गद्दी लोकनृत्याला १९५४ मध्ये राष्ट्रीय पदक मिळाले होते. महाराष्ट्रात ग्रामीण यात्राकाळात धनगरांच्या गजीनृत्याच्या स्पर्धाही आता घेतल्या जातात. लडाखी लोकांच्या धार्मिक मुखवटानृत्यातून त्यांच्या निसर्गाविषयीच्या भययुक्त श्रध्दांच प्रकट होतात. शेखावटी प्रदेशात होळीच्या सुमारास पुरुष नर्तक 'गौदड' हे समूहनृत्य टिप-यांच्या ठेक्यावर फेर धरून करतात. 'खयाल' हया नृत्यनाट्यप्रकाराला चाऱ्से वर्षाची जुनी परंपरा आहे. राजस्थानातील पारंपरिक भवाई नर्तकांचे संघ भवाई नृत्यनाट्य सादर करतात. मध्य प्रदेशात अदिवासीची लोकनृत्ये विपुल आहेत. 'करमा' हा गौड जमातीचा प्रमुख नृत्यप्रकार आहे. त्यांचा घोडकाठयांचा नाचही (घोडेनाचणी) प्रेक्षणीय असतो. गोव्यातत घोडेनाचणी नृत्य होते. बस्त रच्या माडिया आदिवासीमध्ये अनेक वैशिष्ट्यपूर्ण लोकनृत्ये प्रचारात आहेत. 'गौड' हे वनगायीच्या नावाने ओळखले जाणारे वीडपुरुषांचे समूहनृत्या असून त्यात पुरुष गायीची शिंगे व मोरपिसे डोक्याला बांधतात; तर स्त्रिया डोक्यावर तांब्याहवा मुकुट व गळ्यात मण्यांमध्याल माळा घालतात. शेतात बी फेल्यावर 'बीजपुतनी' नृत्य करतात. ओरिसामध्येही आदिवासी विपुल प्रमाणात असल्याने तिथे आदिवासी नृत्यांचे वैविध्य दिसून येते. मुडिया जमातीतील रामबैलाचीच

उत्तान शृंगार चेष्टांचे वर्णन करणारी गाणी म्हणून त्याला पोषक अशी उघड संपादणी करून रा निरमाण करणे म्हणजे रगबाजीअसे स्पष्टीकरण दिले.

सारांश : तमाशातल्या पूर्वार्धात सादर होणाऱ्या गण,गौळण, लावणी व बतावणी या घटकांचा आढावा इथे घेतला आहे. तमाशातच्या एकूण विकासाबाबत या घटकाना विशेष महत्त्व आहे. या सर्व घटकातील पधारचना वाई मयीन गुणवैशिष्ट्यावर आधारित असून त्यातून आशय आणि अभिव्यक्तीसौंदर्य व्यक्त होताना दिसते. तमाशाच्या प्रारंभ काळापासून आजपर्यंत गण, गौळण,लावणी आणि बतावणी तमाशात उत्तम प्रकारे सादर होताना दिसते. बतावणीत सादर होणारी चित्रपट गीते आणि ऑगळ नृत्य आज पहावयास मिळत असले तरी तमाशा आपले अस्तित्त्व टिकवून आहे हे मात्र निश्चित. मुख्य घटकांच्या आधारे सादर होणारा हा तमाशा प्रायोगिक अंगांनी वैशिष्ट्यपूर्ण रूप प्राप्त झालेला कलाविष्कार आहे. त्याआधारे पात्रे, अभिनय, नेपथ्य वेशभूषा, राश्रूषा, आणि विविध वाद्ये इथे महत्वाची करतात. तर वाडू मयीन अभिरूचीच्या दृष्टीने तमाशातील संवाद,विनोद,कथानक,करुणनाबंध, पदरचना व भाषाशैली या दृष्टीने तमाशाचा अभ्यास करता येईल. म्हणूनच इतर लोकनाट्य प्रकारात तमाशा नावलौकिक मिळवून यशस्वी ठरलेला दिसतो.

संदर्भ

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The Role of Female Characters in the Amitav Ghosh's *Sea of Poppies*

Mr. Sakate Bharat Shamarao

Research Scholar

Dr. P.M. Patil

M.A., M.Phil, P.hd. Research Guide

A.S.C. College, Palus

Abstract:

Amitav Ghosh is the historical novelist who represents the past, present and future of mankind with the help of historical phenomena. This representation of history is scattered in fiction with the help of characters. Characters life plays vital role in depiction of history. Hence, the characters of his novel becomes the object of study. The narration of the life of the characters focuses on the historical events of specific period. In Ghosh's novel, the characterization of the female characters accentuates to the historical incident. The female characters are engaged with the social, political and economic facts which is the basic facts of representation of history. In this context, this paper presents the role of female characters in the historical novel *Sea of Poppies*.

Introduction:

The historical novel *Sea of Poppies* is the first piece of Ibis trilogy. It is published in 2008 and is nominated for Man Booker Prize of 2008. It is set in 1838. The story of the novel unfolds in the north India and the Bay of Bengal, first Opium War. It gives the details of three years opium war between British and China. The epic novel compounds the several characters to perform novelistic action, for intended purpose of the author. Amitav Ghosh sketches the gallery of the characters who are belong from different caste, gender, creed, religion, race and nationality etc. These characters gathered at Ibis ship because of the opium farming, trade and slavery. The story of the novel revolves around the characters who are belong to the different layers of the society. They are representatives of the society of the 19th century. It is the novel of the characters, rather than incidents. The incidents of the novel plays minor role in the novel because incidents and characterization of the novel is belong to the characters who are subaltern. They are neglected from the society. Ghosh projects the neglected persons, things, incidents and events of history. Hence, along with the subaltern, women are projected in his novel as the point of discussion. Where new feminists criticized the historians for negligence towards women. In this concern, Buhle noted that: "Feminists observed that the new social historians continued to make men and men's affairs component of their analyses" (Buhle:1993:320). Even further, he noted that: "As feminist scholars began to demonstrate the vitality of sex as a category of historical analysis, they surpasses other social historians in grappling with the theoretical subtext of their own enterprise: the grounds for considering women a discrete group" (Buhle: 1993:321). Ghosh has paved the way to the women in representation of history as prominent factor.

The Ibis was carrying the opium, criminals and indentured labors towards the Mauritius. These people were leaving behind their well-unwell life, expecting the life bestowed upon them

by destiny. Every character is having their own past; this past of character contains the story of social strata of the 19th century's society. This panorama of the characters fulfills the novelistic accomplishment. The novel is divided into three main parts: Land River and Sea. These parts include subparts which contain the story of characters. The novel begins in eastern Bihar's village where protagonist character Deeti was living. The other character's characterization and development in the novel passed through her characterization. Ghosh writes very beginning of the novel about the Ibis ship with the help of her as:

The vision of a tall-masted ship, at sail on the ocean, came to Deeti on an otherwise ordinary day, but she knew instantly that the apparition was a sign of destiny for she had never seen such a vessel before, not even in a dream: how could she have, living as she did in northern Bihar, four hundred miles from the coast? (3).

Deeti is the ordinary village woman who was suffering from the gender biased Indian society. Her appearance in the novel described by the author as '*Chudaliya, dainiya*' (witch) because of colour of her eyes. She is the mother of six year old child Kabutari. She married to afeemkhor Hukum Singh who was serving in the British Army, with his brother Kesari Singh. This marriage took place without her consent, which was ordinary in those days. Hukum Singh was lame by injury of one leg. This lameness was the outcome of shot in leg while serving in the British Army. But this would not become obstacle in the marriage. After this injury, Hukum Singh started to work in the opium factory of Gazipur. He was belong to the high caste Rajput. Deeti was drugged by her mother-in-law to rape her by her brother-in-law Chandan Singh, on wedding night. She realized all reality after some period.

Her suspicions deepened in the following weeks, when Hukum Singh showed no further interest in her, being usually in a state of torpid, opium-induced somnolence by the time he fell on his bed. Deeti tried a few stratagems to break him from the spell of his pipe, but all to no avail: it was pointless to withhold opium from a man who worked in the very factory where it was processed; and when she tried hiding his pipe, he quickly fashioned another. Nor did the effects of temporary deprivation make him desire her any more: on the contrary, it seemed only to make him angry and withdrawn. At length, Deeti was forced to conclude that he could never be a husband to her, in the full sense, either because his injury had rendered him incapable, or because opium had removed the inclination. But then her belly began to swell with the weight of a child and her suspicions acquired an added edge: who could have impregnated her if not her husband? What exactly had happened that night? (36)

Her mother in law tells her that she is like Draupadi of Mahabharata. She knew that her mother in law knows about her pregnancy and father of her child. The opium's influence on mother in law revealed truth. She admitted that the child's father is not Hukum Singh but her brother in law. Deeti's roar of chastity of the Indian woman is expressed through her words as:

“Listen to me: I will burn on my husband’s pyre rather than given myself to you” (154). The Indian society exploits the woman in the name of the honor and respect. After the death of her husband people inhale her opium to sit on pyre of her husband. The brother in law of Deeti Says: “To have a sati in family will make us famous. We’ll build a temple for you and grow rich on the offerings” (150). The custom of sati is discussed by Ghosh as the historical truth related with the Indian woman. Ghosh has put forth the idea of sexual exploitation of women in the great family in the name of clan and family reputation. He uses the female character like mother-in-law of the Deeti as villainous character against woman to show that women never know the fact what are they doing in the name of reputation. The right of liberty is totally demolished in the Indian society of the 19th century. The character of Kalua raises against society to help the exploited woman. As being ox-cart driver, from the lower caste Chamar, he saves the Deeti from the funeral pyre. And elopes with her. Ghosh forms the unification of exploited Deeti and Kalua to show the strong reaction against the traditional Indian society. Even, the change in the behavior of the Deeti focuses the revolutionary attitude of woman. The suppression of women in Indian society came to the edge where all things, customs came to shatter. Even, the identities of woman were changed in the 19th century, due to the social, political suppression. These suppression gives birth to the new identity. Deeti’s migration changed her name. At the beginning, Deeti changed to ‘Kabutari ki Ma’. After elopement with the Kalua, she became Aditi and Kalua as Madhu. Liberty of the woman brutally crushed into the patriarchy of the Indian society.

On Ibis she became the girimityas with new name Madhu. Girmityas called her *bhaugi*. She was the leader of them. She prepared herself for the help of everyone. She intervened in the matter of Jodu and Muniah. When Jodu was beaten and Muniah was locked in room because she had a relationship with the Muslim boy. Indian society is engrossed by communalism whose victim was always a woman. Even Muniah was expelled by parents from village when she became pregnant by illicit relationship with the man who was working in opium factory.

Another female character Heeru represents the historical truth of the society. The women like Heeru was left by the husband for impotency or not giving birth to male heir.

The characters of Ratna and Champa are represent the life of women who were suffering with their husband after land confiscation. Ghosh has shown the social strata of 19th century Indian women.

Sarju is the woman character who came to Ibis as punishment for his mistake in delivery of Thakur’s son. This old lady gave the seeds of different crops to the Deeti. She died on the Ibis due to her health condition. Ghosh depicted the social custom of suppression of woman of lower class from the upper class. They were treated like the slave or animal. The women who were farmers in this period, kept seeds for future use.

Raja Neel Ratan Halder is a bankrupt landowner of Rashkali estate. He had eight years old son and a mistress named Elokeshi. She was once famous dancer. Malti is the wife of the Neel who represents the passiveness of Indian woman. She watches the illicit relationship of Elokeshi and

Neel. When all the property of Neel were confiscated and sent him to Ibis for Mauritius. His wife tells him to take care. She has to live in small house but she never complains about it.

Another female character is Jodu's mother. She was the Ayah of the Lambart Sahib's daughter Miss Paulette. Paulette born on the boat of Jodu's father. Jodu's mother nourishes her like her own child after the death of her mother. She learned Bengali and ate Indian food like, Khichadi. She speaks English and Bengali. She is the woman who tolerate all things to achieve her goal. She became the girmityas with Baboo Nob Kissin on Ibis to reach Mauritius. Mr. Pierre Lambert serves as the assistant curator of Calcutta Botanical garden. Jodu was in search of Miss Paulette, loads his boat with remaining after the burial of his mother.

Taramony is the guru ma of the Baboo Nob Kissin. Baboo Nob Kissin's uncle married to the Taramony six years before to get male heir but unfortunately it would not come into reality. Her husband was much older than her. Her husband's wish was to leave her Brindavan to lead her widowhood life. Baboo Nob Kissin surprised by her spiritual knowledge. He considered her as guru ma. After the death of Taramony due to the fever, he became sensitive towards women. He thinks that she would come to back to fulfill their goal of spiritual life as per her opinion. Ghosh focused on the spiritualism related with woman. Women like, Taramony had to live with spiritualism to lead their widowhood.

Mrs. Burnham and their daughters are example of the women who were influenced by the British. The supremacy of the language, culture and attire of the British influenced to them. Through, these character Ghosh shows the attraction of women towards British culture in the 19th century.

In short, Ghosh has caricatured the social strata of the 19th century through the women characters. Women are tool to the author to depict historical reality. Subaltern and ignored women become the center of this novel. The novel revolves around the female characters. These characters influences to the historical incidents, even it clarifies several ambiguities and depth of the issues. Ghosh has only 'women charactersto present historical reality because male characters never performs any dominant action in the novel. The women characters like, Mrs. Paulette, Taramony, Heeru, Muniah, Ratna, Champa, Deeti, Mrs Burnham and her daughters, Elokeshi, and Malati are dealt with the anyhow prominent history, without them social history of 19th century cannot be completed in Ghosh's novel.

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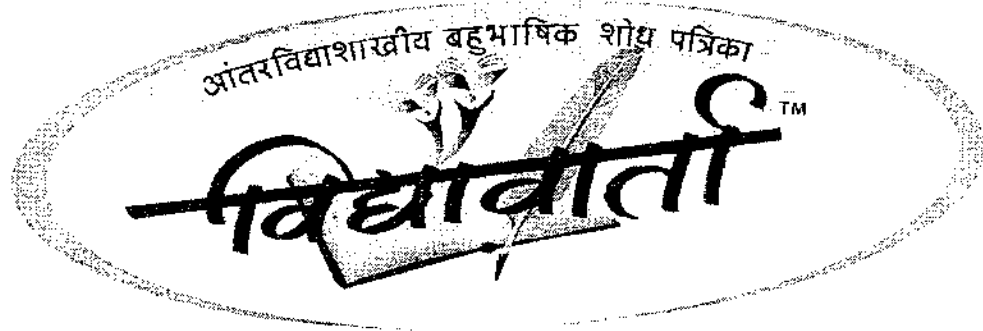
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विद्येविना मति गेली, मतीविना नीति गेली
नीतिविना मति गेली, मतिविना वित्त गेले
वित्तविना शूद्र स्वचले, इतके अनर्थ एका अविद्येने केले

-महात्मा ज्योतीराव फुले

❖ विद्यावार्ता या आंतरविद्याशाखीय बहुभाषिक त्रैमासिकात व्यक्त झालेल्या मतांशी मालक, प्रकाशक, मुद्रक, संपादक सहमत असतीलच असे नाही. न्यायक्षेत्र:बीड



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As the geographical vision Dhadgaon tahsil is the important for satpura mountain and Narmada river. Dense forest, hills, valley catchment area and plateau etc. chandsaili is about 1100 meter and forest villages like fuali, Zapi and old Toranmal are the important villages of Toranmal plateau on the bank of Narmada river. There forest village Bilgaon has great waterfall and contains beautiful sight scenery and environment

In Dhadgaon tahsil the tribal handicraft artisan are backwards in education, because of natural, economic and social factors.

1. The Dhadgaon tahsil is the remote area, hilly valley, plateau catchment in lack communication lacking and lack of freight are the major factor for lack the education of tribal handicrafts artisan.

2. In dhadgaon tahsil the zapi, fali, and shindidigar are located at Narmada river edge. They are lack of primary education. Schools are open or run for 2/3 months only in year. Therefore the children of this handicraft artisan are lack of education.

3. Lack of education in forest villages is responsible to low moderate literacy.

4. In these forest villages every year's rainfalls occurred about 100 to 200 meters. These are the factor of Narmada river floods. Because the children are pedestrian crossing the rivers, in rainy session school 1 to 2 months prohibited. These are back of the tribal children education.

5. This is the important to government should concentrates these area with political members and rating of education will grow.

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15

PERCEPTION OF WOMEN IN INDIAN ENGLISH FICTION

DR. P. M. PATIL

Head, Department of English,
Arts, Commerce & Science College, Palus
Dist- Sangli.

ABSTRACT

Women have made remarkable contribution to Indian English Literature. In fiction, there is ample scope for the expression of feminine sensibility. Woman is herself a creator of literature and is all pervading. Woman is the cause of all action. If woman is absent, there is no poetry, no song, no drama, no tears, no laughter and ultimately no life in this world. But they are still walking on a tight rope to achieve their human rights and social justice. Indian woman at the turn of century are in a transitional phase via- a- vis the interface of tradition and modernity. The different aspects of feminism are stressed through the Indian English fiction. The Women novelists like Anita Desai, Shashi Deshpande and Bharati Mukherjee have made remarkable contribution to fiction in Indian English Literature. They have projected the various images of women in society. This study attempts to present various perceptions and images of women projected by Indian women English novelists.

KEYWORDS: feminism, women writers, Indian, image etc.

The perception of women in Indian women novelists has undergone a change during the last four decades. Female characters from 1980s onwards assert themselves portrayed by them defy marriage and motherhood. They have moved away from traditional portrayals of

enduring, self-sacrificing female characters to more dynamic, ready to unyoke the barriers of tradition, and to spend their lives in search for identity within and outside the social system. The works of some recent well known Indian English women writers like Shashi Deshpande, Anita Desai, Bharti Mukherjee, Kiran Desai and others offer full range of experience of the emerging Indian woman who rooted in traditions. It is firmly committed to redefining her role relatedness to various institutions of the society in the light of modern thought and consciousness. They have also analysed the socio-cultural modes and values that have given Indian new roles and images as their well-argued motives and efforts to achieve a harmonious relationship with their surroundings.

Feminist approach is the prominent in modern and post-modern literature. The modern and post-modern women writers advocated feminist approach in their writings. Feminist literature in English is not a recent innovation. It is a product of the western liberalization in general and feminist thought in particular. The 'feminism' is World-wide movement to secure equality of women with men with all human rights – social, political, economic, moral, religious, education and so on. Feminism argues that woman should be left alone to live on her own strength and means to fight against the unjust system and obtain her won subsistence and thereby remove her dependent status. It is an assertion of the value of woman as woman, and expression of struggle to establish a woman's identity. It is global and revolutionary ideology. It signifies the emergence of female power in order to get rid of their excessive and undue dependence on men. It is socio-cultural movement that aims at the freedom women from male domination in the patriarchal society. In patriarchal culture, woman is a social construct. Feminism is generally seen as a struggle against all patriarchal and sexist oppression. It is concerned with the emancipation of women by

liberating them from man's domination. It demands that women should be treated as autonomous individuals and not as passive objects; that equal attention and opportunities should be given to women for education and employment for their economic independence. What particularly signifies the situation of women is that she finds herself living in a world where she is compelled to assume the status of the 'other'. Society decrees that woman is inferior to man. Legally she has been given equal rights with man, but the submissive and gentle nature of women embedded deeply into their psyche which did not disturb the male-dominance in the family. The issues regarding feminism have been keenly handled in the works of Indian English fiction writers like Anita Desai, Shashi Deshpande, Bharti Mukherjee, Gita Hariharan, Kamala Markandaya, Shobha De, Arundhati Roy, Mahashewta Devi, and Nayantara Sahgal etc. These Indian women novelists have presented women's issues realistically both psychologically and physically in their novels. They have broken the literary and social norms of the past. They studied deep into psyche of their characters and projected various images of women and their status in society. The present research article deals with the feministic aspects and image of women in Indian English fiction with special reference to the select novels of some Indian women writers.

Anita Desai, one of the prominent Indian women English novelists, was born on June 24, 1937 in Delhi to a German mother and a Bengali father. She grew up speaking German at home and Bengali, Urdu, Hindi and English at school and in the city streets. She married with Ashwin Desai, businessman. They have four children including Booker Prize winning novelist, Kiran Desai. Her first book, *Cry, the Peacock*, was published in England in 1963, and other novels include *In Custody* (1984) and *Baumgartner's Bombay* (1988). She is a very distinguished Indian novelist. She has been recognized as such

both in India and abroad. Women writers of all ages have a natural preference for writing about women characters. Anita Desai is no exception in so far as. She has written by and large about women characters through her fiction. Her female characters go through psychological turning point. She herself has admitted that she is a painter of the inner world of her protagonists. Being a woman writer she is more aware of the pains and pangs of the woman. She tries to present a psychological world of the woman through her fictions. She throws light on the psyche tortures, familial troubles, partial social treatment, and marital maladjustment, outdated social and cultural traditions which affect the psychological life of the woman.

Throughout her novels and short stories, Desai focuses on the personal struggles of anglicized, middle class women in contemporary India as they attempt to overcome the societal limitations imposed by a tradition bound patriarchal culture. Her novels move around women characters although she is preoccupied with the theme of incompatible marital couplets. Most of Desai's works engage the complexities of modern Indian culture far from feminine perspective while highlighting the female Indian predicament of maintaining a self identity as an individual.

Cry, the Peacock is a novel mainly concerned with the theme of disharmony between husband and wife relation ship. It deals with the psychological consciousness of the female protagonists and is aptly illustrated amidst detail images, monologues and flashbacks. The female character Maya, in the novel, envelopes the reader as she unfolds the growth, development and climax of her neurosis. Maya is a young girl obsessed by a childhood prediction of disaster. The story unfolds that Maya's father without thinking much married her off to his own lawyer friend – Gautam who was middle aged man. The marriage was never fruitful and slowly Maya turns into a psychopath

whose emotional needs were seen to be collided with that of the extremely practical outlook of her husband. The climax of the story lies when Maya's attachment with her father further develops into and 'Electra Complex' which again acts as the catalyst in the deflowering of her marital relationship with her husband. Extremely frustrated Maya then looks back to the class of her childhood spent with her father. This reminiscence of those long lost days serves as the defense mechanism to set her free from her inner frustration and conflict. This dark state of affair is again unacceptable by the conscious mind of Maya. She relaxes her tension by pondering unconsciously on how "Peacock breaks their bodies" in order to receive their own pain. Here comes the sense of violence, the feeling of killing or get killed which engulfs Maya. The violent desire of killing her husband awakening from her own frustration as revenge against his icy cold impressiveness and indifferences weaves the story Cry, The Peacock. The very concept that woman needs something more than just food, clothes and accommodation are aptly illustrated in this novel. The hyper sensitive mind of the women is illustrated by Anita Desai in the tender way where the atmosphere of tension is set ideally against the backdrop.

In Anita Desai's novels Cry the Peacock, Voices in the City, Fire on the Mountain, She has explored the psyche of both Childless woman and women with Children. She has covered women of all age groups and types. Anita Desai's work represents a unique blending of the Indian and the western. Her novels catch the bewilderment of the individual psyche confronted with the overbearing socio- cultural environment and the ever- beckoning modern promise of self-gratification and self- fulfillment.

Shashi Deshpande (1938) is one of the post independence Indian woman fiction writers. She is known for her sincerity and ability in voicing the concerns of the urban educated middle class women. Her novels reflect the

gamut of Indian cultural issues. She is the living dynamic woman writer on Indian English literary horizon with seven novels and four collections of short stories to her credit. She has been awarded with prestigious Sahitya Academy Award for her novel *That Long Silence* (1989). Her novels like *The Dark Holds No Terrors* (1980), *Roots and Shadows* (1982), *That Long Silence* (1988), *The Binding Vine* (1993), *A Matter Of Time* (1996), *Small Remedies* (2000) etc. reflect image of women and feminine consciousness. The protagonists of her novels are traditional bound women who stand on the threshold of modernity, the new vistas offering them new opportunities but the old values holding them back. Through her work, she tries to depict the struggle of a contemporary Indian woman who is educated and economically strong, but yet succumbs to the pressures of marriage and society, and turns into another submissive one. For her, her novels are about the women trying to understand themselves, their history, their roles and their place in the society.

Her novel, *That Long Silence*, tells us the story of man and woman from woman's point of view and of wife and husband from the wife's point of view. She expresses the silence of the women protagonists Jaya as expression of the silence of the modern Indian housewife. Although modern women writers tried to express the silence that had turned women into non-entities; they could only provide psychological depth to their characters. They either created unreal sentimental romances or succumbed to the temptation of mounting feminist ideology. But Shashi Deshpande's success lies in her representation of real life experience. She realistically depicts the inner conflict of Jaya and her quest for the self identity. The novel sustains its credibility from the fact that Jaya is a convent educated – English – speaking lady with a literary taste. It portrays the conflict raging between the narrators split self and the housewife. Jaya represents urban

and middle class woman. Her upbringing demands the suppression of the self. Her pent up feelings makes her neurotic she is content to play the role of a caring wife. But like Seeta, She fails to accompany her husband in exile. To Jaya the experience turns out to be traumatic. She lives several days in a traumatic state. *That Long Silence* is the masterpiece of feminist writing in Indo- Anglican fiction raises the status of Shashi Deshpande among the writers of the present day. The novel highlights the image of middle class women sandwiched between tradition and modernity. The novel is about gender discrimination and inequality prevalent in society. Here the protagonists raised voice against the role models of the age old patriarchal set up. Her romantic appearance is the feminist mark of the new woman. But she concludes that a husband is a sheltering tree and she plays again the role of an orthodox Hindu Wife. Shashi Deshpande's protagonists look silent and their silence becomes their destiny. But their silence is self imposed one. For P.G. Joshi, "Shashi Deshpande suggests that because women prefer to remain silent about their condition, men begin to assume the dominative mode, which finally results in the domination of women. Women refuse to react to this domination, either through speech or action, and this makes them silent forever. In Shashi Deshpande's novels, silence has negative connotations. It stands for passivity, inactivity, fear, escapism, the inability to communicate and so on" (2003, 71). Though her women seem silent, meek and docile initially, they emerge as also strong individuals as we reach the climax of the story in some novels. Her female characters are close to life with real joys, woes, desires and aspirations. They seem to fight the male dominance in their own way, not by over throwing their marriage or discarding their home and children, but by balancing their new found individuality with their traditional roles of mother and wife.

Bharati Mukherjee, an Indian immigrant

In the USA, is one of the major novelists of Indian Diaspora. She contributed to the field of fiction writing with a special focus on diasporic experience. She was educated in India, England, Canada and America. When she was in Canada, she married a Canadian novelist in America. She immigrated to Canada with her husband and became a naturalized citizen. Her life in Canada was very hard as she found herself discriminated and treated as a member of the 'visible minority'. She stated in her many interviews about her difficult life in Canada; a country that she sees as hostile to its immigrants. Bharati Mukherjee has gone through different cultures and citizen. Her experience as an expatriate in America and Canada forms the main source of her creative writing. Her works focus on the status of new immigrants and the feelings of alienation often experienced by expatriates. Her biography and her works have a close connection.

The novel *Jasmine* is a story of Jyoti, an innocent Hindu girl, begins her life in a small village of Hasnapur, Punjab and ends in Iowa. She is a protagonist of the novel. She undergoes the experiences of expatriates in the new land of multicultural society. She married in her teen age with Prakash, a young engineer, 'a modern man, a city man' (76) who always thinks of making India new and modern. He refuses Hindu traditions, hates feudalism in Indian society. Her marriage with Prakash brings different change in her life. Prakash changed Jyoti's name as 'Jasmine'. He wants to modify her life style according to his own thoughts. He encourages her to study. Usually in Indian society, women are not allowed to address their husbands by their names directly. However, Prakash wants Jasmine to call him by his first name. She was happy with Prakash. For her, Prakash was like an 'idealist' and a man of dynamic vision. But unfortunately, her married life became short-lived as Prakash died in the bomb explosion. After the death of her husband, she was not ready to go with her mother having

widowhood. She wants to complete the incomplete mission of her husband. Jyoti dies with the death of Prakash and Jasmine, who is the product of the new life created by Prakash, starts new life. She decides to fulfill the plans of her husband. Her brothers made illegal documents and for convenience her age was made nineteen years. A lonely girl Jyoti turned towards the USA in search of her destiny.

Throughout the novel, the protagonist Jasmine seems to dislocate and again relocates during her journey. Her journey developed in the different stages like – Jyoti, Jasmine, Kali, Jase and Jane. Each stage provides new experiences to her. She is transformed in various images or stages. Her transformation is full of risk, violence, fear and terror. Each stage of her life ends in fear and terror. Jasmine undergoes several transformations during her journey of life in America, from Jyoti to Jasmine, Jasmine to Jase, Jase to Jane, and often experiences a deep sense of estrangement resulting in a fluid state of identity. This journey becomes a tale of moral courage, a search for self-awareness and self-assertion. Uprooted from her native land India, Jyoti does her best to introduce herself into the new and alien culture as an immigrant. Throughout her life, Jasmine has created many selves, and she is aware of the fact that she has now the power to continue and create more new identity. It also indicates the idea of the humanitarian approach. Her journey from Hasnapur to the USA is not geographical only, but it is from Indian feudalism to modern liberalism.

In nutshell, many Indian Women novelists have explored female subjectivity in order to establish an identity that is not imposed by a patriarchal society. The image of the New Woman and her struggle for an identity of her own also emerges in the Indian English Novel. Such a struggle needs support structures outside the family to enable to survive. Anita Desai, Shashi Deshpande, Bharati Mukherjee have presented the image of a suffering woman

preoccupied with her inner world, her sulking frustration and the storm within; the existential predicament of a woman in a male dominated society. Through women characters they have portrayed Indian women and other suffering wives, and mothers silenced by patriarchy.

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16

A Comparative study of Personal values and Intelligence of College Students of Gurukul System and General Education System

Dr. Anuradha Sindhwani

Associate Professor,
K.M.College of Education, Bhiwani, Haryana,
India

ABSTRACT

The present research study was aimed to assess the personal values profile of College students of Gurukul system and General Education system. Personal values profile of the respondents was assessed by employing Personal Values Questionnaire by Sherry and Verma (2010). The results revealed that significant differences were found between Gurukul students and General system student on the dimensions of 'Democratic', 'Hedonistic', 'Power' and 'Social' values whereas no significant differences were observed on the dimensions of 'Religious', 'Aesthetic', 'Economic', 'Knowledge', 'Family prestige' and 'Health' values. Gurukul students gave more value to power and desired to rule or lead others and preferred a job where they could get opportunity to exercise authority over others whereas General System students give preference to Democratic values. The results further depicted that there are no significant differences in intelligence level of both the groups. However, significant differences were found to exist between students with High Intelligence and Low Intelligence on the dimensions of 'Knowledge', 'Power', 'Hedonistic' and 'Social' values.

Keywords: Personal values, Gurukul System,

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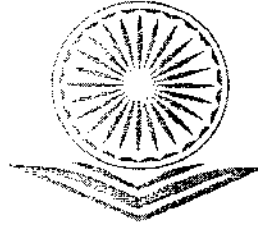
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अर्टन कॉर्नर्स आणि स्टायल्स कॉलेज पदुस.

भारताला स्वातंत्र्य मिळाल्यानंतर भारताची कृषी-औद्योगिक विकासाच्या पुढीने वाटचाल सुरू झाली. केंद्र सरकार व राज्य सरकार यांनी सहकाराच्या माध्यमातून विकास करण्याचा प्रयत्न केला. त्यासाठी अनेक सहकारी संस्था करखाने, सुतगिरण्या, बँका, दुग्धसंस्था, वस्तुभांडारे यासारखे अनेक सहकारी उद्योगधंदे सुरू करून एक सहकारी चळवळच सुरू केली. या पारलामुळे प्रामुख्याने ग्रामीण भागातील सर्वसामान्यांचे जीवनगण सुखानुसार मदत झाली. सहकाराच्या माध्यमातून आपला विकास साध्य करण्यासाठी संपुर्ण भारताच्या ग्रामीण भागातील लाकांनी हातभार लावून आपापल्या भागाचा विकास घडवून आणला. महाराष्ट्रही त्याला अपवाद राहता. याचला सहकार चळवळ महाराष्ट्रात मोठ्या जोमाने सुरू होवून ती रुजली. त्यासाठी अनेक नेत्यांचे अथक व अनिश्रंख परिश्रम कारणीभूत ठरले. त्यापैकीच महाराष्ट्राला लाभलेले एक उत्तुंग व्यक्तिमत्व म्हणजे देशभक्त रत्नाप्पाणा कुंभार हे होत. त्यांनी उत्कट देशप्रेमाने भारापून स्वातंत्र्यपूर्व काळातही व स्वातंत्र्यानंतरही आपल्या कार्यकर्तृत्वाचा उत्तु निर्माण करून आपले नाव अजरामर केले. 'सहकार संस्थांचा संस्थापक' म्हणुन त्यांच्या कार्याचा ऐतिहासिक मागोवा पुढीलप्रमाणे घेण्याचा प्रयत्न करीत आहे.

कट्टर गांधीवादी पं.नेहरू बल्लभभाई पटेल, लालबहादुर शास्त्री यांचे निरस्त्रीभ भक्त, सर्व वरिष्ठ नेत्यांचे चाहते, आपल्या कार्यामुळे लहानपणापासुन थोरांपर्यंत आदराचे स्थान निर्माण केलेले, हाडाचे समाजसेवक, स्वातंत्र्यवीर, आदर्श शासनकर्ते आणि सहकार चळवळीचे अर्धव्यू असलेले रत्नाप्पाणा कुंभार यांचे सहकार क्षेत्रातील कार्य अतुलनीय आहे. संपुर्ण महाराष्ट्र त्यांना देशभक्त रत्नाप्पाणा कुंभार म्हणुन ओळखतो. त्यांच्या कार्याचे महत्वाचे दोन कालखंड पडतात. एक स्वातंत्र्यपूर्व कालखंड व दुसरा स्वातंत्र्योत्तर कालखंड. या दोन्ही कालखंडात त्यांनी कार्य केले.

पुर्ववृत्तांत

कोल्हापूर जिल्ह्यातील शिराळ तालुक्यातील निमशिरगाव या खेड्यात 15 सप्टेंबर 1909 इ.सोली जन्म झालेल्या रत्नाप्पाणांनी आपले प्रारंभीचे प्राथमिक शिक्षण आपल्या गावात म्हणजे निमशिरगाव येथे घेतले. माध्यमिक शिक्षण हातकणंगले येथे घेतले. मुळातच कुशाग्र बौद्धिक क्षमता व शिक्षणाची आवड असलेल्या रत्नाप्पाणांना त्यांच्या वडिलांनी पुढील शिक्षणासाठी कोल्हापूरला पाठविले. राजाराम महाविद्यालयात त्यांनी बी.ए. चे शिक्षण पूर्ण केले. तेथे त्यांना वसंतीगृहात प्रवेश मिळाला. जिद्द व कष्टाळू वृत्ती यामुळे तेथे त्यांना कोल्हापूर दरवारची शिष्टवृत्ती मिळू लागली.मिळाल्या शिष्टवृत्तीची जाणीव ठेवून त्यांनी मन लावून अभ्यास केला. एखादी संघटना व वड्याळ निर्माण होत असेल तर उपजत नेतृत्व गुण असलेली व्यक्ती नेतृत्व कर्तायला पुढे सरसकट तेच अण्णांच्या वादनात घडले. विद्यार्थी वसंतच सामाजिक व राजकीय नेत्यांशी त्यांचा संबंध आल्यामुळे विद्यार्थी आंदोलनाचे नेतृत्वही पकड

जानेवारी 1930 रफिनाथ कायदेशीम चळवळीत स्वदेशीता प्रकृताय अर्थेरां नलाची होळी अशा कार्यक्रमात विवादाभावातून अन्नात करून घेऊन भारतीय स्वातंत्र्य युद्धात पहिले पाठला लागले. एल.एल.पी. च्या पहिल्या वर्षात 1930 मधील प्रश्न घडाला. पण काळामुळे भाई भावराव बागल यांच्या मार्गाने संघटनेतील कार्यकर्त्यांशी त्यांचा संबंध आत्मगर्वाचा बनला. आपले शिक्षण अवैध सोडून स्वातंत्र्य लढ्यात सामील होऊन अन्नात भाग घेतला. तो वसा त्यांनी त्यांच्या कार्यक्रमात रावराव कायदेशीम अतिरिक्तपणे पाळला. प्रत्येकाचा मार्ग वेगवेगळा आदोलन, भूमिगत चळवळीत त्यांनी रावराव सहभाग घेतला. त्यावेळी न.माधीजीनी सर्व भारतातून उदरगणनेत तीव्र लढा देण्याचे आवाहन केले. अन्नात मुंधई रावरावचे प्रमुख केंद्र म्हणून कोल्हापूर होते. त्यात न.माधीजी अन्नात म्हणून रत्नाप्राण अग्रेसर हेम. विदेश संघर्षात उखडून टाकण्यासाठी तुरुंगात अडकुन न वसता नुमिना झालून केलेल्या त्यांच्या कार्याला तोड नाही त्यांना एकडण्यासाठी ब्रिटीशांनी जंगजंग पछाडले, यावरोबरच त्यांना पळवून देणाऱ्यास हजारो रुपयांचे बक्षीस जाहीर केले. पण ब्रिटीशांना यश आले नाही.² यावेळी त्यांचे नेतृत्व सामान्यतः गुलाबूने निघाले.

स्वातंत्र्योत्तर कालखंडातील कार्य

भारताला स्वातंत्र्य मिळाल्यानंतर स्वतंत्र भारतातून अनेक आर्थिक, सामाजिक, प्रादेशिक प्रश्न निर्माण झाले. या नेत्यापुढे फार मोठे आव्हान होते. त्या आव्हानांना यशस्वीपणे ते सामोर गेले. त्यापैकी संस्थांनाच्या विलीनीकरणाचा प्रश्न भारतापुढे आवासाून उभा राहिला. भारताच्या संघटनेच्या संस्थांनाचे विलीनीकरण व्हावे यासाठी रत्नाप्राणांनी जो लढा दिला व यशस्वी केला, त्याबद्दल त्यांना दक्षिणेचे पल्लभभाई अशी पदवी मिळाली.

राजकीय कार्य

त्यांच्या असामान्य कर्तृत्वामुळे देशपातळीवरील मुल्यांनी त्यांच्या कार्याची दखल घेऊन पहिल्या पार्लमेंटचे सदस्यत्व त्यांना मिळाले. या दरम्यान देशाची घटना तयार करण्यासाठी घटना समिती नेमली गेली होती. डॉ. बाबासाहेब आंबेडकराकडून तयार झालेल्या घटनेच्या पहिल्या प्रतीवर त्यांची स्वाक्षरी करण्याचा बहुमान पार्लमेंटचे सदस्य या नात्याने त्यांना मिळाला.³ यावरून त्यांचे देशासाठी असलेले कार्य किती मोठे होते हे लक्षात येते.

शैक्षणिक कार्य

कृषी औद्योगिक क्रांतीचे प्रणेते म्हणून ओळखल्या जाणाऱ्या रत्नाप्राणांनी कृषी, शेती व सहकार क्षेत्रात कार्य केले. बालकापासून वृद्धांपर्यंत ते स्वातंत्र्यसैनिकांपासून सामान्य जनतेच्या हिताकडे लक्ष दिले. बालशिक्षणाच्या हिताकडे विशेष लक्ष पुरविले. 'आधी पाया मग कळस' असे ते बालशिक्षणाबाबत म्हणत. बालवाडी शिक्षणाची फार मोठी गरज त्यांनी दाखवून दिली. समाजाच्या विकारांच्या दृष्टीने त्यांनी विद्यार्थक व रचनात्मक आखणी केली व या कार्यात ते सतत मग्न राहिले. महाविद्यालयीन, उच्च माध्यमिक, मध्यमिक, प्राथमिक, बालवाडी, वसतीगृहे, वाचनालये यांची निर्मिती केली.

सहकार चळवळीचे अग्रदूत

सहकार चळवळीचे अग्रदूत म्हणून ओळखल्या जाणाऱ्या रत्नाप्राणांच्या कुभार यांनी अनेक सहकारी संस्थांची स्थापना केली. त्याबरोबरच इतरही अनेक सहकारी संस्थांचे ते प्रस्थापकांनी व मार्गदर्शक होते. या प्रत्येक संस्थांनी यशस्वी आणल्या अनेक कर्तृत्वांचा वसा उमडविला.

कोषागारं संस्था स्थापना करण्यापूर्वी तिच्या उभारणीचे १९३३ मध्ये काढण्यात आले त्याचा सखोल अभ्यास व सर्वांगीण माहिती मागणं करून तो प्रत्यक्ष कामकाजार्थ रत्नाप्राण प्रयत्न (१९६२)सह शिरसदध, काटकसरी व जनताभिमुख व्यवस्था ही अवलंब करत. संस्था चालविणारी माणसं त्याने निर्माण केली. त्यांनी विणलेले कार्यकर्त्यांचे जाळे राज्यभर पसरलेच आहे. शेतकरी कामगार यांचे जीवन सुधारणं म्हणून असा अर्थक योजना राबविल्या व सहकारी संस्थांचे कार्ये निर्माण केली. त्यापैकी श्री पंचगंगा साखर कारखाना गंगानगर जि.कोल्हापूर, टि पिपल्स को.ऑफ बँक लि. इचलकरंजी, जि.कोल्हापूर, कोल्हापूर महान शेतकरी संघासहकारी सुतगिरणी, रत्नाप्राणा कुभाय नगर व कोल्हापूर जनता सेंट्रल को. ऑफ व्हॉलंटरी स्टोअर लि. कोल्हापूर या सहकारी संस्थांचा ऐतिहासिक नागांचा पुढीप्रमाणे सांगता येईल.

स्वातंत्र्योत्तर काळत भारताच्या आर्थिक जडणघडणीत औद्योगिक यंत्रे सुरू झाले. स्वातंत्र्यपूर्व काळात स्वातंत्र्य लढ्यात भाग घेणे म्हत्वाचे होते. तसेच स्वातंत्र्योत्तर काळात देशाच्या आर्थिक प्रगतीसाठी कृषी औद्योगिक विकास साध्य करणे व त्यासाठी निर्माण झालेल्या संस्था पूर्ण कार्यक्षमतेने चालविणे या गोष्टींना महत्त्व प्राप्त झाले. सहकाराच्या माध्यमातून अनेक संस्थांची निर्मिती रत्नाप्राणा कुभाय यानी करून सामाजिक, सांस्कृतिक, औद्योगिक, शैक्षणिक व आर्थिक विकास करण्याचा प्रयत्न केला. त्यामुळे ही कृषी औद्योगिक कातीचे प्रणेत म्हणून संपूर्ण महाराष्ट्रात ओळखले गेले. त्यांच्या कार्याचा यासाठी गौरव करून सन्मान करण्यात आला.

भारताला स्वातंत्र्य मिळाल्यानंतर रत्नाप्राणांनी स्वतःला पुढाऱ्याने विधायक कार्यात बाहून घेतले. सहकाराच्या माध्यमातून कृषी औद्योगिक क्रांती यशस्वी करण्याचा त्यांचा प्रयत्न होता.

श्री पंचगंगा सहकारी साखर कारखाना –गंगानगर इचलकरंजी

१९५३ मध्ये पंचगंगा सहकारी साखर कारखान्याची मुहूर्तमेढ रोवली. हा कारखाना कोल्हापूर जिल्हाच्या विकासाचा गंगोत्री ठरला.

शेती आणि ग्रामोद्योग विकास हा मुलमंत्र सिद्धकारून रत्नाप्राणांनी साखर कारखान्याद्वारे हरितक्रांती घडविली. सहकारी संस्थामधून होणाऱ्या नफ्याचा आर्थिक वाटा सर्व रक्षकरील जनतेला मिळावा म्हणून त्यांनी कारखान्याच्या कार्यक्षेत्रातील १०२ गावात शिक्षणसंस्था, तालीमसंस्था, बालवाङ्घ्या, हरिजन तकके, क्रीडांगणे, महिला मंडळ, समाज मंदीरे, वाचनालये यासारख्या संस्थांना लाभ मिळावा म्हणून काही भराव योजना आखल्या. आणि त्या कार्यान्वित केल्या. परिणामी या गावातील सामान्य माणसांचा व मरीच शेतकऱ्यांच्या जीवनाचा कायापालट झाला.

श्री पंचगंगा सहकारी साखर कारखाना म्हणजे रत्नाप्राणांच्या कार्यकर्तृत्वातून उभारलेले एक विकासाचे स्थान आहे. समाजाच्या सर्वांगीण विकासासाठी होत असलेले कार्य शिरवास्पद आहे. रत्नाप्राणांनी कृषी औद्योगिक योजना सत्यात उतरविण्यासाठी नियोजनवध विकास करताना त्यांचा चांगला परिष्कार जावा यासाठी देशाचे नियोजन शेतीप्रधान, ग्रामाभिमुख व श्रमप्रधान होणे आवश्यक आहे. देशातील ८० जनता ग्रामीण भाग हा देशाचा कणा असून शेती व्यवसाय वाढला तर देशाची प्रगती होईल हे धोरण समोर ठेऊन रत्नाप्राणांनी आपली पाट बळ सुरू केली. स्थापना व विकास

सहकाराच्या माध्यमातून शेती विकासाच्या योजना उरवून कोल्हापूर जिल्ह्यात वातकरंगले (ता.दुव्यातील कवनुरच्या फोड्या भाजावर श्री पंचगंगा सहकारी साखर कारखाना उभारला गेला. २७ ऑक्टोबर १९५४ पासून शेअर

विक्रीस सुरुवात केली. अत्यंत खडबड पण जनसमूह कारखान्या उभारणीसाठी भांडवल उभारूंक, सहकारी तत्वावर काम राहण्याच्या या कारखान्यासाठी प्रामाण्य भावनांनी सहसामान्य शेतकरी असता हे अर्थीय पण यासाठी अनेक परिश्रमातून हे काम पूर्ण केले. लवकरच सभसदांनी इतर शेतकरी लायसन्स मिळवून घेताने या कारखान्याच्या कामात इंगम १ नोव्हेंबर 1959 रोजी सुरु झाला.

ऊस उत्पादन वाढावे, शेतकरी, कामगार, कामगार जनता याचे जीवनमान उंचावे यासाठी कारखान्यामध्ये अनेक योजना राबविण्यात आल्या. त्या सुधारणांच्या सफलतेत यतील.

1. उपसा जलसिंचन-प्रांभीच्या कारखान्या वहावा नाजकेथ शेतकरी ऊसपीक घेत होते. सहसामान्य शेतकऱ्यांची इच्छा असुनही यापासुन त्यांना जीवत राहणे जागे. यावर उपाय म्हणुन प्रांभीनी उपसा जलसिंचन योजना सुरु केली. याचा आदर्श पध्दत राहण्यातील इतर कारखान्यांनी ही योजना सुरु केली. म्हणुन उपसा जलसिंचन योजनेचे शिल्लकार म्हणुन रत्नाप्याणा ओळखले गेले. कारखान्याच्या कार्यक्षेत्रातल 102 गावात उपसा जलसिंचन योजना सुरु केली. सामान्य शेतकऱ्यांना याचा फायदा फायदा होऊनसामान्य शेतकऱ्यांची शेती आंखताखाली घेऊन तो ऊसपीक घेऊ लागला. परिश्रमी कारखान्याकडे ऊसाचा आंघ वाढला.
2. ऊस विकास योजना-कारखान्याच्या ऊस उत्पादक सभासदांना उत्पादन वाढीसाठी व संवर्धनासाठी चांगले मार्गदर्शन व्हावे व सदसतींचा लाभ घेता यावा यासाठी ऊस विकास योजना विभाग सुरु केला. या माध्यमातून अनुदान व सदसिडी ऊसाचे विद्याण, हिरवळीचे खत, पीकसंरक्षण, तुषार ठिवक योजना, शेती अवजारे व खते याबाबत शेतकऱ्यांचे प्रबंधन करण्यात आले. याचे अनुकरणही अनेक कारखान्यांनी केले.
3. 20 कलमी योजना-1975 मध्ये इदिश गाधी यंती 20 कलमी योजना जनसामान्यांच्या कल्याणासाठी सुरु केला. ती यापूर्वीच रत्नाप्याणांनी सुरु करुन आंद्योगिक क्रांतीबरोबरच लोकशाही समाजवादी समाजरचना यशस्वी करण्याचा प्रयत्न केला होता.

या कारखान्याने आर्थिक प्रगतीबरोबरच सर्वसामान्यांसाठी सामाजिक, सांस्कृतिक, शैक्षणिक विकासासाठी भरीव कामगिरी केली. यासाठी 1995 अखेर कारखान्याने जवळजवळ 8 कोटीपेक्षा जास्त खर्च केला.

4. कामगार योजना-या कारखान्यातील कामगार हा एक जबाबदार घटक मानुन त्याच्यासाठी नियोजनबद्ध कार्यक्रम आखले. त्याच्यासाठी सांडसुबिधा निर्माण केल्या.
5. ऊस उत्पादक-ऊस उत्पादकांनाही ऊसाचा उच्चांक दर देण्यात हा कारखाना अग्रेसर होता. पंचरंगा सहकारी साखर कारखान्यामुळे याविभनातील शेतकरी, कामगार व सर्वसामान्य लोकांचा विकास होण्यास फार मोठे मदत झाली.सामाजिक,सांस्कृतिक,शैक्षणिक बदल जाणवू लागला.

2. दि पीपल्स को.ऑपरेटिव्ह बँक लि. इचलकरंजी जि.कोल्हापूर-इचलकरंजी शहरातील पसरुन या उद्योगाचे अनुषंगाने सामान्य व गरीब लोकांचे छोड्या मोड्या सहयोगस अर्थसहाय्य करुन ते गाडीर लावण्याच्या हेतुने रत्नाप्याणांच्या नेतृत्वातून या बँकेची स्थापना करण्यात आली.

स्थापना व विकास

२१ सप्टेंबर १९६२ रोजी या बँकेची स्थापना इचलकरंजी येथे करण्यात आली. याच वर्षी ईशिया शाखा उघडण्यात आल्या. श्री पंचगंगा समवाय कारखाने, का.टा. याचे कस उत्पादक सभासद, दि.२२ सप्टेंबर, १९६२ रोजी उभारण व त्या अनुषंगाने नगर प्रशासन विभागाचे अधिक समस्या सोडविण्यासाठी या उद्योग मालकांपुढे समस्या माघन सपलब्ध झाले. या बँकेचा पुढे इचलकरंजी येथे नगरपालिका, कारखानदार, समाज कार्यकर्त्यांच्या दबावात यांच्या व्यवसायाच्या दृष्टीने गहनतुसात आर्थिक प्रवृत्ती केली जाऊ लागली. आणि दि.२२ सप्टेंबर १९६२ रोजी काळांतराने या बँकेचे कार्यक्षेत्र इचलकरंजीपुरते मर्यादित न ठेवता व्यापक करण्यात आले. महालापूर नगर, खादी, प्रशासना मंडळ व खादी कमिशन यांनी मंगलोरी काल तयार करण्याच्या कारखान्याचा मसुदा तयार करून देवले यांचे अभ्यास करून संबंधित दूरवेल पात्रकासाठी शेअर्स खरेदी करणेसाठी बँकेचे अध्यक्ष यांचे व त्यामुळे एका मोठ्या उद्योग मिळून जिल्ह्यात मंगलोरी काल तयार करण्याचा कारखाना उभारणीसाठी या बँकेचा योगदान मिळाले.

३) बँकेच्या उभारणीत व प्रगतीत रत्नाम्पाण्याचे नेतृत्व सलगपणे व सातत्याने लाभले. त्यांचे मार्गदर्शन बँकेला अखंडपणे मिळाले. 7

३. कोल्हापूर जनता सेंट्रल को ऑप. कंझुमर स्टोअर लि. कोल्हापूर.

ग्राहकांना जीवनावश्यक वस्तुंचे भेसळविरहीत व योग्य वितरण वाजवी दरात व्हावे आणि उत्पादक व ग्राहक यांच्यातील थरी कमी व्हावी यासाठी रत्नाम्पाण्या कुंभार यांनी कोल्हापूर जनता सेंट्रल को ऑप. कंझुमर स्टोअर लि. कोल्हापूर या संस्थेची स्थापना दि.२४ जाने. १९६३ रोजी केली.या संस्थेने ष्वहराच्या निरनिराळ्या भागात स्वस्थ धान्य दुकाने, राखत कापड, साखर,सिमेंट आणि अत्यंत आणीवाणीच्या वेळी ष्वासनास वितरण व्यवस्थेत मदत करण्याचे उदात्त धोरण राबविले होते.

ग्राहकांच्या हिताचे संरक्षण करण्यासाठी असा कोणताही कायदा नव्हता.ग्राहकांना सर्व जीवनावश्यक वस्तू एका ठिकाणी राखत दरात मिळाव्या यासाठी ७ सप्टेंबर १९८० मध्ये रुईकर कॉलनी येथे या संस्थेच्या वतीने जनतावझारची स्थापना करण्यात आली.तत्कालीन सहकार मंत्री एस्.एन्.देसाई यांच्या हस्ते यांचे उद्घाटन झाले. सुटसुटीत विलाजी पध्दत,योग्य वजनाचा आणि योग्य किंमतीचा दर्जेदार व दैनंदिन गरजेच्या वस्तू स्वयंसेवा पध्दतीने विक्रीची सोय ग्राहकांना उपलब्ध करून देण्यात आली.

७ सप्टेंबर १९८१ रोजी वरुणतीर्थ येथे व राजारामपुरी येथे १५ सप्टेंबर १९९५ जनता वझारच्या मान्ना स्थापना करण्यात आल्या. ऑरमेटिक,इलेक्ट्रिक,औषधे, भांडी,पॅकेज,अन्नधान्य व विविध वस्तुंची येथे विक्री होऊ लागली.

ग्राहकांची उत्तम सेवा व्हावी आणि ष्वहराच्या आसपासच्या खंडेगावातील लोकांना याच लाभ व्हावे यासाठी ह वगैरे या संस्थेने केले.या संस्थेच्या उभारणीत व विकासात रत्नाम्पाण्या कुंभार यांचे योगदान खूप मोठे आहे.

४. कोल्हापूर जिल्हा ष्वेतकरी विणकरी सहकारी सुत गिरणी लि. रत्नाम्पाण्या कुंभारनगर इचलकरंजी.

रत्नाम्पाण्या कुंभार यांच्या पुढाकाराने १९६९ मध्ये कोल्हापूर जिल्हा ष्वेतकरी विणकरी सहकारी सुत गिरणी लि.इचलकरंजी या सहकारी संस्थेची स्थापना करण्यात आली. इचलकरंजी ष्वेतकरी परिशालन कार्यालयपुढे कुर्णवाड,हृयम,रंजाल,कडगाव ही गावे कापसाच्या उत्पादनासाठी वरिष्ठ होती.कानुन विधान त्यांचे स्व. अड्डे

हातमागावर विप्लव पाहू कायदा पार करणे हा येथील लोकांचा मुख्य कायदायुक्त प्रश्न आहे. विणकऱ्यांमध्ये राहकारी संघ भरलेल्या आहेत. विणकऱ्यांच्या घेतकरी व विणकरी यांना अनेक समस्या आहेत. हे त्यांच्यातूनच या संस्थेची निर्मिती झाली.

जेतवीय मजूर संस्थांमध्ये सध्याच चालावा यासाठी उपरगत करण्यात येत आहे. जेतवीय मजूर संस्थांच्या सोई उपलब्ध करून देण्यात आल्याने जेतवीय सहकारी साखर कारखान्यांच्या जेतवीय मजूर संस्थांमध्ये सुविधा उपलब्ध करून देण्यात आल्या. एकदा एक पुढा पुढा जेतवीय घेतल्यामुळे जेतवीय मजूर संस्थांमध्ये हाता हा हाता नये यासाठी कापसाचे उत्पादन घेण्यास प्रोत्साहन देण्यात आले. साखर कारखान्यांच्या एक एक मजूर संस्थांमध्ये म्हणून या सुत गिरणीची उभारणी करण्यात आली.

सामान्य लोकांसाठी सामान्य लोकांनी निर्माण केलेली भरताभार हा महत्त्वाचा गिरणी घेतकरी व विणकरी यांच्या मालकीची होती.

5. विविध सहकारी संस्थांचा पदभार—सहकारी संस्थांच्या उभारण्यामध्ये डॉ. रत्नाप्पाण्णा कुंभार व्यासंग व अनुभव फार मोठा होता. एखादी सहकारी संस्था रथापन करण्यातुनी त्यांचे मार्गदर्शन घेण्यासाठी महाराष्ट्रातून अनेकजण त्यांच्याकडे येत असत.

अनेक सहकारी संस्थांच्या विविध पदांची जबाबदारी सांभाळत त्यांचा लाभ त्या त्या सहकारी संस्थेला घेता आला.

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7. इचलकरंजी सेंट्रल को.ऑप. कॅम्पुस स्टोअर्स लि., कोल्हापूर — संस्थापक व डायरेक्टर
8. कोल्हापूर डिस्ट्रीक्ट खादी ऑपेड व्हिलेज लि., कोल्हापूर — संस्थापक व डायरेक्टर
9. महाराष्ट्र राज्य मार्केटिंग फेडरेशन लि., मुंबई — माजी अध्यक्ष
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11. कोल्हापूर ऑल्युमिना इंडस्ट्रीज प्रा.लि.— चेअरमन
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समारोप

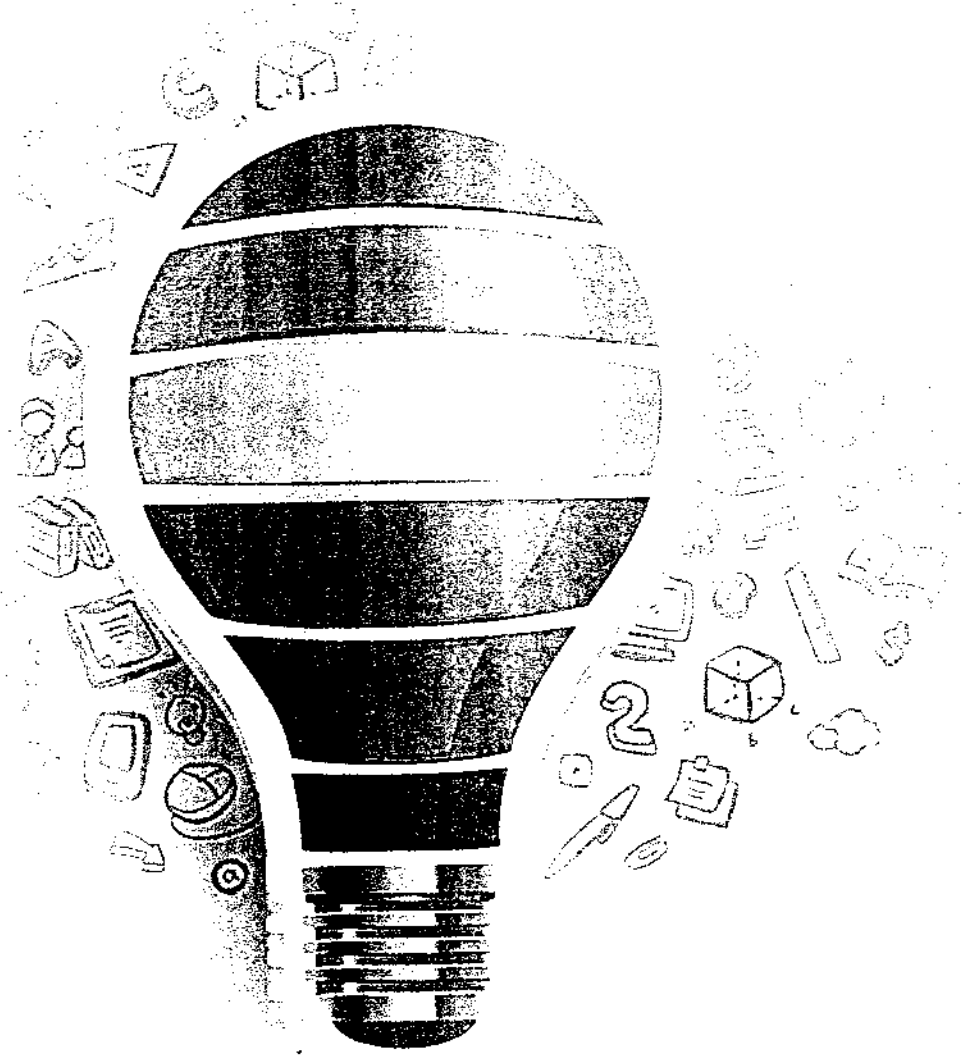
रत्नाप्पाण्णा हे सहकारी जगातील एक महत्त्वाचे व्यक्तिमत्त्व होते. त्यांच्या जनतत्वाचे व कायदाचे शक्यतेतल संस्थांचे वळखलेले वळकट अन्वेषण व अनेक विणकऱ्यांच्या मार्गदर्शन यांचे अर्थ आहे. असे रत्नाप्पाण्णा कुंभार हे एक शायंभू नेत्री, जनजात राष्ट्रवादी अर्थशास्त्रज्ञ, निवायक कार्यकर्ते व गुणवत्ता संशोधक वृत्ता, खरीद शरानकर्ते अखिल

दर्जाचे लोकसेवा इति देशसेवा व लोकसेवा हे त्यांचे द्रीढ संकल्पनाप्रधान (अशा गौरवाचे स्थान मिळाले. मंत्रीमंडळास व शासनसचिवालय सामर्थ्यकार्य कार्य त्यांनी केले. सुगुण्य शासनसचिवालय व शासनसचिवालय निर्माण केली. सर्व विकास योजना भुक्त स्वयंसेवा आयुक्त. शासनसचिवालयची एक देणगीच त्यांना मिळाली. अशा अशा व नत्यावर जनतेचे अपार प्रेम होते. अशा या अशा नत्याचे महासचिवालय 23 डिसेंबर 1998 रोजी झाले.

आपल्या सहकारी शासनसचिवालय यशस्वीतेवद्दल रत्नाप्पाणा कुंभार म्हणतात की, "सहकाराचे प्रत अगिकारल्यापारुन न कुणाचाही अकार केला नाही. व्यक्तीच्या न्यायशासन समृद्धीचे नेतृत्व अधिक चांगले असले पाहिजे. कारण समाजवादाकडे आगळी लीकशाही बळकट करण्ये अशा सहकाराचा चळवळीद्वारेच होऊ शकेल. जिथे कोणत्याही प्रकारची पिळवणूक होत नाही. तो समाजवाद हा समाजवाद सहकारातून साध्य होईल. सहकारी पध्दती ही समाजवाद अगि भांडवलशाही अगि अकार आहे. सहकारी अकारातून पिळवणूक नसते आणि व्यक्तिगत स्वातंत्र्यास तडे जात नाहीत हे सत्य आहे."

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Vinay S. Hatole

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Cell : 9579260877, 9822620877 Ph: 0240 - 2400877

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Website : www.ajantaprakashan.com



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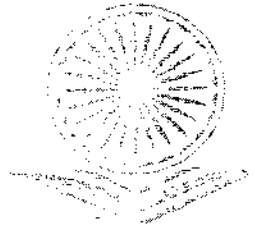
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अर्थशा. कॉमर्स अँड लायन्स, कॉलेज, मुंबई

प्रस्तावना

आधुनिक भारताचे जगाघडण ज्या श्रेष्ठ पुरुषांच्या कर्तृत्वाने आली, त्यापैकी डॉ. बाबासाहेब आंबेडकर एक होते. बाबासाहेब ज्ञानवंत, संशोधक, मुत्सद्दी व लढवये होते. धर्म, समाज, शिक्षण, संस्कृती, मानवसंशोधन, इतिहास हे त्यांचे अभ्यासविषय व लेखनविषय होते. त्यातून परिणतप्रज्ञ बाबासाहेब प्रतिन झाले. आधुनिकता, विधेकवाद आणि विज्ञाननिष्ठा ही त्यांची विचारसूत्रे होती. भारताच्या व जगाच्या राजकीय अर्थव्यवस्थेचे अध्ययन व संशोधन करत निर्भिड व तर्कशुद्ध मांडणी त्यांनी केली.

डॉ. बाबासाहेब आंबेडकर राज्यघटनेचे शिल्पकार, उपेक्षित, वंचित लोकांचे नेते म्हणून सर्वांना परिचित आहेत. परंतु एक अर्थतज्ञ, ग्रामीण भागाचे त्रिरक्षक, कृषीतज्ञ, जल व विद्युत तज्ञ म्हणून फारसे समान असे नाहीत. त्यांनी शेती, शेतकरी, महिला, काश्मिर, मजूर व आदिवासी या शोषित समाजघटकांवरील मिंचन, पाणी, ऊर्जा व वित्त अशा अनेकविध क्षेत्रात केलेले कार्य अतुलनीय आहे. डॉ. आंबेडकरांचे शेतीविषयक विचार मूलभूत, दुरुदृष्टीचे आणि व्यावहारिक आहेत. इंग्रजांनी भारतीय समाजाची आर्थिक रचनाच मोडीत काढली. पण नविस निर्माण केली नाही. ब्रिटिश राजवटीत शेतीच्या समस्या व त्यावरील उपाय या संदर्भात त्यांनी जे विचार मांडले ते आजही अतिशय महत्वाचे आहेत. या शोधनिबंधात डॉ. आंबेडकरांच्या शेतीविषयक विचारांचा थोडक्यात आढावा घेण्याचा मी प्रयत्न केला आहे.

शोधनिबंधाची वैशिष्ट्ये

१. डॉ. बाबासाहेब आंबेडकरांच्या शेतीविषयक विचारांचा आढावा घेणे.
२. डॉ. बाबासाहेब आंबेडकर यांच्या शेतीच्या विकासासाठी मूलभूत सुविधांचा आढावा घेणे.

संशोधन पद्धती

प्रस्तुत शोधनिबंधासाठी प्राथमिक व दुय्यम साधनांचा वापर केला आहे. यामध्ये डॉ. बाबासाहेब आंबेडकरांचे ग्रंथ, पुस्तके, चरित्रखंड, वर्तमानपत्रे व इंटरनेट वरील माहितीचा आधार घेण्यात आला आहे. शोधनिबंधासाठी ऐतिहासिक संशोधन पद्धतीचा वापर केला आहे.

डॉ. बाबासाहेब आंबेडकर यांचे शेतीविषयक विचार

डॉ. बाबासाहेब आंबेडकर यांचे शेतीविषयक विचार शेतकऱ्याला आणि देशाला आर्थिक दृष्ट्या सक्षम करणारे आहेत. भारतीय शेती आणि ग्रामीण समाज हा आंबेडकरांच्या चिंतनाचा विषय होता. त्यासाठी त्यांनी दक्षिण निर्मूलन, सामाजिक आणि आर्थिक विषयतेने निर्मूलन, गरीय व दलिततांच्या पिळवणुकीचे, निर्मूलन इत्यादी कामे करत वेडेल यावर भर दिला. भारतीय अर्थव्यवस्थेतील प्राथमिक उद्योगांच्या विकासासाठी शेतीचा विकास अत्यंत महत्वाचा आहे. म्हणून शेतीला भारतीय

अर्थव्यवस्थेला महत्त्वाचे स्थान आहे. असे डॉ. बाबासाहेबांचे मत होते. म्हणून त्यांनी लहान शेतकऱ्यांचे प्रश्न, भूमिगत शेतमजूर, जमीन धारणा, शेतकऱ्यांच्या यांच्या विकासासाठी रोजगारी कामे वगैरे वेगळे का विषयांची अभिवचने महसूल इ. का निर्मुक्ततासाठी संघर्ष केला. डॉ. बाबासाहेबांचे शेतीविषयक विचार मूलभूत, दृष्टीगोचर आणि व्यावहारिक आहेत. आज ही त्यांचे विचार अतिशय महत्त्वाचे आणि उपयुक्त आहेत.

शेतीसारा संबंधी विचार

ब्रिटिशांचे विद्वेषनात जेव्हाभरण्याच्या नविन पद्धती सुद्धा केल्या होत्या, शेतीत उत्पन्न होणे अवघार न होणे शेतकऱ्या का भावच त्याने जमिनीकडून कोणतेही पाठवाळ नसल्यामुळे शेतकऱ्याला सावकारांकडून कर्ज काढवे लागे. नावकाय अनिर्घोष व्यवहार आकारून शेतकऱ्याच्या कष्टांना मोठ्या कितीत आणल्या नदरत पाहून घेत. डॉ. आंबेडकरांनी सावकारांच्या परतून घ्यावेत. बंधामुक्त करण्याकरिता १ ए. वि. २ मॅग्लेट मॅनिमेंटर्स अॅक्ट' नावाचे विधेयक मांडले होते. याद्वारे सावकारांना सवायनासहती व त्यांच्या कर्जाच्या व्यवहारावर असेक प्रकारची बंधने सुचवली होती. शेतीसाराविषयी डॉ. आंबेडकरांनी शेतीच्या उत्पन्नावर कर वसविणे रद्द केले जावे, शेतकऱ्यांच्या ऐपतिवर शेतसास वसविला जावा, कराच्या प्रमाणामुळे शेतकऱ्यांच्या बऱ्या अन्याय टाळावा, जमीन महसूल वसुलीच्या यावतीत लवचिकपणा टाळावा हे सर्व विचार अंमलात आणले तर शेतकरी सुखी होईल व पर्यायाने देशाचा अर्थिक विकास होईल.

सामुदायिक शेतीविषयी विचार

डॉ. आंबेडकरांच्या मते, मोठ्या, जमीन मालकांकडून शेतीचे हक्क काढून ती जमीन शेतानाने लाब्यात व्ययी व 'सामुदायिक शेती' म्हणजेच 'शेतीचे राष्ट्रीयकरण' करण्याची संकल्पना मांडली, शेतीचे सामुदायिक शेतीत रूपांतर करताना जाद, धर्म इ. विचारात न घेता शेतजमिनीचे समान वाटप करावे. त्यामुळे श्रीमंत, शेतमजूर, कूळ असा वर्गच शिथिलक सहकार नाही. नावपतळीवर जमीन धारणेचे तुकडे करून कुळ्यांना शेती करण्यास द्यावी. जमिनीचे आकारमान पर्याय असल्यामुळे अशा शेतीत जैविक, रासायनिक व यांत्रिक माधने, खते, बी-वियाणे आदींचा पुरवठा राज्यशासनाकडून केला जाईल. शेतीत होणारा उत्पन्नित माल काम करणाऱ्याला समान वाटला जाईल. आपोआपच जमीनदारी पद्धत बंद होईल. शेतीच्या विकासात चालना मिळून शेतकऱ्यांच्या आत्महत्या थांबतील. अशा सामुदायिक शेतीला कायद्याचे स्वरूप देण्यासाठी घटनेमध्ये त्यासाठी तरतूद करावी असे बाबासाहेबांना वाटत होते. आजच्या परिस्थितीत तर 'सामुदायिक शेती' गरजेचे आहे.

खोती पद्धत बंद केली

मुंबई इलाक्यात १३३७ च्या दरम्यान जमीन महसूल वसूल करण्यासाठी ब्रिटिशांनी खोतीची (जमीनदार) नियुक्ती केलेली असे. यांच्याद्वारे जमीनमहसूल शोळा होई. भूधारकांकडून शेतसास गोळाक करून त्याच काही हिस्सा जमिनीकडे भरणा केल्यानंतर खोत आणल्या अधिकाराने शेतकऱ्यांवर अन्याय करत असत. म्हणून डॉ. बाबासाहेबांनी १७ नवेंबर १९३७ रोजी मुंबई कायदेमंडळात खोती पद्धत रद्द करण्याविषयी विधेयक मांडले. खोतीचे जमिनीवरील स्वामित्व नष्ट करून प्रत्येक त्याका जमिनीची मालकी द्यावी. भूधारकांच्या शेतसास शेतकरी करून खोतीला तुळसून भूगर्भीची तरतूद का विधेयक केले. डॉ. बाबासाहेबांचे हे विधेयक म्हणजे स्वातंत्र्योत्तर काळातील देशात करण्यात आलेल्या जमीन सुधारणा विधेयकांचे कायदाच नोंदीच होती.

सहकारी शेती

विद्युत्पुरवठा व धारण क्षेत्राच्या लहान आकारमानाच्या समन्वयक उपाय म्हणून त्यांनी सहकार शेतीचा अर्थ मुंबईच्या त्वाणुटे लहान शेतकऱ्यांना विनाशापासून वाचवता येईल. शिवाय शेतकऱ्यांच्या जमिनीवरील नालकी वकत अर्थव्यय माल्या म्हणूनच त्यांनी धारणा हक्क कायद्यावर नद्यांचा वापर या संघेवधान विरोध केला.

भारतातील लहान धारण क्षेत्रे आणि त्यावरील उपाय

डॉ. अंबेडकरांच्या मते, लहान धारण क्षेत्रे हा भारतीय शेतीचा भंडसवणारी गंभीर समस्या आहे. सध्याचे लहान क्षेत्राचे आकार लहान होत असून छोट्या आकाराच्या जमिनी नष्ट होत आहेत. वारसा हक्काचे जमिनीचे लहान तुकडे पडतात. त्यांना जोडणे व आकारमान वाढविले हा त्यांच्या उपाय नाही. पण शेती हा उत्पादनाचा मुख्य पध्द अस्तव्यस्तुटे मंडी व लहान धरण क्षेत्रे अशी गोष्ट असू शकते नाही. म्हणून भारतातील धारणाक्षेत्राचे आकारमान मोठे करणे व शेतीसमस्येवगना उपाय नसून भांडवल व इतर साधनसमुद्धानी उपलब्धता वाढविणे महत्वाचे आहे असा विचार त्यांनी मांडला.

डॉ. बाबासाहेबांचे उद्योग, वीज आणि जलधोरण

आंदोलिकरण हे भारताला नवी दिशा देईल असा विचार त्यांनी व्यक्त केला. १९३९ साली मुंबई काँग्रेसमध्ये राज्याच्या अंदाजपत्रकावर हल्ला करताना त्यांनी उद्योगधंदे वाढीस लावणे आवश्यक आहे याचे समर्थन केले.

शेतीसाठी जमिन व पाणी हे मुख्य घटक आहेत. पाण्याशिवाय उत्पादकता वाढविणे आणि शेतकऱ्यांचा आर्थिक स्तर उंचावणे शक्य नाही हे ब्रिटिश सरकारच्या निदर्शनास आणून दिले. जल व विद्युत शक्ती धोरण समितीचे अध्यक्ष असताना डॉ. आंबेडकरांनी देशाच्या विकासासाठी आवश्यक असलेल्या स्वरूप व मुबलक विद्युत पुरवठ्यावर भर दिला. देशात उपलब्ध असणाऱ्या नद्यांचा, नदी खोऱ्यात उपलब्ध असणाऱ्या पाण्याचा वापर सिंचन, वीज निर्मिती आणि जलवाहतूक अशा तीनही कामासाठी केला पाहिजे. अशी त्यांची भूमिका होती. डॉ. आंबेडकरांनी प्रथम पॉवर ग्रीड, ची संकल्पना मांडली, पॉवर ग्रीड निर्मितीस प्रारंभ होवून केंद्रात ऊर्जा पुरवठा सुरु झाला. १९४५ मध्ये केंद्रीय विद्युत बोर्ड व केंद्रीय जल आयोगाच्या निर्मितीत त्यांची भूमिका महत्वाची आहे. भाक्रा नांगल, दानेवर व्हर्ली, नहानदी, सोन नद्यांच्या खोऱ्यातील बहुउपयोगी नदी व धरणविकास प्रकल्पांसाठी आवश्यक संरचनात्मक संस्थांची निर्मिती ही बाबासाहेबांच्या दूरदृष्टीची परिणीती होय. आज जी जलस्रोत, विद्युत ऊर्जा या क्षेत्रात देशाची प्रगती दिसते त्याची पायाभरणी डॉ. आंबेडकरांनी केली आहे.

शेती व शेतमजूर

शेती व शेतमजूर समृद्ध झाल्या तरच देश समृद्ध होईल. हा मौलिक विचार डॉ. बाबासाहेबांनी मांडला. शेतकऱ्यांसाठी पीक बीज योजना सुरुवली. गरीब व दगिरी शेतकऱ्यांना न्याय मिळवून देण्यासाठी १९२८ पासूनच शेतकऱ्यांचे प्रश्न हाती घेतले. ऑगस्ट १९३६ मध्ये 'स्वतंत्र मजूर पक्ष' स्थापन केला. त्याचा जाहीरनामा प्रसिद्ध केला. नविन धंदे चालू करणे, कुळांचे संरक्षण करणे, कामगार हिताच्या दृष्टीने कायदे करणे, भूमिहीनांक जमीन देणे, समाजनुधाराकांना सहाय्य करणे, लोके-सवलती देणे. शेतकऱ्यांच्या अनेक समस्यांमध्ये त्यांनी भर घेतला. शेतमजूर व शेतकरी यांच्यासाठी चळवळी चालू करून त्यांचे प्रश्न बाबासाहेबांना सोडवायचे होते.

सारांश

डॉ. बाबासाहेब आंबेडकरांनी शेतीविषयी मूलगामी विचार मांडले. शेतीचे व्यवस्थापन, विपणन सामूहिक असेल आर्थिक स्थितीचा चांगला होईल. सरकारचा प्रत्यक्ष सहभाग तर शेतीच्या विकसासाठी आवश्यक ठरेल. अन्यायी खोती पद्धत थांबवली. सामाजिक न्याय जागतिक पातळीवरील अत्याचर तर जागतिक आर्थिक भूमितीतून जून सुटेल. भाग्यकारणाने देशात पाणी आणि जमीन यांचा समतोलच नसत नाही तर भाग्य समुद्र देशात होण्यास वेळ लागणार नाही. ही भूमिका डॉ. बाबासाहेबांनी मांडली. म्हणूनच त्यांनी हिराकूड धरण, दामोदर नदी इ. प्रकल्पांची अंमलबजावणी करून जल धोरण व व्यवस्थापन करून सामान्यांना त्यांचे देण्याचे प्रयत्न केले. शेतीकडे उद्योग म्हणून बघण्याचा प्रयत्न त्यांनी केला. शेती विकसित होईल शेतकरी अर्थीक दृष्ट्या स्थिर बनला तर ग्रामीण भागात परिवर्तन घडेल व देशाची अर्थव्यवस्था मजबूत होईल. शेतसाग या उत्पादनात न आकरता शेतकऱ्यांच्या ऐवजीप्रमाणे आकारता जाय हा त्यांचा दृष्टीकोन आज ही किती महत्वाचा आहे याची जाणीव होते. सामुदायिक व सहकारी शेतीमधून उत्पादन वाढवून सर्वांना समान वाटा मिळाल्यास सामाजिक समता व स्थिर प्रस्थापित होण्यास मदत होईल. डॉ. आंबेडकर कृतीशील अर्थतज्ज्ञ होते. त्यामुळे भारतीय शेतीसमोरील फक्त समस्या सांगून ते थांबले नाहीत तर अल्प शेत जमीन धारणा, तुकडीकरण हा उपाय मांडितेले. शेतमजूर व कामगारांच्या संघटना त्यांनी स्थापन केल्या. डॉ. बाबासाहेबांनी आंबेडकरांनी ब्रिटिश राजवटीमध्ये शेती, उद्योग, जल, विद्युत, शेतमजूर याबाबतीत मांडलेल्या विचारांची धोरणांची सरकारने अंमलबजावणीस केली तर भारत अजून समृद्ध बनेल.

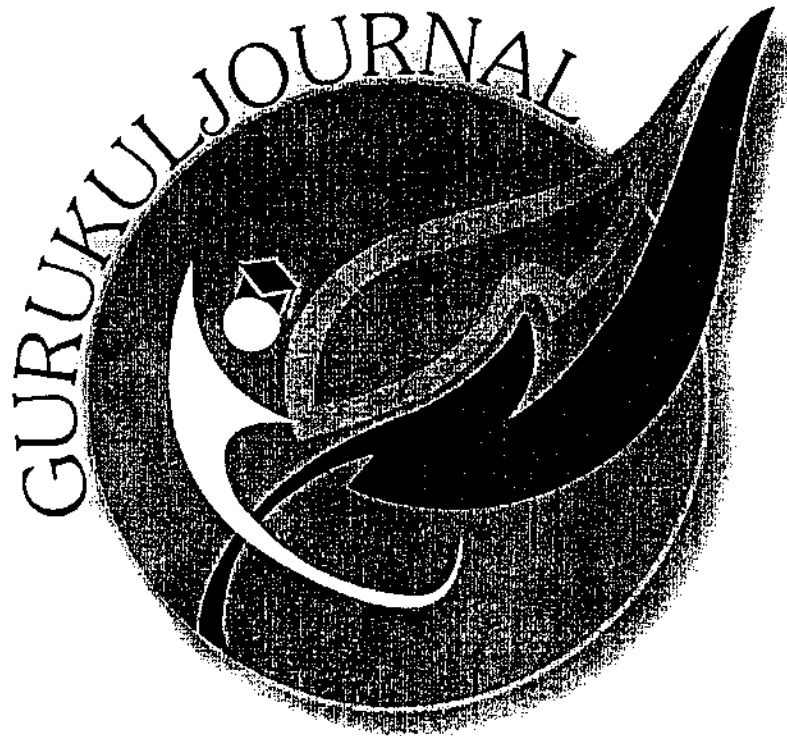
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भारतातील शहरीकरणाचे स्वरूप व समस्या

प्रा.सौ.एन.एस. पाटील

कला, वाणिज्य व विज्ञान महाविद्यालय, पलूस, जि. सांगली

प्रास्ताविक

भारतात अति प्राचीन काळापासून शहरीकरणाची प्रक्रिया सुरु झाल्याचे दिसून येते. सिंधु संस्कृतीत हडप्पा, मोहनजोदडो यांसारखी विशाल व गजबजलेली शहरे प्रसिध्द होती. या शहरांमध्ये नागरी सुखसोई व समृध्दी होती. शहरांना एक प्रकारची वैभवशाली परंपरा होती. मात्र प्राचीन शहरांपेक्षा आधुनिक शहरे खूपच वेगळी आहेत. आजचे शहरीकरण हे औद्योगिक क्रांतीचे अपत्य आहे. भारतात जसजसे औद्योगिकरण होत गेले तसतसे शहरांची संख्या वाढत गेली.

शहरीकरण आणि विकास यांचा खूपच जवळचा संबंध आहे. देशाच्या आर्थिक विकासाच्या दृष्टीने शहरीकरण आवश्यक आहे. ही गोष्ट खरी असली तरी शहरीकरणाच्या फायद्याप्रमाणेच शहरीकरणाला निर्माण होणा-या समस्याही दिवसेंदिवस वाढत आहेत. शहरीकरणाला निर्माण होणा-या समस्या जाणून घेण्यासाठी प्रस्तुत शोधनिबंधाचा विषय निवडलेला आहे.

शोधनिबंधाची उद्दिष्टे

1. भारतातील शहरीकरणाचे स्वरूप जाणून घेणे.
2. भारतातील शहरीकरणाच्या समस्या अभ्यासणे.

शोधनिबंधाची अभ्यासपध्दती

प्रस्तुत शोधनिबंध हा दुय्यम साधनसामुग्रीवर आधारलेला असून पुस्तके, संदर्भ ग्रंथ, मासिके, नियतकालीके, वर्तमानपत्रे व इंटरनेट यामधून माहिती व आकडेवारी गोळा केलेली आहे.

शहरीकरणाचा अर्थ व व्याख्या

शहरीकरण म्हणजे शहराच्या लोकसंख्येची व त्यांच्या भौगोलिक क्षेत्राची वाढ होय. औद्योगिकरण व खेडयातून शहराकडे होणारे लोकांचे स्थलांतरण याचाही शहरीकरणामध्ये समावेश होतो.

व्याख्या

1. लोकसंख्येच्या केंद्रीकरणाची प्रक्रिया म्हणजे शहरीकरण होय.
2. देशाच्या एकूण लोकसंख्येच्या प्रमाणात नागरी भागात लोकसंख्येची झालेली अधिक वाढ म्हणजे शहरीकरण होय.

भारतातील शहरीकरण

भारतातील शहरीकरणाच्या प्रक्रियेचा आढावा घेताना आपणास प्रामुख्याने तीन कालखंडाचा विचार करावा लागतो.

प्राचीन भारतातील शहरीकरण

प्राचीन कालखंडातील सिंधु संस्कृतीमध्ये मोहनजोदडो व हडप्पा ही महत्वाची शहरे म्हणून ओळखली जातात. मौर्यकालीन भारतातील पाटलीपुत्र हे सर्वात महत्वाचे मोठे व राजधानीचे शहर म्हणून ओळखले जाते.



मध्ययुगीन भारतातील शहरीकरण

मध्ययुगीन कालखंडात मुस्लीम राज्यकर्त्यांनी दिल्ली, लाहोर, लालकोट, तुघलकाबाद, फिरोजाबाद, अग्रा, फत्तेपूर सिद्वी, विजयनगर, अहमदाबाद, लखनौ, हैद्राबाद, म्हैसूर, उदयपूर, जयपूर, बिकानेर, अमृतसर, या शहरांचा उदय व विकास घडवून आणला.

आधुनिक भारतातील शहरीकरण

आधुनिक भारतातील ब्रिटीश कालखंडात मुंबई, दिल्ली, कोलकत्ता व मद्रास ही प्रमुख शहरे म्हणून ओळखली जातात.

21 व्या शतकात भारतात शहरीकरणाचा वेग प्रचंड वाढलेला दिसतो. 2030 पर्यंत भारतातील किमान 50 टक्के लोक शहरात राहत असल्याचे दिसून येईल असा तज्ञांचा अंदाज आहे. भारतात शहरीकरणात महाराष्ट्र, गुजरात, केरळ, तमिळनाडू, दिल्ली ही राज्ये आघाडीवर आहेत.

सध्या भारतात दिल्ली, मुंबई, कोलकत्ता या शहरांची लोकसंख्या 1 कोटी पेक्षा जास्त आहे. तर 2030 पर्यंत पुणे, बंगलोर, चेन्नई, हैद्राबाद, अहमदाबाद व चंदीगड या शहरांची लोकसंख्या 1 कोटीच्या वर जाण्याची शक्यता आहे.

भारतातील तीन मेट्रो शहरांची लोकसंख्या ही कॅनडा, मलेशिया, सौदी अरेबिया, आस्ट्रेलिया या देशांपेक्षा जास्त आहे. या सर्व वाढत्या लोकसंख्येचा आजच्या शहरांवर परिणाम होत आहे. कारण शहरीकरण आणि त्याचा वेग थोपविणे आता जवळपास अशक्य आहे.

स्वातंत्र्यप्राप्तीनंतर भारतातील शहरीकरणाची वाढ

जनगणना वर्ष	एकूण लोकसंख्या	शहरी लोकसंख्या	टक्केवारी
1951	36-10	6-24	17-29
1961	43-92	7-89	17-96
1971	54-81	10-9	19-91
1981	68-33	15-9	23-33
1991	84-63	21-7	25-71
2001	102-71	28-5	27-78
2011	121-02	37-7	31-16

(स्रोत जनगणना अहवाल)

भारतातील शहरीकरणाची कारणे

- वाढती लोकसंख्या
- शेतीचा विकास
- औद्योगिकरण
- वाहतूक व दळणवळणाचा विकास
- सेवा क्षेत्राचा विकास
- बाजारपेठांचा विस्तार
- शैक्षणिक सोयीत वाढ
- प्रशासकीय कार्यालयांचे केंद्रीकरण



- सांस्कृतिक केंद्र
- शहराचे आकर्षण

भारतातील शहरीकरणाच्या समस्या

मानवाने रथाची जीवन जगण्याला सुरवात केल्यापासून शहरीकरणाच्या विकासाला सुरवात झाली. मात्र शहरीकरणाला खरी गती मिळाली ती औद्योगिक क्रांतीमुळे. औद्योगिक क्रांतीनंतर सर्वत्र कारखानदारीचा उदय झाला. त्याबरोबर शहरांची संख्या वाढू लागली. अस्तित्वात असलेल्या शहरांचा विस्तार झाला. तर काही नवीन शहरे उदयास आली. शहरीकरणाच्या प्रक्रियेने जसा आर्थिक विकासाचा टप्पा यशस्वीपणे गाठला. तसे काही समस्याही शहरीकरणाने निर्माण झाल्याचे दिसून येते. भारतात शहरीकरणाने कोणत्या समस्या निर्माण झालेल्या आहेत. त्याची चर्चा पुढीलप्रमाणे

1) वाढती लोकसंख्या

शहरातील अनेक समस्यांचे मूळ शोधण्याचा प्रयत्न केल्यास ते वाढत्या लोकसंख्येत सापडते. व्यवसायाच्या, शिक्षणाच्या व इतर निमित्ताने ग्रामीण भागातील लोकसंख्येचे शहरी भागात सतत स्थलांतर होत असते. त्यामुळे शहरातील मूळच्या लोकसंख्येत दिवसेंदिवस भरच पडत आहे. वाढत्या लोकसंख्येमुळे शहरातील मूलभूत सोई सुविधांवर ताण पडतो.

2) निवा-याची समस्या

वाढत्या लोकसंख्येमुळे शहरी भागात निवा-याची समस्या निर्माण झालेली दिसून येते. कमी उत्पन्न गटातील लोकांना परवडणारी घरे खरेदी करणे कठीण बनलेले आहे. त्यामुळे ते अशा ठिकाणी राहतात जेथे भरपूर सूर्यप्रकाश, स्वच्छ हवा, पुरेसा पाणीपुरवठा, सांडपाण्याचे व्यवस्थापन अशा सोई असत नाहीत. दिल्ली शहराचा विचार केल्यास येत्या 10 वर्षात सरासरी 5 लाख घरांचा तुटवडा निर्माण होण्याची शक्यता आहे. युनायटेड नेशन्स सेंटर फॉर ह्युमन सेटलमेन्टस् (UNCHS)ने गृह दारिद्र्य ही एक नवीन संकल्पना मांडलेली आहे. या संकल्पनेत असे लोक समाविष्ट होतात की, ज्यांना सुरक्षित व निरोगी निवारा मिळू शकत नाही.

3) झोपडपट्टीची समस्या

शहरातील सततच्या वाढत्या लोकसंख्येमुळे निवा-याची समस्या निर्माण होते त्यामुळे मिळेल त्या ठिकाणी लोकवसाहती निर्माण होतात. त्यातूनच झोपडपट्टीचा उदय होतो. अशा अनियोजित वसाहतीमध्ये रस्ते, वीज, पाणी, स्वच्छता गृहे यांचा तुटवडा असतो. शिवाय सांडपाण्याची व्यवस्था नसल्याने ठिकठिकाणी दुर्गंध पाणी, घाणीचे ढीग निर्माण होतात.

4) आरोग्याची समस्या

शहरी भागातील झोपडपट्ट्यांमध्ये मोठ्या प्रमाणात अस्वच्छता दिसून येते. ठिकठिकाणी कच-याचे ढीग, दुर्गंधी, दूषित हवा, दूषित पाणी, सांडपाण्याची समस्या इ.मुळे डेंग्यू, मलेरिया, डायरिया, स्वाईन फ्ल्यू यासारखे आजार निर्माण होऊन मानवी आरोग्य धोक्यात आले आहे.

5) पाणीपुरवठ्याची समस्या

शहरातील लोकसंख्येला आवश्यक असणारा पाणीपुरवठा करताना प्रशासनाला अनेक अडचणींना सामोरे जावे लागते. शहरी भागात पिण्याच्या पाण्याबरोबर कारखाने, हॉटेल व्यवसाय व इतर कारणांमुळे पाण्याची मागणी होत असते. त्यामुळे शहरातील नागरिकांना स्वच्छ व गरजेनुसार पिण्याच्या पुरवठा करावा ही एक समस्या निर्माण होते.

6) प्रदूषणाची समस्या



- शहरी भागातील दैनंदिन घडामोडींमुळे वातावरणात वेगवेगळे विषारी वायू पसरले जातात उदा. कार्बनडाय ऑक्साईड, सल्फरडाय ऑक्साईड इ. म्हणजेच कारखाने, वाहने यापासून हवा प्रदूषण, ध्वनी प्रदूषण व जलप्रदूषण मोठ्या प्रमाणात होत आहे. तसेच सिमेंट कोंकीटच्या इमारती उष्णता शोषून घेतात. त्यामुळे शहरीचे तापमान तुलनेने जास्त राहते. त्याचे परिणाम आरोग्यावर होत असतात.
- 7) पर्यावरणाचा -हास
शहरीकरणाचे अनिष्ट परिणाम पर्यावरणावर मोठ्या प्रमाणात होत असतात. शहराच्या विस्तारासाठी मोठ्या प्रमाणात वृक्षतोड केली जाते. नैसर्गिक नाले, तलाव, मुजवले जातात. पर्यावरण संवेदनशील क्षेत्रांमध्ये अनाधिकत बांधकाम केले जाते. त्यामुळे पर्यावरणावर आणि जैवविविधतेवर विपरित परिणाम होतात. जमिनीतील भूजल पातळीत घट होत आहे. महापूर, जलप्रलय यांसारखी संकटे निर्माण होत आहेत. समुद्राच्या पाणीपातळीत वाढ, डोंगर टेकड्यांचा -हास होत आहे. थोडक्यात पर्यावरणाचा समतोल बिघडत आहे. म्हणूनच दिल्ली हे प्रदूषित शहर, कलकत्ता हे उष्णतेचे बेट तर मुंबई हे झोपडपट्ट्याचे शहर म्हणून ओळखले जाते.
- 8) अतिकमणाची समस्या
वाढत्या लोकसंख्येमुळे शहरांमध्ये अतिकमणाची समस्या वाढत आहे. जागेच्या अभावामुळे किरकोळ व्यापारी, फिरते व्यापारी रस्त्यावरच दुकाने मांडतात, त्यामुळे वाहतुकीची कोंडी होताना दिसते. अतिकमणामुळे शहरातील रिकाम्या जागा, खेळाची मैदाने, बाग बगीचे कमी होत आहेत.
- 9) वाहतूक समस्येवर ताण
शहरातील वाढत्या लोकसंख्येबरोबर वाहनांची संख्याही वाढत आहे. शहरातील लोक कामानिमित्त बाहेर पडताना स्वतः च्या खाजगी वाहनांचा वापर करतात. तसेच प्रवासी वाहतुकीसाठी शहरी बसेस, मालवाहतुकीची साधने यांची रस्त्यावर सतत रहदारी सुरू असते. त्यामुळे वाहतुकीची कोंडी निर्माण होऊन वाहतूक व्यवस्था कोलमडते. परिणामी अपघातांचे प्रमाण वाढते.
- 10) घनकच-याची समस्या
शहरातील वाढत्या लोकसंख्येमुळे घनकच-याचे प्रमाण वाढत आहे. त्याची विल्हेवाट लावण्यासाठी योग्य जागा व पुरेशी व्यवस्था उपलब्ध नाही. त्यामुळे टिकटिकाणी घाणीचे ढीग निर्माण झालेले दिसतात. त्यामुळे घनकच-याच्या व्यवस्थापनाची समस्या निर्माण होते.
- 11) तीव्र स्पर्धा व भ्रष्टाचार
शहरी जीवन हे खूपच गतीमान असले. त्यामुळे सर्वत्र स्पर्धा दिसून येते. या स्पर्धेत टिकून राहण्यासाठी प्रत्येकाची धडपड सुरू असते. शिवाय वाढती महागाई, अपूरा पगार, उच्च राहणीमानाची लालसा या कारणामुळे मिळेल त्या मार्गाने पैसा मिळविण्याचा प्रयत्न केला जातो. यातूनच भ्रष्टाचार, लाचलुचपत, दप्तर दिरंगाई हे दोष निर्माण झालेले दिसतात.
- 12) गुन्हेगारीत वाढ
मोठी शहरे ही आर्थिक सत्तेचे केंद्रीकरण बनलेली आहेत. त्यामुळे शहरी लोक आत्मकेंद्री व स्वार्थी बनतात. झटपट श्रीमंत होण्यासाठी, चुकीच्या मार्गाचा अवलंब केला जातो. यातून गुन्हेगारी प्रवृत्ती वाढते. दहशतवादी हल्ले घडून येतात. सामाजिक शांतता नष्ट होते. आजपर्यंत भारतात जे दहशतवादी हल्ले झाले. ते प्रामुख्याने दिल्ली, मुंबई, पुर्ण यासारख्या मोठ्या शहरात झालेले आहेत. कडक सुरक्षा व्यवस्था असूनही असे हल्ले रोखणे अवघड झाले आहे.
- 13) सामाजिक जबाबदारीचा अभाव
शहरीकरणामुळे सामाजिक जबाबदारीचा अभाव दिसून येतो. शहरी भागात एकत्र कुटुंबपध्दती ऐवजी विभक्त कुटुंबपध्दती निर्माण झालेली दिसते. त्यामुळे शहरी लोकांची कौटुंबिक व सामाजिक बांधिलकी कमी झालेली आहे. आदरातिथ्य, पाहणचार, शेजारधर्म ही सामाजिक मूल्ये जोपासली जात नाहीत.



भारतीय वयोवृद्ध लोकांची जबाबदारी स्विकारण्यास शहरी लोकांकडे वेळ नाही. त्यामुळे शहरात
पृथक्पृथक् संख्या वाढत आहे.

सारांश

भारतात भविष्यकाळात शहरीकरणालाच निर्माण होणा-या समस्यांबाबत संयुक्त राष्ट्रसंघाने
बोकाच्या इशारा दिलेला आहे. त्यांच्या अहवालानुसार भारताची राजधानी असलेले दिल्ली हे शहर जगातील
सर्वाधिक लोकसंख्येचे दुसरे शहर आहे. भारतातील शहरांच्या वाढीचा वेग पाहता येत्या 15 ते 20 वर्षात
जगातील सर्वात मोठी शहरे भारतात असतील.

भारतीय शेतीची घटती उत्पादकता, ग्रामीण भागात पर्यायी राजगाराचा अभाव त्यामुळे ग्रामीण भागातील
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आहे. प्रशासन व्यवस्थेवर ताण वाढत आहे. या पार्श्वभूमीवर भारतातील केंद्र सरकार, राज्य सरकारे व स्थानिक
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Impacts Of Covid 19 On Various Sectors And Rebooting The Economy Post-Lockdown

Dr. R. S. Salunkhe

Acting Principal

Arts, Commerce and Science College, Palus Dist: Sangli (Maharashtra)

Abstract

COVID-19 Corona-Virus is very dangerous for everyone. Spreading of this virus is very high due to this all over world is facing so many troubles. The world is becoming very dynamic in every sector but Corona-Virus has stopped all activities and also decreasing the speed of changing. No one can imagine what will happen in a coming situation. We can't plan for work. Manufacturing, services, and all sectors are stopped their all type of activities, therefore, income source of everyone is also stopped. A restart of all these activities is now taking place but the speed of restarting is very low. In about one year we are facing such a problem. The income of all companies, peoples, and institutions is highly decreased that's why the economy comes in trouble. The impacts of COVID on the economy are short-term, many can have lasting effects. The lockdowns have tremendously impacted the supply-chain management and sent the GDP and import-export cycle reducing. There are three major sectors of impact for Indian businesses which are linkages, supply chain, and macroeconomic factors. In this paper, the researcher is an attempt to understand the impact of Corona-Virus on various sectors and rebooting the Indian economy post lockdown.

Keywords: Corona, impact, economy, sectors

Introduction:

The COVID-19 pandemic, conjointly called the corona virus pandemic, is associated current pandemic of corona virus unwellness a pair of 019 (COVID-19) caused by severe acute metastasis syndrome corona virus 2 (SARS-CoV-2). It had been 1st known in December 2019 in Wuhan, China. The globe Health Organization declared the happening a Public Health Emergency of International Concern in Jan 2020 and a scourge in March 2020. As of twenty February 2021, over one hundred ten million cases are confirmed, with over a pair of.45 million deaths attributed to COVID-19. Symptoms of COVID-19 square measure extremely variable, starting from none to critical diseases. The virus spreads chiefly through the air once individuals square measure close to one another. It leaves an associate infected person as they breathe, cough, sneeze, or speak and enters another person via their mouth, nose, or eyes. it should conjointly unfold via contaminated surfaces. Individuals stay infectious for up to 2 weeks and might unfold the virus notwithstanding they are doing not show symptoms

Objectives of the Study:

1. To know the worldwide situation of COVID-19 Cases
2. To Understand the impact of COVID-19 on Indian economy
3. To suggest the rebooting measure towards economy

A Study and Species Abundance of Freshwater Crabs in Sangli and Kolhapur Districts of Maharashtra

Satyawan S. Patil and Abhijit B. Ghadage

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A Study and Species Abundance of Freshwater Crabs in Sangli and Kolhapur Districts of Maharashtra

Satyawan S. Patil*¹ and Abhijit B. Ghadage²

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ABSTRACT

A study of crabs was conducted at eight different localities in two districts of Maharashtra, during January to December, 2019 with a view to assess the availability and to study taxonomic description of freshwater crabs. The study investigated species diversity which includes their taxonomic description, habitat, distribution and ecological role. The specimens were collected in different times covering the major seasons rounded the year by hand picking method and also collected from market. A total 3 species of freshwater crabs under single family were recorded. The identified 3 species of crabs were *Barytelphusa cunicularis*, *Barytelphusa guerini* and *Oziotelphusa wagrakarowensis* all of these were under family Gecarcinucidae. *Barytelphusa cunicularis* species was the dominant species in Sangli and Kolhapur districts of Maharashtra.

Key words: Freshwater crabs, Diversity, Abundance, Sangli, Kolhapur

Sangli and Kolhapur districts of Maharashtra state are mostly composed of hill ranges of Sahyadri with flat tops and plains. These regions include areas of rivers, lakes, streams, ponds and waterfalls that are excellent ground for biodiversity. Various small and moderate water bodies and tributaries of river in Sangli district have been found as a source of water. Crabs are very ecologically important species. These water bodies contain diversity of crab species that have yet to discover. Freshwater crabs are mostly distributed throughout the tropical and sub-tropical regions of the world. They live in a wide range of water bodies, from fast-flowing rivers to swamps. The majority of species are endemics, occurring only in a small geographical area. This is due to their poor dispersal ability and low fecundity [1] and due to habitat fragmentation caused by the world's human population [2].

Freshwater crabs prefer live or dead animal as food. They are the chief source of food for fishes, birds and mammals. Freshwater crabs also serve as a cheap and important source of protein to human being particularly tribal and poor people. Freshwater crabs are highly endemic due to their limited dispersal ability, low fecundity and selected habitat preferences [3].

In most of decapods, the gonopores (sexual openings) are found on the legs. However, crabs use the first two pairs of pleopods (abdominal appendages) for sperm transfer, these arrangements has changed. As the male abdomen evolved into

a narrow shape, the gonopores have moved towards the midline; away from the legs, and onto the sternum [4]. The Freshwater crab fauna of Sangli and Kolhapur districts of Maharashtra state have been broadly surveyed by researchers. It is necessary to know the biodiversity of freshwater crabs in Sangli and Kolhapur districts of Maharashtra state for the conservation purpose. So, the present study was focused to identify the crab species in the study area and also to study the species abundance.

MATERIALS AND METHODS

The study was conducted in eight selected sites, four sites from Sangli district are Takari, Sagarshwar wildlife Sanctuary, Bhilwadi and Kokrud while other four sites are from Kolhapur district are Panchganga Ghat, Kagal, Amba Ghat and Barki (Fig 1). The study was conducted from January 2019 to December 2019 in the different seasons with four times of crab collection.

Collection and preservation of specimens

Crab specimens were collected from above mentioned areas. After collecting the crabs, were photographed and preserved in plastic container with 70% alcohol. The specimens were permanently preserved in 5-10% formalin. About 120 specimens were collected from all the areas and 25 adult specimens were chosen for morphometric study.

Crab identification

The specimens were identified by using crab identification key by Alcock [5] and Cumberlidge and Sachs [6] (1989). Identified species are confirmed by ZSI Pune.

* Satyawan S. Patil

✉ sspatilzoology@gmail.com

^{1,2} Department of Zoology, Arts, Commerce and Science College, Palus Dist. Sangli - 416 310, Maharashtra, India

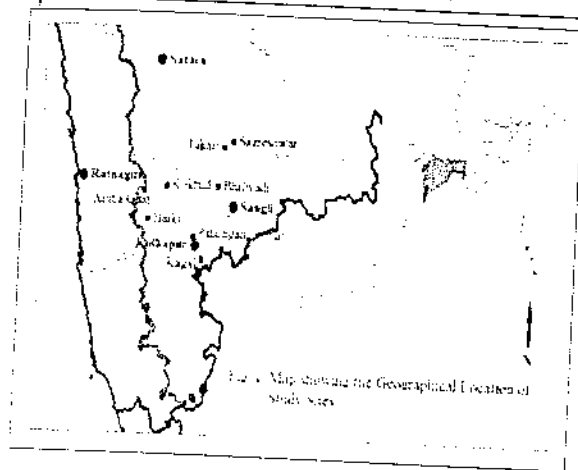


Fig 1 Map showing the geographical location of study sites



Fig 2 *Barytelphusa cunicularis*



Fig 2 *Barytelphusa guerini*



Fig 4 *Ozioelphusa wagrakarowensis*

Measurement

Morphometric measurements were taken by using scale, tape and 'Vernier Caliper'. The colour noted in live condition. Body length, width, depth was measured by scale. The unit of measurement was in cm. The selected morphometric or morphological characteristic for identification of specimen were taken from the fresh and preserved specimens.

Statistical analysis

The data were analyzed by estimating the mean value and standard deviation to determine correlation among carapace length (CL) and carapace width (CW). Correlation was calculated by using Pearson Correlation Equation:

$$r = \frac{1}{n-1} \sum \left[\frac{(xi - \bar{x})}{sx} \times \frac{(yi - \bar{y})}{sy} \right]$$

Where, the carapace length x represents the values of independent variable and carapace width y represents the values of dependent variables. X and Y denote the average values.

The value of r ranges between +1 and -1

r > 0 indicates a positive relationship of X and Y; as one gets larger.

r < 0 indicates a negative relationship; as one gets larger the

other gets smaller.

r = 0 indicates no relationship

If two variables are positively associated, then positive values of $(xi - \bar{x})$ will match up with positive values $(yi - \bar{y})$, and negative values with the negative values. The sum of $(xi - \bar{x})(yi - \bar{y})$ will produce a positive correlation. In a negative relationship, positive values of $(xi - \bar{x})$ will match up with negative values of $(yi - \bar{y})$ and vice versa. Then the sum of $(xi - \bar{x})(yi - \bar{y})$ and r, will be negative. If we calculate the Pearson correlation of x with itself, the result will be 1. If there is no association between X and Y, there will be no systemic relationship between $(xi - \bar{x})$ and $(yi - \bar{y})$. Therefore, the positive value of one match up with positive and negative values of the first variable.

RESULTS AND DISCUSSION

In the present study 3 species of crabs recorded from the selected sites of Sangli and Kolhapur districts. These are *Barytelphusa cunicularis* (Westwood in Sykes 1836), *Barytelphusa guerini* (H. Milne Edwards 1853) and *Ozioelphusa wagrakarowensis* (Rathbun 1904) belongs to family Gecarcinucidae. The percentage of crabs found in Sangli and Kolhapur districts was 48% dominant species *Barytelphusa cunicularis*. The lowest abundance recorded was 12% *Ozioelphusa wagrakarowensis* [7]. Also, the *Barytelphusa guerini* was 40% of the studied specimens (Fig 2-4).

Table 1 Observed crab species in the study areas

Family	Species	Sites of occurrence							
		Sangli				Kolhapur			
		Takari	Sagareswar	Bhilwadi	Kokrud	Panchaganga Ghat	Kagal	Amba Ghat	Barki
Gecarcinucidae	<i>B. guerini</i>	+	+	+	+	+	+	+	+
	<i>B. cunicularis</i>	+	+	+	+	+	+	+	+
	<i>O. wagrakarowensis</i>	-	+	-	-	-	-	+	+

Table 2 Habitat diversity of the study sites

Study sites	GPS coordinator		Habitat
	Latitude	Longitude	
1) Takari	17.119257 N	74.355615 E	Krishna river bank
2) Sagareswar	17.146927 N	74.367094 E	Wildlife sanctuary, Hill streams
3) Bhilwadi	16.993488 N	74.470617 E	Paddy Field
4) Kokrud	17.008502 N	73.978223 E	Warana river bank
5) Panchaganga Ghat	16.706425 N	74.217491 E	Panchganga river bank
6) Kagal	16.554474 N	74.318877 E	Dudhganga river bank
7) Amba Ghat	17.000743 N	73.777234 E	Hill streams
8) Barki	16.768539 N	73.841161 E	Waterfall and lake

Table 3 Biometric measurements of *Barytelphusa cunicularis*

Measurement	Biometric measurements			
	Min cm	Max cm	Mean cm	SD
Carapace length	4.51	6.84	5.58	0.66
Carapace width	2.69	4.13	3.40	0.43
Abdominal length	2.10	3.23	2.63	0.34
Telson length	0.57	0.94	0.75	0.11
Merus length	1.59	2.57	2.07	0.29
Carpel length	1.96	2.92	2.41	0.32
Palm length	0.98	1.69	1.36	0.19

Table 4 Biometric measurements of *Barytelphusa guerini*

Measurement	Biometric measurements			
	Min cm	Max cm	Mean cm	SD
Carapace length	3.57	5.32	4.38	0.67
Carapace width	2.45	3.73	2.99	0.45
Abdominal length	1.58	2.43	1.95	0.30
Telson length	0.37	0.61	0.49	0.08
Merus length	1.22	1.91	1.52	0.22
Carpel length	1.19	1.89	1.52	0.23
Palm length	0.97	1.51	1.23	0.20

Table 5 Biometric measurements of *Oziotelphusa wagrakarowensis*

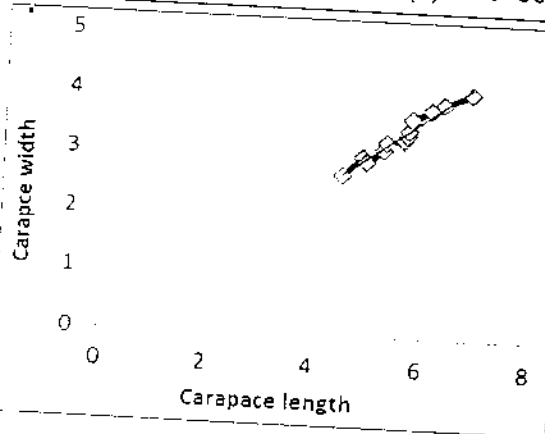
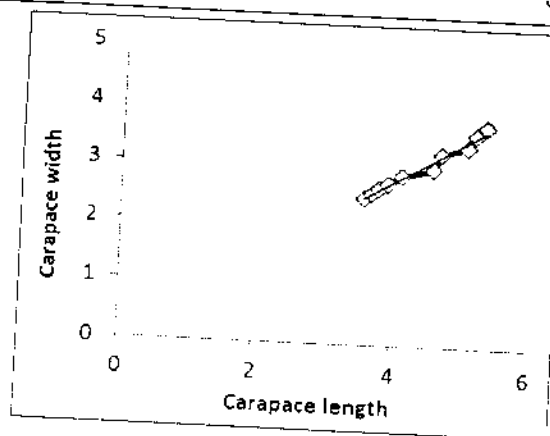
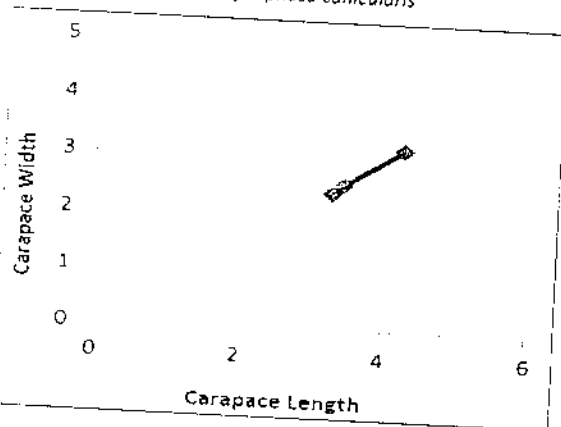
Measurement	Biometric measurements			
	Min cm	Max cm	Mean cm	SD
Carapace length	3.29	4.26	3.66	0.52
Carapace width	2.38	3.17	2.70	0.41
Abdominal length	1.52	1.78	1.65	0.13
Telson length	0.52	0.74	0.61	0.11
Merus length	1.12	1.49	1.26	0.20
Carpel length	1.19	1.51	1.31	0.17
Palm length	0.80	1.08	0.91	0.15

Barytelphusa cunicularis and *Barytelphusa guerini* are closely related species under the same genus. There are some dissimilarities present in their morphology. *Barytelphusa cunicularis* is more robust than *Barytelphusa cunicularis guerini* and carapace of *Barytelphusa cunicularis* is slightly convex and gradually sloped posteriorly which is wider and more convex in *Barytelphusa guerini*. The epibranchial tooth is distinct, blunt or sometimes slightly sharp and markedly above the level of postorbital cristae. In *Barytelphusa guerini* sixth male abdominal somite broader nearly equal in length to telson in *B. cunicularis* which is trapezoidal with straight lateral margins broader than long nearly equal in length to telson in *B. guerini*. *Oziotelphusa wagrakarowensis* is clearly remarked by having carapace broader and long, highly convex

in frontal view, epibranchial tooth moderate in size, male abdominal somite trapezoidal, wider than long, sub equal in length to telson with distinctly concave lateral margins [8-9].

The study habitats of the crabs are greatly varied. Crab species lives in a wide variety of habitats like mudflats, under stones, in the gravel, in the crevices of rocks and freshwater crabs are found in all important habitats types, including flood plains, swamps, lakes, streams, constructed burrows, tunnel like burrows in river bed, river bank with trees, river bank near agricultural field (Table 1-2).

In the biometrical study carapace length and width, abdominal length, merus length, carpal length and palm length of 3 studies crabs were measured [10]. Correlation of carapace length and carapace width were measured (Table 2-5). The

Fig 6 *Barytelphusa cunicularis*Fig 7 *Barytelphusa guerini*Fig 8 *Oziotelphusa wagrakarowensis*

value of correlation coefficient (r) is 0.965 For *Barytelphusa cunicularis*, 0.972 for *Barytelphusa guerini* and 0.997 for *Oziotelphusa wagrakarowensis* which implies that there is strong positive linear association between the variables carapace length and carapace width (Fig 6-8).

CONCLUSION

Previous information of freshwater crabs was not adequate in Sangli and Kolhapur districts of Maharashtra, and thus the comparison of the present findings with previous one was not possible. Total 3 species of crabs found in this study. Among the three species and this species is under data deficiency conservation rank. The present study mainly focused on morphological characteristic and habitats of crab species. The study area is regarded as hot spot of biodiversity and crabs have enhanced this biodiversity. Tribal peoples of study area depend on crabs for food. The present study signals that the study area contains a rich biodiversity which is usually less known and it strongly suggests the further extensive survey of these districts by long term basis.

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On the freshwater fish fauna of Krishna River, Sangli District, Maharashtra, India

Suresh M. Kumbar¹, Shrikant S. Jadhav², Swapnali B. Lad³, Abhijit B. Ghadage⁴,
Satyawan S. Patil⁵ & C. Shiva Shankar⁶

^{1,3,4,5}Department of Zoology, Arts, Commerce and Science College, Vidyanagar, Tal. Palus, District Sangli, Maharashtra 416310, India.

^{2,6}Zoological Survey of India, Freshwater Biology Regional Centre, Inner Ring Road, Attapur, Hyderguda, Hyderabad, Telangana 500048, India.

¹smkumbar@rediffmail.com (corresponding author), ²shrikantjadhavzi@gmail.com, ³swapnali3lad@gmail.com,

⁴abghadage82@gmail.com, ⁵sspatilzoology@gmail.com, ⁶cshivashankarchinna@gmail.com

Abstract: Freshwater fish fauna of Krishna River, Sangli district was studied from 2013 to 2017. A total of 73 species belonging to 10 orders, 22 families, and 49 genera were recorded, of which, 29 species are endemic to the Western Ghats and 11 species endemic to the Krishna River system. *Labeo kontius*, an endemic barb of the Cauvery River System was recorded for the first time from the Krishna River, Maharashtra. As per the IUCN Red List of Threatened Species, 54 species are assessed as 'Least Concern', four species as 'Near Threatened', three species as 'Vulnerable', five as 'Endangered', and two as 'Data Deficient'. The conservation status of two species has not yet been assessed. Fish fauna of the Krishna River within the study area is threatened as a result of alien species, and several anthropogenic stressors such as pollution from industrial as well as agricultural sources, human settlements, and overfishing. Since, this small study area harbours 28 endemic and eight threatened species, their conservation should be given high priority.

Keywords: Conservation, endemic species, fish diversity, threats, Western Ghats.

The Western Ghats of India is global biodiversity hotspot (Myers et al. 2000), known for its high level of endemism of taxonomic groups such as amphibians and freshwater fish. Around 320 species belonging to 11 orders, 35 families, and 112 genera are known from this

region (Dahanukar & Raghavan 2013) and this number is certain to increase given the high number of species being discovered on a yearly basis. Krishna is one of the major perennial rivers of the northern Western Ghats. The river originates at Mahabaleshwar (17.988°N; 73.637°E), Satara District, Maharashtra, and traverses a distance of 290 km through Satara, Sangli, and Kolhapur districts in Maharashtra, thereafter flowing through the states of Karnataka and Telangana before emptying into the Bay of Bengal at Hamasaladeevi in Andhra Pradesh.

Earliest studies on the fish fauna of Deccan was carried out by Sykes (1839). Specific studies on the fish fauna of the Krishna River (in addition to the Godavari) were carried out by David (1963), but no separate 'river-wise' locations for the species collected, were provided. A major study on the fish fauna of Krishna River was also carried out by Jayaram (1995), but no separate list of fishes collected specifically from the tributaries in Sangli District was provided.

Previous studies on the fish fauna of Krishna River has largely focused on the tributaries in Satara District.

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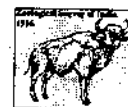
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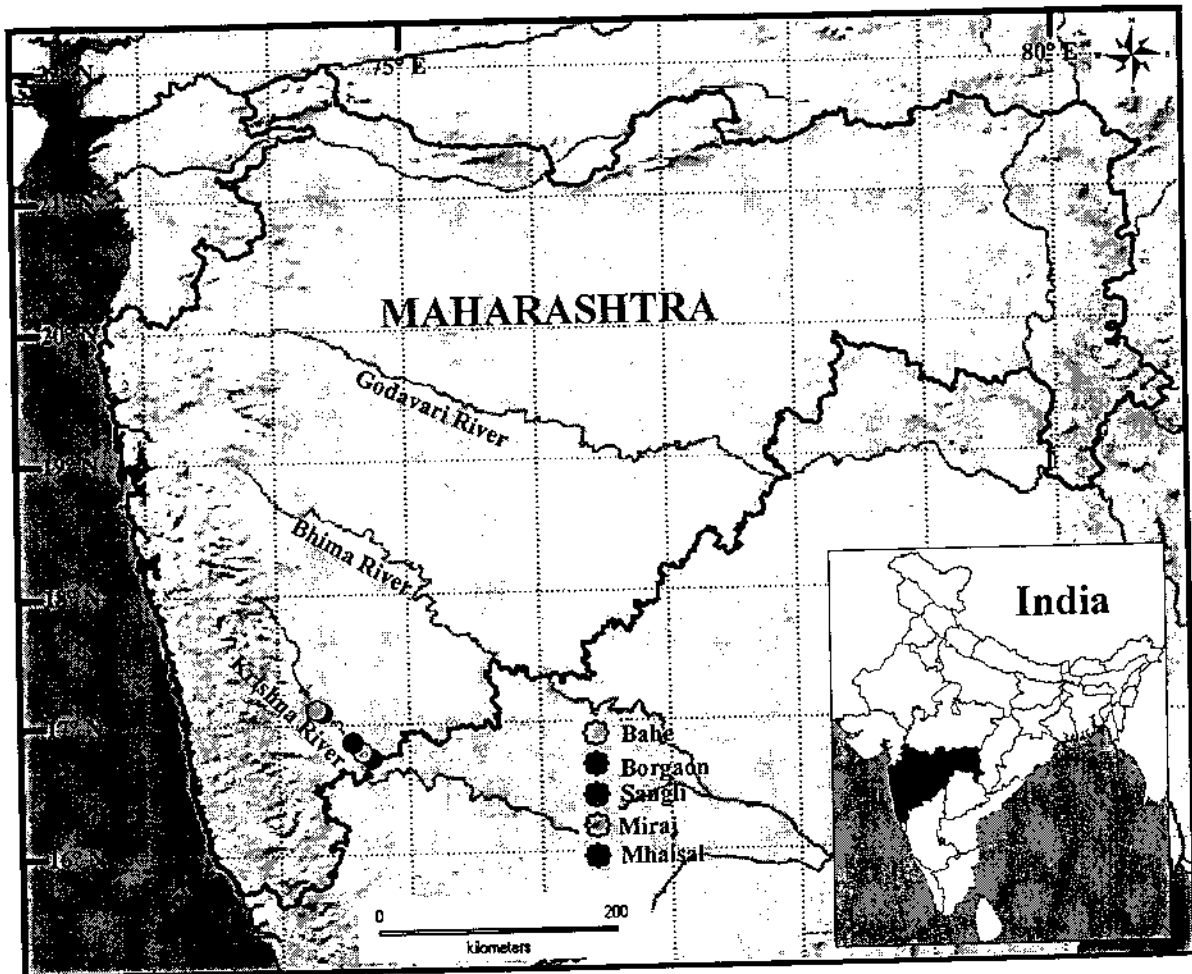


Figure 1. Sampling sites in the Krishna River surveyed as part of the study

Annandale (1919) reported 18 species from the Yenna River at Medha, followed by Silas (1953) who studied the fish fauna of Mahabaleshwar and Wai and recorded 14 species. Arunachalam et al. (2002) recorded 14 species from Dhom reservoir, and subsequently Jadhav et al. (2011) reported 58 species from the Koyna tributary. More recently, Kharat et al. (2012) provided an updated checklist of the fish fauna of Krishna River at Wai and Dhom reservoir, and reported the presence of 51 species. The only published work on the freshwater fishes of the Krishna River in Sangli District is by Kumbar & Lad (2014) who recorded 13 species of catfishes. In the present paper, we provide a comprehensive checklist of the freshwater fishes of the Krishna River flowing through Sangli district in Maharashtra and identify possible threats so as to build baseline data for future conservation action.

METHODS

Field surveys were undertaken in the Krishna River, Sangli district, Western Maharashtra from the year 2013 to 2017. Fish specimens were collected from Bahe (17.1138°N & 74.2811°E), Borgaon (17.0808°N & 74.3691°E), Sangli (16.8591°N & 74.5577°E), Miraj (16.7877°N & 74.6291°E), and Mhalsal (16.7358°N & 74.6986°E) (Figure 1), with the help of local fishers using different mesh-sized gill nets and cast nets. Alternatively, fish samples were also procured from local fish markets.

Assuming that the fishing effort for a given type of net was constant, the relative abundance of the fish was grossly categorized following Dahanukar et al. (2012), namely abundant (76–100 % of total catch), common (51–75 % of total catch), moderate (26–50 % of total catch), and rare (1–25 % of total catch). Samples were preserved in 10% formalin and identified using the available literature (Menon 1987, 1992; Talwar & Jhingran 1991; Jayaram & Dhas 2000; Jayaram &

Sanyal 2003; Jayaram 1991, 2006, 2010) and relevant recent taxonomic literature related to different groups (Dahanukar et al. 2011; Keskar et al. 2015; Katawate et al. 2016; Lavoué et al. 2020; Sudasinghe et al. 2020). All identified specimens are deposited at the Department of Zoology, Arts, Commerce and Science College, Palus, Sangli District, Maharashtra, with accession numbers from ZID 01–73.

RESULTS

We recorded a total 73 species of freshwater fish belonging to 10 orders, 22 families and 49 genera from the Krishna River in Sangli district (Table 1). Order Cypriniformes dominated with 42 species, followed by Siluriformes (18 species), Anabantiformes (three species), Synbranchiformes, Perciformes, & Belontiiformes (two species each), and Cyprinodontiformes, Gobiiformes, Osteoglossiformes, & Cichliformes (one species each). Representative species of fish collected from Krishna River are shown in (Images 1, 2, 3 & 4). As per the IUCN Red List of Threatened Species, 54 species are assessed as 'Least Concern', four species as 'Near Threatened', three species as 'Vulnerable', five as 'Endangered', two as 'Data Deficient', and the conservation status of two species has not yet been assessed. Of the 73 species, 29 are endemic to the Western Ghats, and 11 are endemic to the Krishna River System (Table 1). Microlevel distribution of species along the upstream-downstream gradient showed that 56 species occurred in upper reaches, 28 species in middle stream, and 37 species in downstream respectively (Figure 1). Of the total fish collected, 15 species were found to be common, six abundant, 28 moderate and 24 rare.

Fish fauna of Krishna River is severely threatened by pollution from organic wastes particularly around

the towns of Sangli and Miraj as well as from pollution due to agricultural runoff and sewage. Recently, sand mining has also increased significantly along the stretch of the river near Bahe and Borgaon, resulting in the loss of available habitats to the fish fauna of these areas. Similarly, overfishing, indiscriminate use of poison to collect fish in large numbers and using fine-meshed gill-nets, is a specific threat to species of the genera *Bangana*, *Tor*, *Hypselobarbus*, *Labeo*, *Cirrhinus*, *Opsarius*, *Salmostoma*, *Botia*, *Mystus*, *Cirrhinus*, and *Puntius*.

We also recorded seven non-native species—four transplanted: *Cirrhinus mrigala*, *Labeo rohita*, *Labeo catla*, *Labeo calbasu* in all sites and three alien invasive species: *Oreochromis mossambicus*, *Cyprinus carpio* and *Clarias gariepinus* at Sangli and Miraj. Studies in their entirety of Krishna River by Jayaram (1995) have recorded 10 invasive alien species, but interestingly Jadhav et al. (2011) could not record any alien species from Koyna tributary. However, Dahanukar et al. (2012) recorded seven introduced species from Indrayani River near Pune, and four species from Hiranyakeshi River by Kumkar et al. (2017).

DISCUSSION

Krishna River harbours a number of endemic and threatened species. We collected *Glyptothorax cf. poonaensis* from Bahe near Islampur in moderate numbers. These specimens resemble *G. poonaensis* (Hora 1938), but differs considerably with the description provided in Dahanukar et al. (2011). It is therefore possible that this species might comprise a 'complex'. The population of Endangered and endemic *Bangana nukta* is declining drastically in the study area as per the local knowledge of fishers. Pollution, overfishing and the competition created by transplanted carps such as

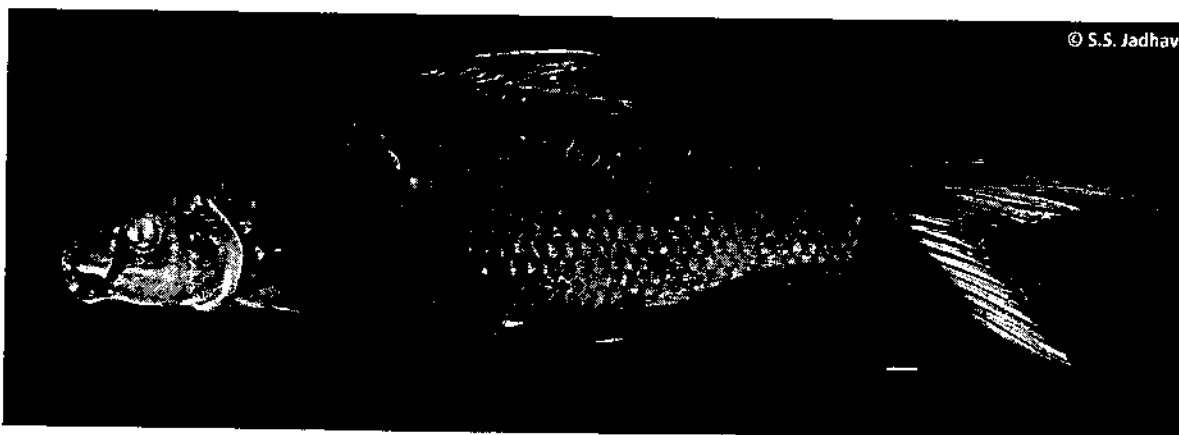


Image 1. *Labeo kontius* collected from Krishna River near Miraj. Lateral view. After preservation. Scale= 10 mm. (Voucher No, ZID 26)

Table 1. List of Freshwater Fishes collected from the Krishna River, Sangli District, Maharashtra

	Order	Family	Species	Status	WGE	KRE	IUCN Red List
1	Anabantiformes	Channidae	<i>Channa gachua</i> (Hamilton, 1822)	M	-	-	LC
2			<i>Channa punctata</i> (Bloch, 1793)	M	-	-	LC
3			<i>Channa striata</i> (Bloch, 1793)	R	-	-	LC
4	Beloniformes	Belonidae	<i>Xenentodon concilia</i> (Hamilton, 1822)	R	-	-	LC
5		Hemiramphidae	<i>Hyporhamphus limbatus</i> (Valenciennes, 1847)	R	-	-	LC
6	Cichliiformes	Cichlidae	<i>Oreochromis mossambicus</i> (Peters, 1852)	C	-	-	
7		Botiidae	<i>Botia striata</i> Rao, 1920	A	+	+	EN
8	Cypriniformes	Cobitidae	<i>Lepidocephalichthys thermalis</i> (Valenciennes, 1846)	A	-	-	LC
9		Cyprinidae	<i>Bangana nukta</i> (Sykes, 1839)	R	+	-	EN
10			<i>Cirrhinus reba</i> (Hamilton, 1822)	M	-	-	LC
11			<i>Cyprinus carpio</i> Linnaeus, 1758	R	-	-	
12			<i>Garra bicarnea</i> Rao, 1920	C	+	+	NT
13			<i>Garra mulya</i> (Sykes, 1839)	A	-	-	LC
14			<i>Gymnostomus ariza</i> (Hamilton, 1807)	R	-	-	LC
15			<i>Gymnostomus fulungee</i> (Sykes, 1839)	M	+	+	LC
16			<i>Hypselobarbus jerdoni</i> (Day, 1870)	M	+	-	LC
17			<i>Hypselobarbus kalus</i> (Sykes, 1839)	M	+	-	VU
18			<i>Hypselobarbus mussullah</i> (Sykes, 1839)	M	+	-	EN
19			<i>Labeo calbasu</i> (Hamilton, 1822)	M	-	-	LC
20			<i>Labeo catla</i> (Hamilton, 1822)	R	-	-	LC
21			<i>Labeo fimbriatus</i> (Bloch, 1795)	R	-	-	LC
22			<i>Labeo kantius</i> (Jerdon, 1849)	R	+	-	LC
23			<i>Labeo porcellus</i> (Heckel, 1844)	R	+	-	LC
24			<i>Labeo potail</i> (Sykes, 1839)	R	+	-	EN
25			<i>Labeo rohita</i> (Hamilton, 1822)	R	-	-	LC
26			<i>Osteobrama neilli</i> (Day, 1873)	R	+	+	LC
27			<i>Osteobrama peninsularis</i> Silas, 1952	M	+	-	DD
28			<i>Osteobrama vigorisii</i> (Sykes, 1839)	C	-	-	LC
29			<i>Parapsilarghynchus discopharus</i> Hora, 1921	R	+	-	VU
30			<i>Pethia sanjaymaluri</i> Katwate, Jadhav, Kumkar, Raghavan & Dahanukar, 2016	A	+	+	NE
31			<i>Puntius choia</i> (Hamilton, 1822)	M	-	-	LC
32		<i>Puntius saphore</i> (Hamilton, 1822)	C	-	-	LC	
33		<i>Rohitee ogilbii</i> Sykes, 1839	M	+	+	LC	
34		<i>Systomus sarana</i> (Hamilton, 1822)	C	+	-	LC	
35		Danionidae	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	R	-	-	NE
36			<i>Devaria aequipinnatus</i> (McClelland, 1839)	C	-	-	LC
37			<i>Opsarius bendelisis</i> (Hamilton, 1807)	M	-	-	LC
38			<i>Rasbora daniconius</i> (Hamilton, 1822)	C	-	-	LC
39			<i>Salmostoma acinaces</i> (Valenciennes, 1844)	C	+	-	LC
40			<i>Salmostoma balookee</i> (Sykes, 1839)	C	-	-	LC
41			<i>Salmostoma bacaila</i> (Hamilton, 1822)	M	-	-	LC
42	<i>Salmostoma boopis</i> (Day, 1874)		A	+	-	LC	
43	<i>Salmostoma novacula</i> (Valenciennes, 1838)		M	+	-	LC	
44	<i>Indoreonectes cf. evezardi</i> (Day, 1872)		R	-	-	LC	
45	Nemacheilidae	<i>Nemacheilus anguilla</i> Annandale, 1919	M	+	+	LC	
46		<i>Nemachilichthys rueppelli</i> (Sykes, 1839)	M	+	+	LC	
47		<i>Paracanthocobitis mooreh</i> (Sykes, 1839)	A	-	-	LC	
48		<i>Schistura denisoni</i> (Day, 1867)	R	-	-	LC	
49	Cyprinodontiformes	Aplocheilidae	<i>Aplocheilus lineatus</i> (Valenciennes, 1846)	R	-	-	LC
50	Gobiiformes	Gobiidae	<i>Glossogobius giuris</i> (Hamilton, 1822)	C	-	-	LC
51	Osteoglossiformes	Notopteridae	<i>Notopterus synurus</i> (Bloch & Schneider, 1801)	C	-	-	LC
52	Perciformes	Ambassidae	<i>Chanda nama</i> Hamilton, 1822	M	-	-	LC
53			<i>Parambassis rango</i> (Hamilton, 1822)	M	-	-	LC

	Order	Family	Species	Status	WGE	KRE	IUCN Red List
54	Siluriformes	Ailiidae	<i>Proeutropichthys taakree</i> (Sykes, 1839)	M	-	-	LC
55		Bagridae	<i>Hemibagrus maydelli</i> (Rassell, 1964)	M	+	+	LC
56			<i>Mystus bleekeri</i> (Day, 1877)	M	-	-	LC
57			<i>Mystus malabaricus</i> (Jerdon, 1849)	M	+	-	NT
58			<i>Mystus seengtee</i> (Sykes, 1839)	M	+	-	LC
59			<i>Mystus vittatus</i> (Bloch, 1794)	R	-	-	LC
60			<i>Rita gagra</i> (Sykes, 1839)	M	+	-	LC
61			<i>Rita katurnee</i> (Sykes, 1839)	M	+	-	LC
62			<i>Sperata cf. aor</i> (Hamilton, 1822)	C	-	-	LC
63			<i>Sperata seenghala</i> (Sykes, 1839)	M	-	-	LC
64			Clariidae	<i>Clarias gariepinus</i> (Burchell, 1822)	C	-	-
65		Heteropneustidae	<i>Heteropneustes fossilis</i> (Bloch, 1794)	M	-	-	LC
66		Horabagridae	<i>Pachypterus khavalchor</i> (Kulkarni, 1952)	R	+	+	DD
67		Pangasiidae	<i>Pangasius pangasius</i> (Hamilton, 1822)	R	-	-	LC
68		Siluridae	<i>Ompok bimaculatus</i> (Bloch, 1794)	C	-	-	NT
69	Sisoridae	<i>Wallaga attu</i> (Bloch & Schneider, 1801)	R	-	-	NT	
70		<i>Glyptothorax cf. poonaensis</i> Hora, 1938	R	+	+	EN	
71		<i>Gagata itchkeea</i> (Sykes, 1839)	R	+	-	VU	
72	Synbranchiformes	Mastacembeiidae	<i>Macrogathus pancalis</i> (Hamilton, 1822)	M	-	-	LC
73			<i>Mastacembeius armatus</i> (Lacepede, 1800)	C	-	-	LC

A—Abundant | C—Common | M—Moderate | R—Rare | EN—Endangered | VU—Vulnerable | NT—Near Threatened | DD—Data Deficient | LC—Least Concern. Taxonomic status as per Fricke et al. (2020). Status for invasive alien species are not provided.

Cirrhinus mrigala, *Labeo rohita*, and *Labeo catla* may also be contributing to the population decline of *B. nukta* (Ghate et al. 2002; Kharat et al. 2003; Dahanukar et al. 2012). Similarly, *Hypselobarbus mussullah* assessed as 'Endangered' as per IUCN criteria (Dahanukar & Raghavan 2011) was collected in low numbers at Bahe. *Labeo potail*, a species that has been assessed as 'Endangered' due to population decline of 50–60 % in the last 10 years due to organic and inorganic pollution, exploitation and competition created by transplanted carps (Dahanukar 2011) was collected near Palus and Sangli. However, their numbers are declining rapidly due to pollution from domestic organic waste and effluents released heavily from industries situated on the river-bank. Another Krishna River endemic and threatened species, *Botia striata* (locally called 'waghmasa') (Image 3-22) was recorded from Bahe, Borgaon and Islampur. At Bahe and Borgaon, indiscriminate collection of this species by aquarium traders in the summer months is a major threat to the species. The species is however relatively abundant in the study area, and also in Koyna River (Jadhav et al. 2011).

Gagata itchkeea (Image 3-25) a species recorded previously from the Krishna River system (Kalwar & Kelkar 1956; Jayaram 1995; Kharat et al. 2003; Wagh & Ghate 2003; Chandanshive et al. 2007) was collected from Bahe in very low numbers. Other important endemic species such as *Garra bicornuta*, *Parapsilorhynchus discophorus*,

Pachypterus khavalchor were also collected from various sampling sites.

We recorded *Labeo kontius* (Image 1) for the first time from the Krishna River system in, Maharashtra State, through samples from Miraj, thus extending its range to the northern part of the Western Ghats. *Labeo kontius* was described by Jerdon (1849) from Cauvery River and its tributaries. Currently, the species is also known to occur in the Bhavani and Moyar rivers and their tributaries (Rajan 1955; Manimekalan 1998), as well as in the main stretch of the Cauvery River (Jayaram et al. 1982; Jayaram & Dhas 2000).

Krishna River harbours a rich diversity of endemic and threatened fishes of Western Ghats. However, this fauna is threatened due to overfishing, introduced species, sand mining and organic and inorganic pollution. If the present anthropogenic impact continues, this might lead to a drastic decline of habitats and populations of fish species available in this region. It is therefore essential to declare some stretch of rivers as aquatic sanctuaries, particularly near Bahe and Miraj for protection and preservation of endemic and threatened species and mitigation of anthropogenic stress.

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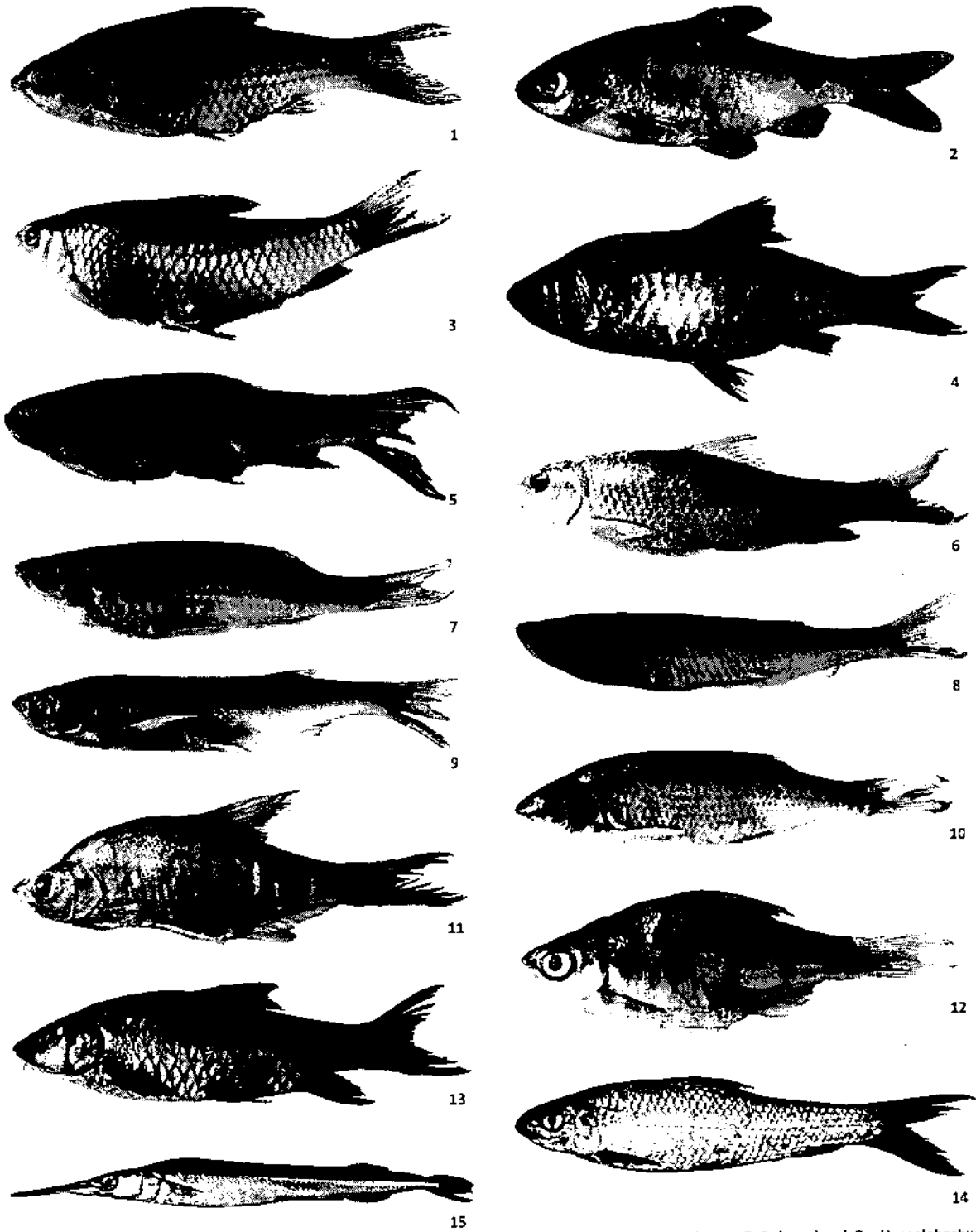


Image 2. 1—*Systomus sarana* (Hamilton) | 2—*Pethia sanjaimoluri* Katwate, Jadhav, Kumkar, Raghavan & Dahanukar | 3—*Hypselobarbus jerdoni* (Day) | 4—*Puntius chola* (Hamilton) | 5—*Bangana nukta* (Sykes) | 6—*Hypselobarbus kolus* (Sykes) | 7—*Devario aequipinnatus* (McClelland) | 8—*Salmostoma bacaila* (Hamilton) | 9—*Salmostoma navacula* (Valenciennes) | 10—*Opsarius bendelisis* (Hamilton) | 11—*Osteobrama vigersii* (Sykes) | 12—*Rohtee agilbii* (Sykes) | 13—*Hypselobarbus mussullah* (Sykes) | 14—*Gymnostomus ariza* (Hamilton) | 15—*Xenentodon cancila* (Hamilton).

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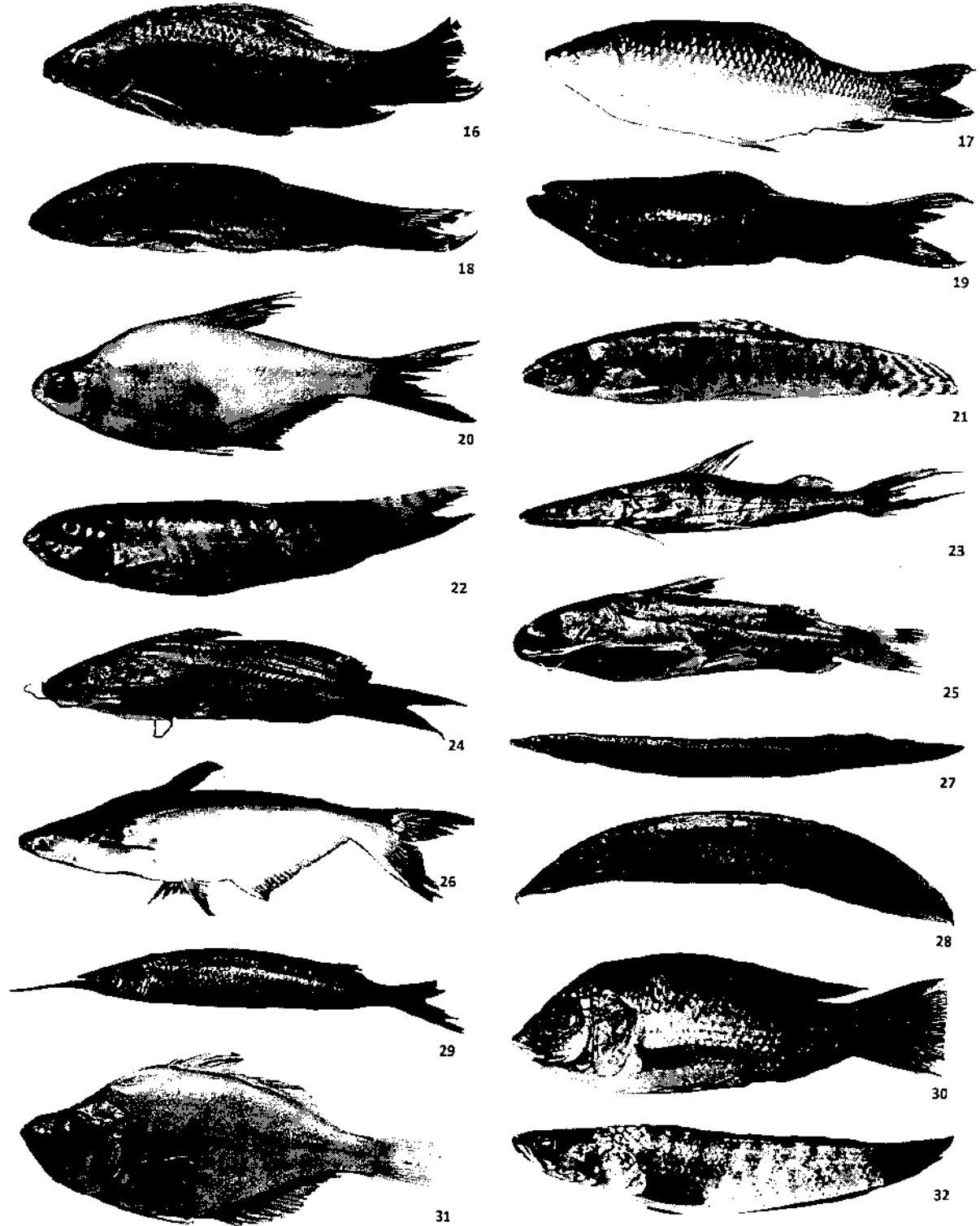


Image 3. 16—*Labeo fimbriatus* (Bloch) | 17—*Labeo rohita* (Hamilton) | 18—*Cirrhinus reba* (Hamilton) | 19—*Garra bicornuta* Rao | 20—*Osteobrama peninsularis* Silas | 21—*Paraanthocobitis mooreh* (Sykes) | 22—*Botta striata* Rao | 23—*Sperata seenghala* (Sykes) | 24—*Mystus vittatus* (Bloch) | 25—*Gogata itchkeea* (Sykes) | 26—*Pangasius pangasius* (Hamilton) | 27—*Mastacembelus armatus* (Lacepede) | 28—*Macrognathus pancalus* (Hamilton) | 29—*Hyporhamphus limbatus* (Valenciennes) | 30—*Oreochromis mossambicus* (Peters) | 31—*Parambassis ranga* (Hamilton) | 32—*Channa punctata* (Bloch).

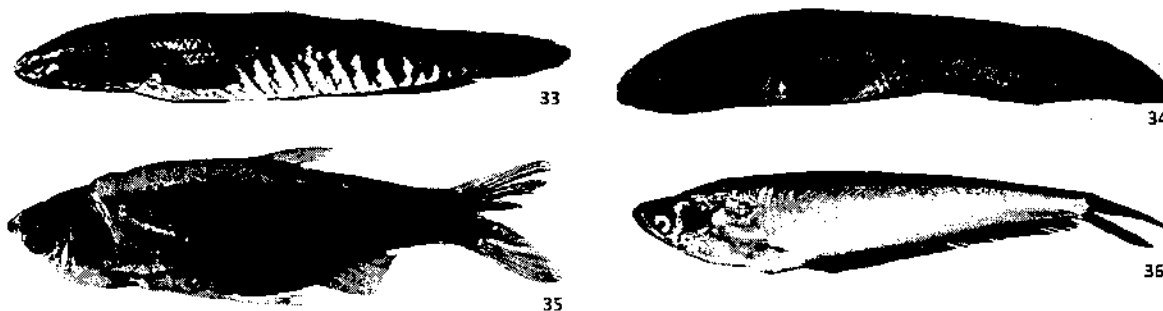


Image 4. 33—*Channa striata* (Bloch) | 34—*Channa gachua* (Hamilton) | 35—*Amblypharyngodon mola* (Hamilton) | 36—*Ompok bimaculatus* (Bloch).

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Occurrence of Growth Marks in the Phalanges of the Indian Black Rat, *Rattus Rattus* (Linnaeus, 1758)

Suresh M. Kumbhar

Department of Zoology, Arts, Commerce & Science College, Palus,
Dist. Sangli, - 416310, (Maharashtra)

ABSTRACT

Generally vertebrate age was determined by growth layers found in the cementum in the dentine. Age was determined for the first time by enumerating the number of growth marks present in the cross sections of phalanges of the Indian black rat (Rattusrattus) inhabiting southern India. Mid-diaphyseal sections of phalanges exhibited growth rings, each ring consisting of a broader growth zone and a chromophilic line of arrested growth (LAG). One to five growth marks were observed in specimens with different body sizes. There is a strong positive correlation between body size and LAGs, indicating that larger individuals have experienced greater number of growth cycles and hence may be older.

Key words: Rat, age, Skeletochronology, Tropics

Age composition study is one of the life history parameters needed to assess the dynamics of wild mammalian species populations (Klevezal, 1996). Different criteria have been practiced to estimate physiological age in some mammalian species such as, eye lens weight, degree of closure of cranial sutures; tooth wear and the number of corpora albicantia (Scheffer and Myrick, 1980). Majority of marine mammals' age has been determined on the basis of presence of growth

microtome (Model GE-70) and stained with Harris haematoxylin. The sections were observed under a compound microscope (Olympus CX-41) for the presence of growth rings, which were enumerated when present.

Results

The hematoxylin stained sections of the phalanges showed central bone marrow cavity surrounded by an inner narrow endosteal layer and outer relatively broad periosteal bone layer (Fig. 1A-D). In the periosteal layer a series of thin darkly stained chromophilic lines separated by wider light purple rings with sparsely distributed osteocytes were seen; the former were interpreted as lines of arrested growth (LAGs) and the latter as growth rings in the phalanges of *R. rattus*. One to four LAGs were equally distributed in the periosteal layer (Fig. 1B-D). Correlation coefficient analysis showed a positive correlation between body mass and body size ($r = 0.87$) as well as body size and the number of LAGs ($r = 0.70$).

Explanations to Figure

PLATE 1

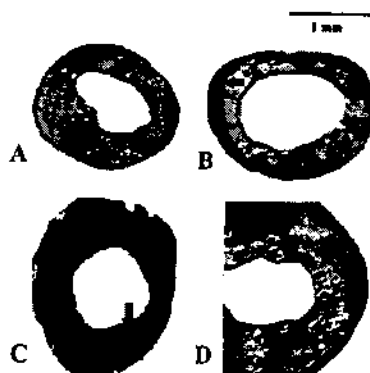


Fig. 1A - D: Mid-diaphyseal cross sections of right phalanges of *Rattusrattus* (Hematoxylin). A, Showing the absence of LAG in the rat with SVL 7.5 cm; B, one LAG in the phalange of rat with SVL 14 cm; C, two LAGs in the phalanges of rat with SVL 28.2 cm; D, four LAGs (arrows) in the rat with SVL 30.2 cm; Scale line = 100 Fm.

Abbreviations: MC = Marrow Cavity; PL = Periosteal Layer; Arrows = Lines of Arrested Growth (LAGs).

Discussion

Studies on age, longevity and reproduction of the wild mammals are most essential for knowing the population dynamics and their proper management in the field. Among the various techniques, the use of lines of arrested growth (LAGs), periodically laid down in teeth and skeletal tissues (long tubular bones) is one of the best ways to obtain the age of individuals. Experimental evidence indicates that the formation of growth marks in the teeth and skeletal tissues in the different regions is controlled by different physiological factors such as nutrition, breeding activity, intrinsic rhythms and photoperiod (Castanet *et al.*, 2004; Klevezal and Kleinenberg, 1969). In many tropical and temperate amphibians and reptiles, cyclical pattern of bone growth has been well established (Smirina, 1994; Pancharatna, 2002; Kumbar and Pancharatna, 2001b). Although, formation of bone growth marks in temperate species is a result of annual temperature fluctuations (Castanet and Smirina, 1990; Esteban *et al.*, 1996; Smirina, 1994), in tropics LAGs are laid down during rainy months that coincide with the breeding activity (Castanet and Smirina, 1990; Kumbar and Pancharatna, 2001a; Kumbar and Pancharatna, 2001b; Kumbar and Pancharatna, 2004). However, both male and female of this species are strictly seasonal breeders and show breeding activity for a greater part of the year from March to October with peaks during June to September (Chauhan and Saxena, 1985a & b). The results of the present study demonstrate that growth marks comparable to those found in amphibians and reptiles, are also detectable in the phalanges of Indian black rat, *R. rattus*. Although, environmental factors are believed to favour continuous growth, many rodents inhabiting the Indian peninsula exhibit marked seasonality in the gametogenetic, reproductive and breeding activity (Chauhan and Saxena, 1985a; Chauhan and Saxena 1985b; Vadell *et al.*, 2010), suggesting that the bone growth is a cyclical phenomenon leading to the formation of LAGs even in tropical species. Further, the positive correlation between body size vs LAGs in *R. rattus* indicate that larger individuals have experienced greater number of growth cycles and hence, may be older. Further, detailed study is essential to confirm whether the growth marks are formed annually or not and hence can

be used as 'year rings' for estimating age and longevity in tropical mammalian species.

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
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Biowaste-Derived Heterogeneous Catalyst for the One-Pot Multicomponent Synthesis of Diverse and Densely Functionalized 2-Amino-4*H*-Chromenes

U. P. Patil, Rupesh C. Patil & Suresh S. Patil



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
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Biowaste-Derived Heterogeneous Catalyst for the One-Pot Multicomponent Synthesis of Diverse and Densely Functionalized 2-Amino-4*H*-Chromenes

U. P. Patil^a, Rupesh C. Patil^b, and Suresh S. Patil^c

^aDepartment of Chemistry, ACS College, Palus, Sangli, affiliated to Shivaji University, Kolhapur, Maharashtra, India; ^bGreen Chemistry Research Laboratory, SMDBS College, Miraj, Sangli, affiliated to Shivaji University, Kolhapur, Maharashtra, India; ^cSynthetic Research Laboratory, PG Department of Chemistry, PDVP College, Tasgaon, Sangli, affiliated to Shivaji University, Kolhapur, Maharashtra, India


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Chromene skeletons are crucial structural motifs existing in abundant natural products and drug molecules.¹ These oxygen-containing heterocyclic compounds have a broad range of biological properties such as antimicrobial,² anti-HIV,³ anti-inflammatory,⁴ and cytotoxic activities.⁵ They are being investigated in neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, and Huntington's disease.^{6–8} Notably, several drug molecules possessing 4*H*-chromene moieties are currently in use for the treatment of such ailments as asthma, hypertension, ischemia and urinary incontinence.^{9–11}

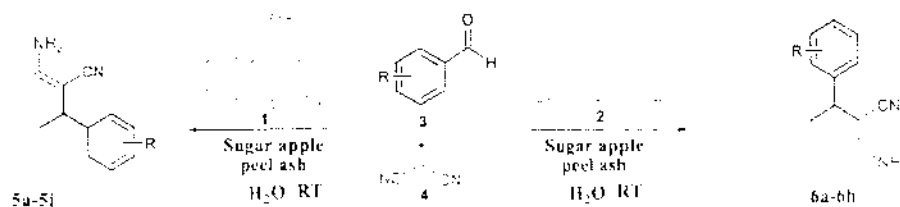
The synthesis of these O-heterocycles involves the three-component coupling of C-H activated acids with malononitrile and aromatic aldehydes in the presence of homogeneous and heterogeneous catalysts such as piperidine,¹² triethylamine,¹³ DBU,¹⁴ (NH₄)₂HPO₄,¹⁵ POPINO,¹⁶ piperazine,¹⁷ aqueous K₂CO₃,¹⁸ hydrotalcite (HT),¹⁹ TiO₂ nanowire,²⁰ MgO,²¹ mesolite,²² nanozeolite clinoptilolite,²³ trichloroisocyanuric acid²⁴ and 2-aminopyridine.²⁵ In no denial of fact, the reported methods are creditable; however, the implication of hazardous reagents and solvents, lengthy processes, energy investment for heating purposes and complications in the separation of products are realistic problems associated with these methods. Considering the diverse functionality of 2-amino-4*H*-chromenes, it was deemed worthwhile to explore a convenient protocol for the synthesis of these heterocycles.

Waste biomass has been increasingly targeted as a renewable feedstock for the production of high energy-density fuels, construction materials and, more recently, platform chemicals and high-value functional products. Using waste material to develop promising heterogeneous catalysts in addition to the target product makes the system more cost-effective and environmentally benign.^{26,27} The functionalized heterogeneous catalysts evaluated from waste biomass are mainly composed of metal oxides and possess high surface area and significant pore volume with high thermal stability.²⁸ The basic active sites of the heterogeneous ash catalyst may be responsible for the acceleration of the rate of reactions.

CONTACT U. P. Patil  uppatil4143@rediffmail.com  Department of Chemistry, ACS College, Palus-416310, Dist: Sangli, affiliated to Shivaji University Kolhapur-416004, Maharashtra, India

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Scheme 1. Sugar apple peel ash catalyzed one-pot three-component synthesis of 2-amino-4H-chromene derivatives.

Table 1. Screening of reaction conditions.^a

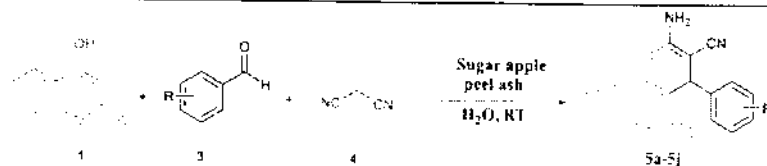
Entry	Catalyst	Solvent	Temp. (°C)	Time (min)	Yield ^b (%)
1	–	–	r.t.	120	–
2	–	–	100	120	–
3	–	Water	r.t.	120	Trace
4	–	Water	Reflux	120	35
5	Sugar apple peel ash (25 mg)	Water	r.t.	60	69
6	Sugar apple peel ash (50 mg)	Water	r.t.	60	81
7	Sugar apple peel ash (75 mg)	Water	r.t.	60	92
8	Sugar apple peel ash (100 mg)	Water	r.t.	60	92
9	Sugar apple peel ash (75 mg)	–	r.t.	60	Trace
10	Sugar apple peel ash (75 mg)	EtOH	r.t.	60	84
11	Sugar apple peel ash (75 mg)	MeOH	r.t.	60	69
12	Sugar apple peel ash (75 mg)	CH ₃ CN	r.t.	60	29

^aReaction conditions: 4-hydroxycoumarin 1 (1 mmol), 4-chlorobenzaldehyde 3 (1 mmol), malononitrile 4 (1.2 mmol), solvent (3 mL).

^bIsolated yield.

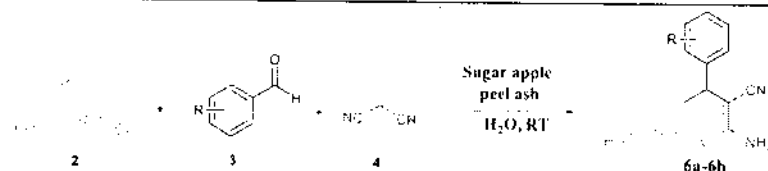
With our current interest in the application of waste biomass as a catalyst,²⁹ we turned our attention towards industrial waste fruit peels of sugar apple. We believed that sugar apple peel ash could be a promising catalyst for the synthesis of 2-amino-4H-chromenes. The sugar apple (*Annona squamosa*) species are distributed in the US, Brazil, Mexico, Jamaica, Australia, Hawaii, India, Egypt, Africa, the Philippines, and many other countries.³⁰ The fruit processing industries produce a large amount of bio-waste, which is dumped near the production site, incinerated or burned, and that can cause environmental pollution. Continuing our research with the aim to develop environmentally benign synthetic routes,^{31,32} we used this bio-waste material as a catalyst for the one-pot three-component synthesis of highly functional 2-amino-4H-chromenes in water at room temperature (Scheme 1). To our knowledge, this would be the first report for the synthesis of these bioactive heterocycles employing sugar apple peel ash as a catalyst in water without an external base, hazardous reagents, or organic solvents.

Initially, to examine the catalytic efficiency of the sugar apple peel ash and for the optimization of the reaction conditions, we carried out a series of trial reactions using 4-hydroxycoumarin 1 (1 mmol), 4-chlorobenzaldehyde 3 (1 mmol), and malononitrile 4 (1.2 mmol). In the absence of the catalyst, under various reaction conditions, the desired product was formed in low amounts at best (Table 1, entries 1-4). For further investigation, we introduced the catalyst, and the model reaction was carried out in water at room temperature. Surprisingly, a moderate amount of the desired product was detected. Excited by the result, we used variable amounts of the catalyst, and the reaction was performed in water at room temperature. From these preliminary exercises,

Table 2. Synthesis of 2-amino-4*H*,5*H*-pyrano[3,2-*c*]chromene derivatives.^a

5a, R = Ph (75 min. 89 %); 5b, R = 3-NO₂Ph (90 min. 86 %); 5c, R = 4-OHPh (95 min. 83 %); 5d, R = 4-OMePh (80 min. 83 %); 5e, R = 2-NO₂Ph (90 min. 84 %); 5f, R = 4-NO₂Ph (85 min. 86 %); 5g, R = 4-ClPh (60 min. 92 %); 5h, R = 2-OHPh (95 min. 81 %); 5i, R = 2-ClPh (60 min. 89 %); 5j, R = 4-FPh (65 min. 88 %).

^aReaction conditions: 4-hydroxycoumarin 1 (1 mmol), aromatic aldehydes 3 (1 mmol), malononitrile 4 (1.2 mmol), water (3 mL), sugar apple peel ash catalyst (75 mg).

Table 3. Synthesis of 2-amino-4*H*-chromene derivatives.^a

6a, R = Ph (20 min. 89 %); 6b, R = 3-NO₂Ph (35 min. 85 %); 6c, R = 4-OHPh (45 min. 84 %); 6d, R = furan-2-yl (50 min. 85 %); 6e, R = 3-ClPh (20 min. 90 %); 6f, R = 4-FPh (25 min. 89 %); 6g, R = 4-ClPh (20 min. 91 %); 6h, R = 4-OMePh (35 min. 86 %).

^aReaction conditions: resorcinol 2 (1 mmol), aromatic aldehydes 3 (1 mmol), malononitrile 4 (1.2 mmol), water (3 mL), sugar apple peel ash catalyst (75 mg).

75 mg of the ash catalyst in water (3 mL) at room temperature came out as optimal for the reaction in terms of yield and time (Table 1, entry 7) for the desired product 5g (92%). In the presence of the catalyst, under solvent-free conditions, the model reaction gave only a trace yield of the product. Solvent effects were then explored; compared to other industrial solvents, ethanol afforded a good yield (Table 1, entry 10).

For comparative study, the model reaction was carried out using other biowaste-derived catalysts such as banana peel ash, papaya tree bark ash, and bael fruit rind ash. The yields obtained were 87%, 84%, and 59%, respectively. The model reaction was also performed using base catalysts such as K₂CO₃, CaO, Na₂CO₃, and CaCO₃, which gave the desired product in 67%, 57%, 48%, and 31% yields, respectively. Comparatively, in terms of the yield and time, sugar apple peel ash was found to be a promising catalyst for efficient synthesis of 2-amino-4*H*-chromenes.

For the investigation of the scope and generality of the protocol, the reaction of 4-hydroxycoumarin 1 with aromatic aldehydes 3 and malononitrile 4 was performed under optimized reaction conditions (Table 2). Yields were uniformly very good to excellent for aldehydes with electron-withdrawing or electron-donating substituents.

Further, to expand the applicability of the catalyst to the other reactions of these categories, a series of 2-amino-4*H*-chromene derivatives (6a-6h) were prepared using resorcinol 2, aromatic aldehydes 3, and malononitrile 4 under optimized reaction conditions (Table 3). Resorcinol reacted at position-6, probably because of the steric hindrance between hydroxyl groups.

Fortunately, all the reactions described for the synthesis of 2-amino-4*H*-chromenes were straightforward single-pot three-component reactions, and the desired products (5a-5j), and 6a-6h) precipitated out from the reaction mixture without any undesired

able products. The crude products were recrystallized from ethanol without chromatographic separation.

From the viewpoint of green chemistry, it is crucial to examine the reusability of the ash catalyst. After the first run, the ash catalyst was separated from the reaction mixture of 4-hydroxycoumarin **1**, 4-chlorobenzaldehyde **3** and malononitrile **4** by filtration. It was washed with hot ethanol and dried at 70 °C for one hour. The recovered catalyst could be reused at least five times with only a slight reduction in the catalytic activity. The yield of **5g** in five consecutive cycles was 92, 90, 88, 87, and 85% respectively.

In summary, we have developed a novel, practical approach for the synthesis of bio-active 2-amino-4H-chromene derivatives using cost-free, innocuous, biowaste-derived sugar apple peel ash as a heterogeneous catalyst. In view of the current high prices of reagents and organic solvents and their environmental impact, the unprecedented activity of this ash catalyst makes the process described here more economical and an attractive alternative to conventional methods.

Experimental section

The waste peels of sugar apple (*Annona squamosa L.*) were collected from the industrial area of Aask Food Products, Tasgaon, M.S., India. The collected peels were washed with distilled water, dried in the sun, cut into small pieces, and completely burnt in the open air. The obtained ash was ground to fine powder, and it was used as a catalyst. Dry peels calcined (400 °C) in a muffle furnace exhibited almost the same catalytic activity. The catalyst was characterized by FT-IR, XRD, SEM, EDS, BET technique, XRF, ICP-AES, and DSC-TGA and the surface basic strength was determined by the Hammett indicator test.³⁵ These analytical tools prominently highlighted the presence of basic active sites in the catalyst. The characterization data were submitted for editorial review. They are available from the corresponding author upon request. All essential reagents were purchased from Sigma-Aldrich and used as received without further purification. FT-IR spectra were recorded on a Bruker (Alpha 100508, USA) instrument and wavenumbers were reported in cm^{-1} . ^1H and ^{13}C NMR spectra of compounds were recorded on an AVANCE-300 spectrometer (Bruker, USA). Chemical shifts (δ) are given in parts per million (ppm) using the residue solvent peaks as references relative to TMS. Pre-coated plates of silica gel 60 F254 were used for thin-layer chromatography (TLC).

General procedure for the synthesis of 2-amino-4H-chromene derivatives

In a 25 mL round bottom flask, a mixture of C-H activated acid (1 mmol), aromatic aldehyde (1 mmol), malononitrile (1.2 mmol), and sugar apple peel ash (75 mg) in water (3 mL) was stirred at room temperature. After completion of the reaction, as evident by TLC (n-hexane:ethyl acetate, 4:1), the reaction mixture was filtered. The residual mass was mixed with hot ethanol; and, to recover the catalyst, the reaction mixture was filtered. Then, the isolated reaction mixture was cooled to room temperature. After precipitation of the crude product, it was filtered. The crude product was then recrystallized from ethanol to get the analytical sample.

2-Amino-5-oxo-4-phenyl-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5a)

Mp 257 °C, lit mp 258-259 °C; ¹² FT-IR (cm⁻¹): 3492, 3154, 2224, 1679, 1391, 1286; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.90 (d, 1H, *J* = 7.6 Hz), 7.69 (t, 1H, *J* = 7.5 Hz), 7.39 (m, 4H), 7.25 (m, 5H), 4.43 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 159.49, 157.94, 153.38, 152.10, 143.29, 132.89, 128.47, 127.58, 127.07, 124.63, 122.43, 119.17, 116.53, 112.93, 103.93, 57.96, 36.93; MS: *m/z* 316.0848 (100.0%); found: 316.1168.

Anal. Calcd for C₁₉H₁₂N₂O₃: C, 72.15; H, 3.82; N, 8.86. Found: C, 72.16; H, 3.81; N, 8.85.

2-Amino-4-(3-nitrophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5b)

Mp 259 °C, lit mp 260-262 °C; ¹² FT-IR (cm⁻¹): 3502, 3164, 2226, 1669, 1345, 1278; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 8.12 (d, 2H, *J* = 7.6 Hz), 7.54 (m, 8H), 4.71 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 159.56, 158.13, 153.85, 152.24, 147.82, 145.45, 134.73, 133.06, 130.02, 124.65, 122.56, 122.42, 122.23, 118.91, 116.55, 112.91, 102.84, 56.93, 39.59; MS: *m/z* 361.0699 (100.0%); found: 362.0754.

Anal. Calcd for C₁₉H₁₁N₃O₅: C, 63.16; H, 3.07; N, 11.63. Found: C, 63.17; H, 3.08; N, 11.65.

2-Amino-4-(4-hydroxyphenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5c)

Mp 259 °C, lit mp 260-263 °C; ¹² FT-IR (cm⁻¹): 3380, 3150, 2243, 1642, 1321, 1211, 734; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.33 (s, 1H), 7.88 (d, 1H, *J* = 8.7 Hz), 7.69 (t, 1H, *J* = 8.2 Hz), 7.45 (m, 2H), 7.32 (s, 2H), 7.01 (d, 2H, *J* = 8.3 Hz), 6.68 (d, 2H, *J* = 8.3 Hz), 4.31 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 159.89, 159.54, 157.49, 154.78, 151.66, 134.42, 129.63, 129.09, 127.41, 124.12, 122.89, 118.31, 115.41, 114.91, 114.74, 114.42, 104.22, 55.41, 35.17; MS: *m/z* 332.0797 (100.0%); found: 332.4952.

Anal. Calcd for C₁₉H₁₃N₂O₄: C, 68.67; H, 3.64; N, 8.43. Found: C, 68.64; H, 3.65; N, 8.41.

2-Amino-4-(4-methoxyphenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5d)

Mp 234 °C, lit mp 235-237 °C; ¹² FT-IR (cm⁻¹): 3362, 3286, 3176, 2185, 1664, 1598, 1377, 1246, 1170, 836, 750; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.86 (d, 1H, *J* = 7.3 Hz), 7.69 (t, 1H, *J* = 7.0 Hz), 7.35 (m, 4H), 7.14 (d, 2H, *J* = 7.4 Hz), 6.86 (d, 2H), 4.38 (s, 1H), 3.33 (s, 3H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.07, 159.89, 159.42, 156.52, 151.78, 135.43, 129.31, 129.09, 127.53, 122.32, 118.81, 115.67, 114.91, 114.32, 104.22, 57.59, 54.24, 36.04; MS: *m/z* 346.0954 (100.0%); found: 346.2762.

Anal. Calcd for C₂₀H₁₄N₂O₄: C, 69.36; H, 4.07; N, 8.09. Found: C, 69.34; H, 4.05; N, 8.07.

2-Amino-4-(2-nitrophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5e)

Mp 254 °C, lit mp 255-257 °C;³³ FT-IR (cm⁻¹): 3386, 3293, 3179, 2186, 1664, 1521, 1373, 1258, 859, 748; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.90 (d, 2H, *J* = 8.2 Hz), 7.55 (m, 8H), 5.23 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.61, 160.34, 159.23, 152.22, 147.43, 134.16, 130.67, 129.77, 128.61, 126.71, 125.45, 124.50, 123.42, 119.25, 116.31, 115.55, 105.51, 58.43, 33.51; MS: *m/z* 361.0699 (100.0%); found: 361.1275.

Anal. Calcd for C₁₉H₁₁N₃O₅: C, 63.16; H, 3.07; N, 11.63. Found: C, 63.17; H, 3.08; N, 11.65.

2-Amino-4-(4-nitrophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5f)

Mp 255 °C, lit mp 255-257 °C;¹² FT-IR (cm⁻¹): 3456, 3102, 2234, 1702, 1654, 1321, 1289, 822, 716; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 8.18 (d, 2H, *J* = 8.4 Hz), 7.91 (d, 1H, *J* = 8.6 Hz), 7.72 (t, 1H, *J* = 7.7 Hz), 7.54 (m, 6H), 4.66 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.51, 160.45, 160.12, 153.21, 152.34, 146.81, 130.02, 128.95, 128.67, 126.34, 125.56, 124.41, 123.20, 119.91, 116.53, 115.90, 106.82, 58.91, 36.35; MS: *m/z* 361.0699 (100.0%); found: 361.1189.

Anal. Calcd for C₁₉H₁₁N₃O₅: C, 63.16; H, 3.07; N, 11.63. Found: C, 63.14; H, 3.09; N, 11.64.

2-Amino-4-(4-chlorophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5g)

Mp 264 °C, lit mp 263-265 °C;¹³ FT-IR (cm⁻¹): 3409, 3161, 2227, 1728, 1669, 1317, 1259, 824, 766; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.87 (d, 1H, *J* = 8.6 Hz), 7.69 (t, 1H, *J* = 7.2 Hz), 7.44 (m, 4H), 7.34 (m, 4H), 4.47 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 159.48, 157.94, 153.51, 152.14, 142.28, 132.94, 131.67, 129.60, 128.39, 124.62, 122.47, 119.04, 116.52, 112.90, 103.45, 57.51, 39.50; MS: *m/z* 350.0458 (100.0%); found: 350.1274.

Anal. Calcd for C₁₉H₁₁ClN₂O₃: C, 65.06; H, 3.16; N, 7.99. Found: C, 65.09; H, 3.11; N, 7.95.

2-Amino-4-(2-hydroxyphenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5h)

Mp 272 °C, lit mp 271-273 °C;³⁴ FT-IR (cm⁻¹): 3456, 3255, 2885, 2193, 1670, 1576, 1397, 1215, 860, 746; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 11.88 (s, 1H), 8.02 (d, 1H), 7.60 (t, 1H, *J* = 7.2 Hz), 7.35 (d, 2H, *J* = 7.2 Hz), 7.18 (s, 1H), 7.01 (t, 3H, *J* = 7.4 Hz), 6.78 (s, 2H), 5.31 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 162.12, 160.23, 159.24, 157.22, 153.45, 130.09, 128.96, 127.98, 126.23, 123.45, 122.91, 121.78, 116.38, 115.96, 114.78, 106.23, 58.72, 32.12; MS: *m/z* 332.0797 (100.0%); found: 332.1856.

Anal. Calcd for C₁₉H₁₂N₂O₄: C, 68.67; H, 3.64; N, 8.43. Found: C, 68.62; H, 3.61; N, 8.40.

2-Amino-4-(2-chlorophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5i)

Mp 275 °C, lit mp 275-277 °C;¹² FT-IR (cm⁻¹): 3490, 3187, 2232, 1781, 1640, 1340, 1234, 834, 751; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.90-7.87 (q, 1H *J* = 8.2 Hz), 7.72-7.66 (m, 1H), 7.50-7.41 (m, 4H), 7.33-7.28 (m, 2H), 7.14 (s, 2H), 4.47 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.68, 159.91, 159.35, 152.42, 143.76, 132.34, 128.93, 128.65, 127.44, 126.89, 126.34, 125.33, 124.09, 119.86, 116.76, 115.07, 106.21, 58.91, 33.78; MS: *m/z* 350.0458 (100.0%); found: 350.0719.

Anal. Calcd for C₁₉H₁₁ClN₂O₃: C, 65.06; H, 3.16; N, 7.99. Found: C, 65.07; H, 3.14; N, 7.99.

2-Amino-4-(4-fluorophenyl)-5-oxo-4H,5H-pyrano[3,2-c]chromene-3-carbonitrile (5j)

Mp 258 °C, lit mp 256-258 °C;¹² FT-IR (cm⁻¹): 3321, 3082, 2201, 1745, 1658, 1365, 1211, 845, 730; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 7.91 (d, 1H *J* = 7.6 Hz), 7.73-7.68 (t, 1H *J* = 7.5 Hz), 7.51-7.38 (m, 5H), 7.32-7.22 (m, 3H), 4.92 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.22, 160.12, 159.87 (d, *J* = 272.5 Hz, C-F), 159.46 (d, *J* = 6.8 Hz, C-F), 153.01, 139.93, 129.34 (d, *J* = 8.2 Hz, C-F), 128.38, 125.72, 123.51, 119.41, 116.72, 115.98 (d, *J* = 21.7 Hz, C-F), 115.78 (d, *J* = 21.7 Hz, C-F), 112.35, 105.69, 59.11, 33.76; MS: *m/z* 334.0754 (100.0%); found: 335.1341.

Anal. Calcd for C₁₉H₁₁FN₂O₃: C, 68.26; H, 3.32; N, 8.38. Found: C, 68.25; H, 3.30; N, 8.37.

2-Amino-7-hydroxy-4-phenyl-4H-chromene-3-carbonitrile (6a)

Mp 233 °C, lit mp 234-236 °C;¹⁹ FT-IR (cm⁻¹): 3471, 3328, 3210, 2971, 2190, 1642, 1506, 1399, 1144, 847, 752; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.69 (s, 1H), 7.30 (t, 2H, *J* = 7.1 Hz), 7.17 (m, 3H), 6.87 (s, 2H), 6.49 (d, 1H, *J* = 7.6 Hz), 6.47 (d, 1H, *J* = 7.2 Hz), 6.41 (s, 1H), 4.61 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.29, 157.12, 148.90, 146.38, 129.95, 128.61, 127.40, 126.66, 120.71, 113.76, 112.43, 102.23, 56.36; MS: *m/z* 264.0899 (100.0%); found: 265.1308.

Anal. Calcd for C₁₆H₁₂N₂O₂: C, 72.72; H, 4.58; N, 10.60. Found: C, 72.71; H, 4.55; N, 10.57.

2-Amino-7-hydroxy-4-(3-nitrophenyl)-4H-chromene-3-carbonitrile (6b)

Mp 188 °C, lit mp 188-190 °C;¹⁹ FT-IR (cm⁻¹): 3476, 3391, 3254, 2986, 2192, 1677, 1567, 1450, 1389, 1167, 878, 734; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.77 (1H), 8.02 (t, 2H, *J* = 7.6 Hz), 7.64 (d, 2H, *J* = 7.3 Hz), 7.01 (s, 2H), 6.84 (d, 1H, *J* = 8.4 Hz), 6.45 (t, 2H, *J* = 8.2 Hz), 4.90 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.51, 157.50, 148.94, 148.58, 147.97, 134.30, 130.32, 129.98, 121.85, 121.77, 120.38, 112.70, 112.55, 102.42, 56.07; MS: *m/z* 309.0750 (100.0%); found: 309.9762.

Anal. Calcd for C₁₆H₁₁N₃O₄: C, 62.14; H, 3.59; N, 13.59. Found: C, 62.12; H, 3.55; N, 13.57.

2-Amino-7-hydroxy-4-(4-hydroxyphenyl)-4H-chromene-3-carbonitrile (6c)

Mp 242 °C, lit mp 248-250 °C;¹⁹ FT-IR (cm⁻¹): 3492, 3347, 2968, 2197, 1643, 1506, 1356, 1267, 816, 735; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.63 (s, 1H), 9.26 (s, 1H), 6.92 (d, 2H, *J* = 8.1 Hz), 6.77 (m, 3H), 6.67 (d, 2H, *J* = 8.4 Hz), 6.46 (d, 1H, *J* = 8.3 Hz), 6.44 (d, 1H, *J* = 7.6 Hz), 4.47 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.02, 156.85, 156.01, 148.74, 136.77, 129.86, 128.33, 120.73, 115.20, 114.30, 112.25, 102.05, 56.79; MS: *m/z* 280.0848 (100.0%); found: 281.0158.

Anal. Calcd for C₁₆H₁₂N₂O₃: C, 68.56; H, 4.32; N, 9.99. Found: C, 68.54; H, 4.30; N, 9.99.

2-Amino-4-(furan-2-yl)-7-hydroxy-4H-chromene-3-carbonitrile (6d)

Mp 209 °C, lit mp 185-187 °C;¹⁶ FT-IR (cm⁻¹): 3471, 3328, 3210, 2968, 2191, 1647, 1406, 1329, 1294, 855, 763; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.72 (s, 1H), 7.49 (s, 1H), 6.92 (d, 3H, *J* = 7.4 Hz), 6.59 (d, 1H, *J* = 7.6 Hz), 6.38 (d, 2H, *J* = 8.4 Hz), 6.12 (s, 1H), 4.74 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.06, 154.11, 153.98, 148.34, 135.67, 129.03, 128.12, 119.44, 114.65, 108.23, 102.43, 56.21; MS: *m/z* 254.0691 (100.0%); found: 255.0142.

Anal. Calcd for C₁₄H₁₀N₂O₃: C, 66.14; H, 3.96; N, 11.02. Found: C, 66.10; H, 3.93; N, 11.01.

2-Amino-7-hydroxy-4-(3-chlorophenyl)-4H-chromene-3-carbonitrile (6e)

Mp 162 °C, lit mp 176-178 °C;¹⁹ FT-IR (cm⁻¹): 3394, 3208, 2968, 2192, 1642, 1504, 1367, 1150, 850, 728; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.73 (s, 1H), 7.35 (m, 2H), 7.29 (m, 1H), 7.15 (d, 1H, *J* = 7.4 Hz), 6.95 (s, 2H), 6.84 (d, 1H, *J* = 8.4 Hz), 6.52 (d, 1H, *J* = 8.3 Hz), 6.42 (d, 1H, *J* = 8.2 Hz), 4.69 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.56, 157.67, 149.32, 133.78, 131.89, 130.09, 127.45, 126.81, 120.89, 113.09, 102.45, 62.34; MS: *m/z* 298.0509 (100.0%); found: 299.0912.

Anal. Calcd for C₁₆H₁₁ClN₂O₂: C, 64.33; H, 3.71; N, 9.38. Found: C, 64.31; H, 3.69; N, 9.35.

2-Amino-7-hydroxy-4-(4-fluorophenyl)-4H-chromene-3-carbonitrile (6f)

Mp 186 °C, lit mp 186-188 °C;¹⁹ FT-IR (cm⁻¹): 3394, 3328, 2965, 2189, 1642, 1501, 1368, 1147, 856, 777; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.70 (s, 1H), 7.11 (m, 4H), 6.87 (s, 2H), 6.75 (d, 1H, *J* = 8.6 Hz), 6.48 (d, 1H, *J* = 8.4 Hz), 6.39 (s, 1H), 4.64 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.54 (d, *J* = 232.0 Hz, C-F), 157.09, 149.28, 142.11, 129.61 (d, *J* = 7.6 Hz, C-F), 129.55 (d, *J* = 7.6 Hz, C-F), 120.78, 115.89 (d, *J* = 24.2 Hz, C-F), 115.45 (d, *J* = 24.2 Hz, C-F), 113.12, 112.43, 102.22, 56.91; MS: *m/z* 282.0805 (100.0%); found: 283.0741.

Anal. Calcd for C₁₆H₁₁FN₂O₂: C, 68.08; H, 3.93; N, 9.92. Found: C, 68.06; H, 3.90; N, 9.90.

2-Amino-7-hydroxy-4-(4-chlorophenyl)-4H-chromene-3-carbonitrile (6g)

Mp 160 °C, lit mp 159-161 °C;¹⁹ FT-IR (cm⁻¹): 3501, 3412, 2991, 2196, 1644, 1543, 1489, 1191, 1135, 825, 731; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.76 (s, 1H), 7.34 (d, 2H, J = 7.4 Hz), 7.19 (d, 2H, J = 8.2 Hz), 6.91 (s, 2H), 6.78 (d, 1H, J = 7.4 Hz), 6.51 (d, 1H, J = 8.2 Hz), 6.43 (s, 1H), 4.71 (s, 1H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 160.67, 157.56, 149.22, 144.99, 131.42, 130.67, 129.88, 129.68, 121.33, 113.90, 113.09, 102.66, 56.29; MS: m/z 298.0509 (100.0%); found: 299.0783.

Anal. Calcd for C₁₆H₁₁ClN₂O₂: C, 64.33; H, 3.71; N, 9.38. Found: C, 64.30; H, 3.70; N, 9.37.

2-Amino-7-hydroxy-4-(4-methoxyphenyl)-4H-chromene-3-carbonitrile (6h)

Mp 111 °C, lit mp 112-114 °C;¹⁹ FT-IR (cm⁻¹): 3454, 3387, 2945, 2206, 1679, 1520, 1132, 1268, 1227, 832, 734; ¹H NMR (300 MHz, DMSO-d₆): δ (ppm) 9.74 (s, 1H), 7.04 (m, 4H), 6.92 (s, 2H), 6.67 (d, 2H, J = 8.1 Hz), 6.41 (d, 1H, J = 8.2 Hz), 4.78 (s, 1H), 3.82 (s, 3H); ¹³C-NMR (75.46 MHz, DMSO-d₆): δ (ppm) 161.02, 157.32, 153.45, 151.78, 149.12, 134.89, 130.02, 121.22, 115.52, 114.11, 113.21, 112.42, 112.11, 102.31, 68.09, 56.17; MS: m/z 294.1004 (100.0%); found: 295.0157.

Anal. Calcd for C₁₇H₁₄N₂O₃: C, 69.38; H, 4.79; N, 9.52. Found: C, 69.37; H, 4.75; N, 9.51.

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ORCID

U. P. Patil <http://orcid.org/0000-0001-6519-2494>

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A synergetic role of *Aegle marmelos* fruit ash in the synthesis of biscoumarins and 2-amino-4*H*-chromenes

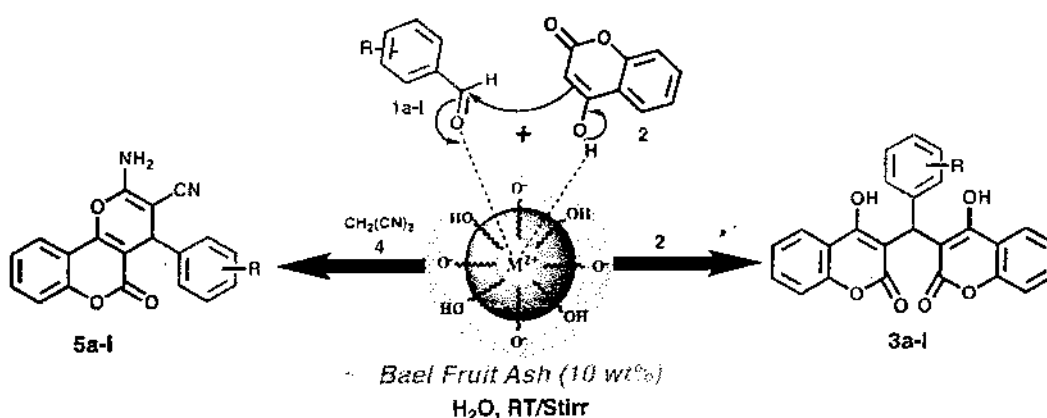
Rupesh C. Patil, et al. [full author details at the end of the article]

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Abstract

A dry rind of *Aegle marmelos* (bael) fruit ash as a synergetic alternative material to an expensive, toxic and corrosive catalysts for the synthesis of biscoumarins and 2-amino-4*H*-chromenes at ambient temperature in water is reported. The spectroscopic evidence from EDX, FTIR, XRD and SEM analysis of bael fruit ash supports the presence of metal oxides, carbonates and hydroxides which are intensely responsible for the acceleration of the reactions. The striking features of this protocol are utilization of bio-waste, cost-effective, recyclable and biodegradable catalytic system, which provide good to excellent yields in a short reaction time.

Graphic abstract



Keywords Bio-waste · Bael fruit · Natural catalyst · Biscoumarins · 2-Amino-4*H*-chromenes

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Introduction

One-pot multi-component reaction strategies offer eco-friendly and significant advantages over conventional linear-type syntheses by virtue of their convergence, productivity, reduction in work-up and purification steps, facile execution and high yield [1]. Because of these versatile advantages, recently, multi-component reactions have been widely used in the field of organic, medicinal and combinatorial chemistry.

The attractive features of 4*H*-chromenes motivated scientific community to design and develop natural product-derived analog of alkaloids, for example, Arisugacin A [2], Ophioglonin [3] and Hyperxanthone [4]. Similarly, some biscoumarin moieties have been found in nature including Bisosthenon (*Citrus funadocao*), Ismailin (*Diospyros ismaili*), Dicoumarol (*Melilotus alba*) and Gerberinol (*Gerbera lanuginose*) as shown in Fig. 1 [5].

Nowadays, the development of biscoumarins has received significant attention because they have potent biological [6, 7] and many pharmacological activities, such as antitumor [8], antioxidant [9], anti-inflammatory [10], cytotoxicity [11], anticancer [12], antiviral [13], antipyretic [14] and antimicrobial [15] properties. Some of the applied methodologies with the use of various catalysts such as water extract of waste onion peel ash [16], FeNi₃-ILs [17], CuO–CeO₂ [18], DBSA [19], molecular iodine [20], Zn(proline)₂ [21], sodium dodecyl sulfate [22], W-doped ZnO nanocomposite [23], DBU [24], [bmim][BF₄] [25], ruthenium(III) chloride hydrate [26], SiO₂Cl [27], TBAB [28] and Fe(SD)₃ [29, 30] have been reported.

2-Amino-4*H*-chromenes and their derivatives exhibit a broad spectrum of biological and pharmaceutical activities such as antioxidant [31], anticancer [32], anti-HIV [33], anti-dyslipidemic [34], anti-hyperglycemic [35], xanthine oxidase inhibitory [36], antimicrobial [37], antiallergic [38], acetylcholinesterase, butyrylcholinesterase inhibitory [39] and Src kinase inhibitory activities [40]. For the synthesis of 2-amino-4*H*-chromenes from aryl aldehydes, 4-hydroxycoumarin and malononitrile with various catalysts such as polymer-supported sulfanilic acid [41], sodium dodecyl sulfate [42], ionic liquid [43], Fe₃O₄@SiO₂-imid-PMAN [44], ammonium

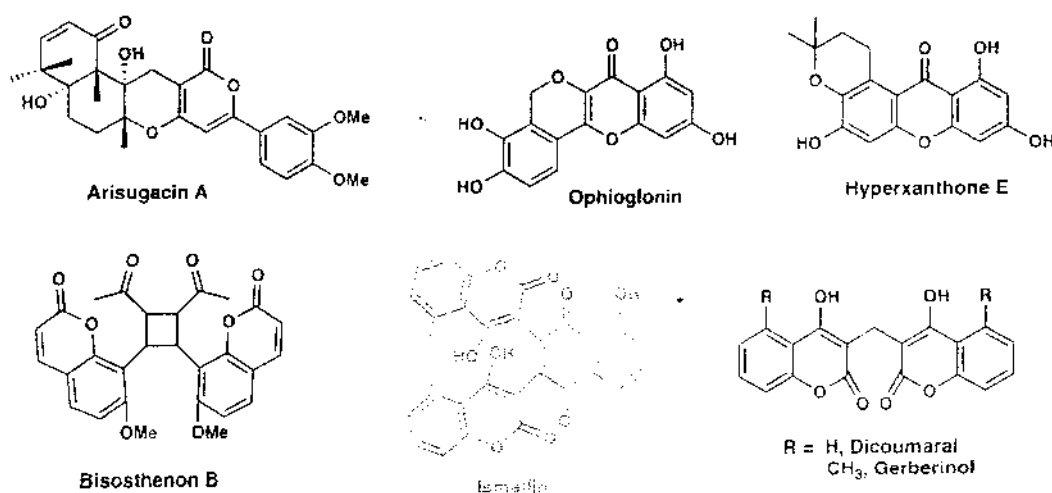


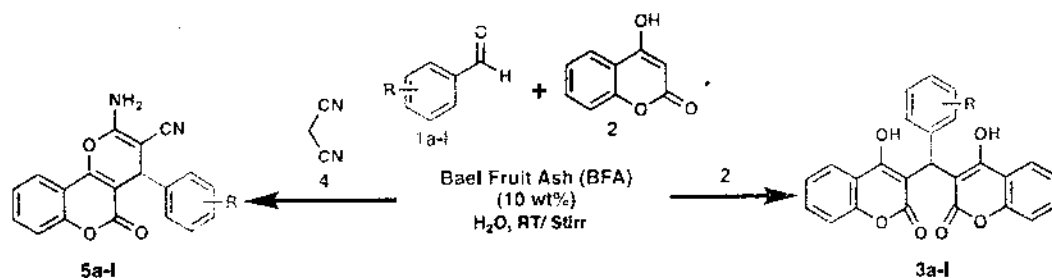
Fig. 1 Naturally found some bioactive compounds bearing 4*H*-chromenes scaffolds and biscoumarins

metavanadate [45], DBU [46], TBAB [47], $N(\text{Et})_3$ [48], MgO [49], starch [50], aqueous K_2CO_3 [51], $\text{H}_6\text{P}_2\text{W}_{18}\text{O}_{62}\cdot 18\text{H}_2\text{O}$ [52] and piperidine [53] have been used.

Water is the universal solvent that plays a significant role in all chemical reactions of life [54, 55]. Water as a reaction media came from the studies on 'Hydrophobic effects on simple organic reactions in the water' by Ronald Breslow in the 1980s [56]. Recently, Sharpless and co-workers have defined 'on water' conditions using water as a solvent for the reaction of water-insoluble reactants without the use of organic cosolvent [57]. Another study done by Engberts has shown that the Diels–Alder cycloaddition reaction accelerated very rapidly in water [58]. Notably, the use of water as a solvent has attracted much interest in recent years. Indeed, water offers many advantages because it is a cheap, readily available, non-toxic and nonflammable solvent, thus being very attractive from both an economic and environmental point of view [59].

Sustainability is a broad discipline which has become a watchword and guiding principle for modern society, and a growing appreciation is that the anthropogenic 'bio-waste,' in all its manifold forms can offer a valuable source of energy, chemicals, construction materials and high-value functional products. In the context of organic transformations, the waste material provides an alternative renewable natural feedstock as well as a good resource to create catalysts. The catalytic system developed from waste material serves to improve the overall energy and atom efficiency of existing as well as novel chemical processes [60].

In view of these data and in continuation of our research program concerning the development of catalyst from natural feedstock [61–64], herein, we report first time bio-waste-derived rind of bael fruit ash (BFA) as a green catalyst for the facile synthesis of biscoumarins and 2-amino-4*H*-chromenes using aryl aldehyde, 4-hydroxycoumarin and malononitrile via a tandem Knoevenagel–Michael reaction under aqueous medium (Scheme 1). Bael (*Aegle marmelos*) is a sacred tree of the Hindus, origin from India and known from ancient times. It is found growing along foothills of Himalaya in India. It is also grown in Egyptian gardens in Trinidad and Surinam as well as other countries [65, 66]. All parts of bael tree are medicinally useful, like leaves, flower, stem bark, roots, fruits, seeds, etc., and are used extensively in the Indian traditional system of medicine, the Ayurved [67, 68]. In the literature, it has been well studied and reported [69] that bael fruit ash contains K and Ca as major constituents along with host of other trace elements like Mn, Fe, Cu, Zn, Na and



Scheme 1 Synthesis of biscoumarin and 2-amino-4*H*-chromene derivatives using BFA catalyst

Mg. It is believed that metal oxides, carbonates and hydroxides may act as a promoter to catalyze the reaction.

The BFA catalyst was found to be cost-effective, highly efficient, innocuous, biodegradable and renewable resource material, which is an attractive alternative to other conventional reagents. Recently, bio-waste has been successfully employed as a catalyst by many researchers in organic transformation [70–72]. Therefore, we strongly believed that our developed catalytic system is the best and accomplished with excellent yield for a broad range of substrates that are highly attractive for industrial applications in the near future.

Experimental

Materials and methods

Except bael fruit rinds, all other chemicals used in the study were purchased from *Sigma-Aldrich* and used without any purification. The completion of reaction and purity of products were checked by TLC on Merck silica gel (60 F254) plates. The melting points were recorded using DBK programmable melting point apparatus by capillary methods and uncorrected. FTIR spectrum was recorded in ATR technique on a Bruker ALPHA FTIR spectrometer. Powder XRD patterns were collected on the Bruker AXS Analytical Instruments Pvt. Ltd. Germany (Model: D2 phaser diffractometer) by using Cu K α radiation ($\lambda = 1.5406 \text{ \AA}$) at 10 mA, 30 kV, a scan step time 0.5 per sec, and a start position 10.0184 and end position 90.00 [2° Th.]. Scanning electron microscope images were obtained on FEI, NOVA, NanoSem 450 equipment. Quanta 200 3D FEI scanning electron microscope was used for energy-dispersive X-ray spectroscopy analysis. ^1H and ^{13}C NMR spectra were recorded with an Avance 300 instrument in CDCl_3 and DMSO as a solvent with TMS as an internal standard. Chemical shifts (δ) are expressed in ppm.

Preparation of BFA catalyst

The dry rinds of bael fruits (Fig. 2a) were obtained from the local area, and species were authenticated by the department of botany. The collected dry rinds of bael fruit were washed with distilled water and then dried in the oven at 100°C . The dried



Fig. 2 a Dry bael fruit rinds. b Small pieces of bael. c BFA catalyst

rinds were manually broken into smaller pieces (Fig. 2b) and then thermally treated for 2 h at 900 °C in a muffle furnace at a heating rate of 2 °C/min, and this temperature was maintained till no evolution of smoke, which resulted in fine soft ash. The resulting solid ash (Fig. 2c) was denominated as bael fruit ash (BFA) catalyst.

Typical procedure for the synthesis of 4-hydroxy-3-((4-hydroxy-2-oxo-2H-chromen-3-yl)(4-methoxyphenyl)methyl)-2H-chromen-2-one (3a)

In a 25-mL reaction flask, 4-methoxybenzaldehyde (1.0 mmol, 136 mg), 4-hydroxycoumarin (2.0 mmol, 324 mg), BFA (10 wt%, 13.6 mg) and H₂O (3 mL) were placed. A resulting reaction mixture was stirred at ambient temperature for 15 min. The progress of the reaction was monitored by TLC (n-hexane/EtOAc, 7:3). After completion of the reaction, the product **3a** was extracted with EtOAc (2 × 10 mL) from the reaction mixture. The combined organic phase was washed with H₂O and dried (Na₂SO₄), and the solvent was removed under reduced pressure to afford a crude product. The pure product was obtained in a quantitative yield by recrystallization from 96% EtOH. All other derivatives were synthesized by employing the same procedure, and their structures were confirmed on the basis of spectral techniques (ESI). The physical and spectroscopic data are in consistent with the proposed structures and are in harmony with the literature values.

Typical procedure for the synthesis of 2-amino-4,5-dihydro-4-(4-methoxyphenyl)-5-oxopyrano[3,2-c]chromene-3-carbonitrile (5c)

In a 25-mL reaction flask, 4-methoxybenzaldehyde (1.0 mmol, 136 mg), 4-hydroxycoumarin (1.0 mmol, 162 mg), malononitrile (1.0 mmol, 66 mg), BFA (10 wt%, 13.6 mg) and H₂O (3 mL) were placed. A resulting reaction mixture was stirred at ambient temperature for 10 min. The progress of the reaction was monitored by TLC (n-hexane/EtOAc 7:3). After completion of the reaction, the product **5c** was extracted with EtOAc (2 × 10 mL) from the reaction mixture. The combined organic phase was washed with H₂O and dried (Na₂SO₄), and the solvent was removed under reduced pressure to afford a crude product. The pure product was obtained in a quantitative yield by recrystallization from 96% EtOH. All other derivatives were synthesized by employing the same procedure, and their structures were confirmed on the basis of spectral techniques (ESI). The physical and spectroscopic data are in consistent with the proposed structures and are in harmony with the literature values.

Results and discussion

Catalyst characterization

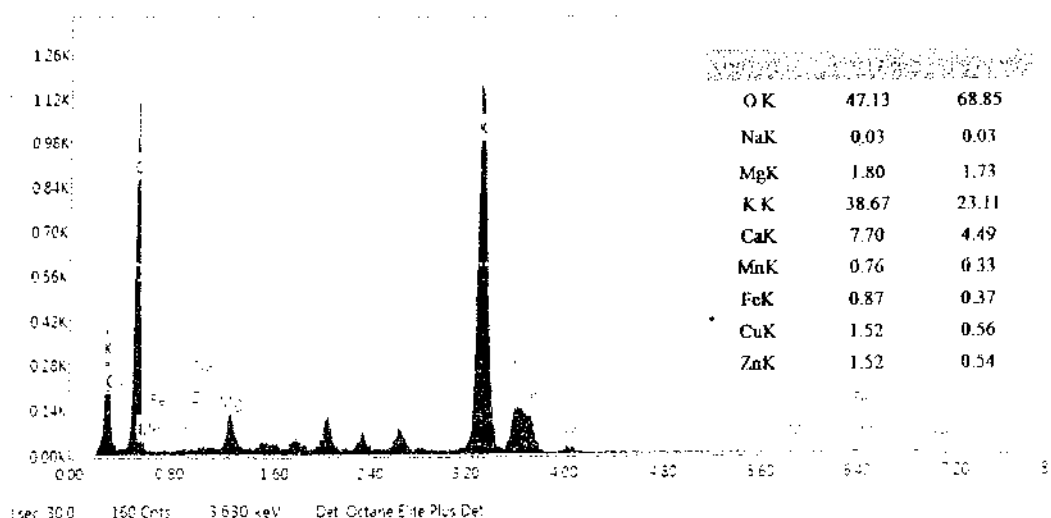
The literature reports of BFA reveal that the presence of metal oxides, carbonates and hydroxides along with transition elements has been studied and characterized by using various analytical techniques like EDX, FTIR, XRD and SEM analyses.

Energy-dispersive X-ray spectroscopy (EDX)

The distribution of elements as based on the EDX analysis of the BFA is shown in Fig. 3. The report reveals the distribution of the oxides of K, Ca, Mn, Fe, Cu, Zn, Na and Mg. It is believed that oxides of these metals react with reaction medium water to produce hydroxides, which provides basic sites for tandem Knoevenagel–Michael reaction pathway.

X-ray diffraction pattern (XRD)

The X-ray diffraction analysis of the BFA catalyst (Fig. 4) showed the characteristic peaks of metal oxides and carbonates present in the catalyst. The peaks at $2\theta = 26.35, 28.37, 29.70, 30.68, 31.86, 32.99, 33.39, 35.81, 40.55, 41.80, 43.18, 50.17, 62.31, 66.23$ and 73.75 attributed to metal oxides and carbonates. Another peaks were also observed at $2\theta = 13.38$ and 19.40 due to metal hydroxides. The crystallite size of BFA was found to be 58 nm calculated using the Scherrer equation. Therefore, this active phase of the BFA catalyst was utilized for the conversion of reactants into the desired products.



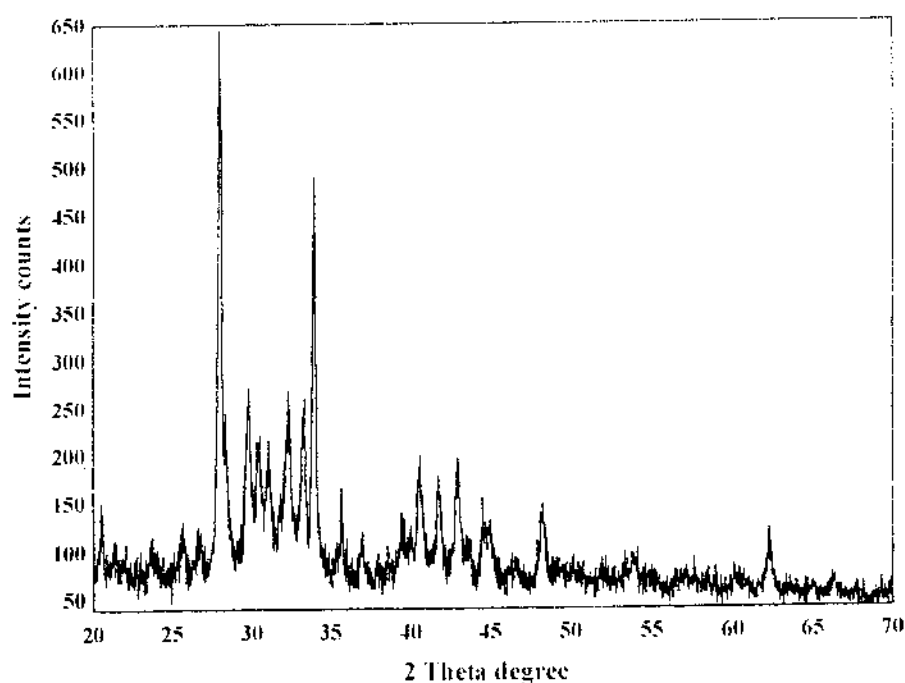


Fig. 4 X-ray diffraction patterns of BFA catalyst

Fourier transform infrared (FTIR) spectroscopy

The FTIR analysis was performed to investigate the functional groups present in BFA catalyst (Fig. 5). The characteristic absorption bands at 602, 1006, 1499 and 1660 cm^{-1} provide strong revelations about the presence of potassium oxides (K–O–K stretching), other metal oxides (CaO, MgO) and metal carbonates (C=O stretching), respectively. Also, the observation of broad and sharp absorption bands at 3336 cm^{-1} and 3740 cm^{-1} due to the small concentration of the hydroxyl group (–OH) in the spectrum supports the formation of metal hydroxides due to the absorption of moisture from the environment.

Scanning electron microscope (SEM)

The apparent morphology of BFA catalyst was examined by SEM analysis and is shown in Fig. 6. As observed from SEM micrographs, BFA appears porous in nature which provides a smooth and soft surface area for catalyzing the reaction.

Catalytic performance of BFA catalyst

The catalytic efficiency of BFA was explored in the one-pot three-component reaction, which involves 4-methoxybenzaldehyde and 4-hydroxycoumarin as a model precursor under different reaction conditions to afford 4-hydroxy-3-((4-hydroxy-2-oxo-2H-chromen-3-yl)(4-methoxyphenyl)methyl)-2H-chromen-2-one **3a**. The

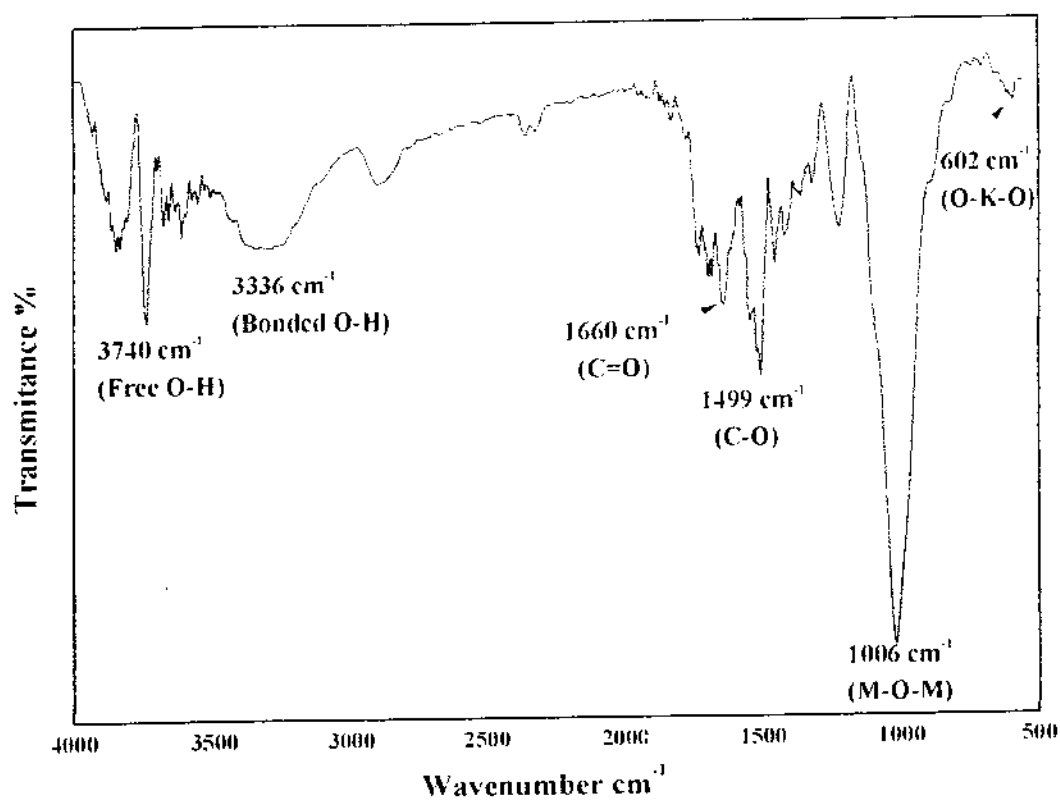


Fig. 5 FTIR of BFA catalyst

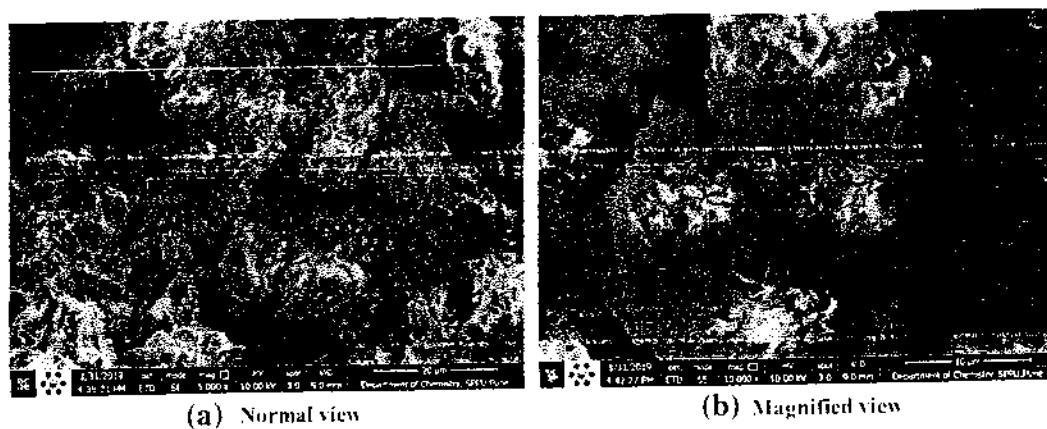
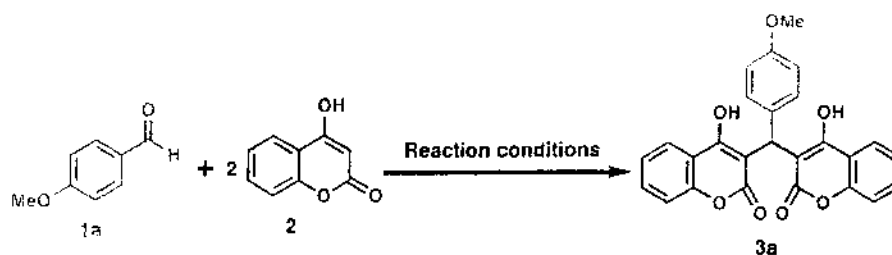


Fig. 6 SEM images of BFA catalyst: **a** a normal view, **b** magnified view

success of the model reaction was examined in various reaction parameters with BFA (wt%) as a catalyst (Table 1). Initially, the model reaction was examined under catalyst-free and solvent-free conditions, and after 2 h, the formation of corresponding product was not observed on TLC (Table 1, entry 1).

Table 1 Optimization of reaction condition for the synthesis of **3a**

Entry	Catalyst (wt%)	Solvent (3 mL)	Time (min)	Yield ^a (%)
1	–	–	120	Nr ^b
2	BFA (2)	H ₂ O	120	39
3	BFA (5)	H ₂ O	60	70 (76) ^c
4	BFA (10)	H ₂ O	15	94
5	BFA (15)	H ₂ O	15	94 (94) ^d
6	BFA (10)	EtOH,	15	94 (93) ^e
7	BFA (10)	THF ^f	60	56 (55, 68) ^g
8	BFA (10)	CHCl ₃	60	60 (62) ^h
9	BFA (10)	H ₂ O: EtOH (1:1)	15	94
10	WEBFA (3 mL)	–	15	94
11	PBF (5)	H ₂ O	120	Nr ^b

Reaction conditions: 4-methoxybenzaldehyde **1a** (1 mmol), 4-hydroxycoumarin **2** (2 mmol), BFA (wt%) and H₂O (3 mL) at RT

WEBFA water extract of bael fruit ash (pH = 12.6)

^aIsolated yield

^bNo reaction

^cCatalyst amount 7 (wt%)

^dCatalyst amount 20 (wt%)

^e*iso*-PrOH

^fDCM, CH₃CN

^gToluene

As the reaction requires a catalyst, we examine the effect of BFA catalyst on this transformation; the model reaction was performed using various amounts of BFA catalyst (1–20 wt%) in H₂O (3 mL) (Table 1, entries 2–5). The results show that excellent yield (94%) of desired product was obtained in 15 min when

10 wt% of BFA was employed in 3 mL H₂O as a solvent (Table 1, entry 4). As reaction requires solvent, we also examined model reaction in different conventional organic solvents like EtOH, *iso*-PrOH, THF, DCM, CH₃CN CHCl₃ and toluene. The results reveal that polar protic and nonpolar solvent afforded moderate yields (Table 1, entries 6–8), while pure EtOH and H₂O/EtOH (1:1) solvent system shows equally good results for the present synthesis (Table 1, entry 6 and 9). Also, we perform model reaction in water extract of bael fruit ash (3 mL) which shows equally good results after 15 min (Table 1, entry 10). For comparison purposes, we also performed the model reaction in the presence of parent bael fruit (PBF) powder and it was observed that no product was obtained (Table 1, entry 11) even after 2 h.

To determine the influence of the ashing temperature for preparation of BFA, bael fruit rinds were thermally treated at different temperatures between 200 and 900 °C and the resulted ash was tested for the model reaction to produce desired product (Table 2). The results show that BFA obtained after 900 °C temperature gave better result than BFA obtained at lower temperatures of thermal treatment (Table 2 entry 5).

By reacting a variety of differently substituted aryl aldehydes (**1a–l**) with a 4-hydroxycoumarin (**2**) under optimized reaction conditions, we managed to prepare a range of biscoumarin derivatives (**3a–l**) and the results are shown in Table 3. As shown, aryl aldehydes with substituents carrying either electron-withdrawing or electron-donating groups reacted successfully and gave the expected products in stipulated time period.

Although we did not investigate reaction mechanism, the proposed mechanism for the biscoumarins formation is depicted in Scheme 2. The BFA catalyst containing the mixture of active metal oxides and carbonates along with transition metals is responsible for its basicity, which is soluble to some extent in H₂O which provides a number of Lewis basic sites (O₂⁻ and OH) along with Lewis acid sites (M²⁺) for the activation of reactants in the proper direction. At first, the aryl aldehyde **1** is activated by Lewis acidic sites of catalyst. The nucleophilic attack of

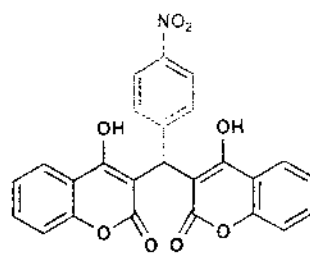
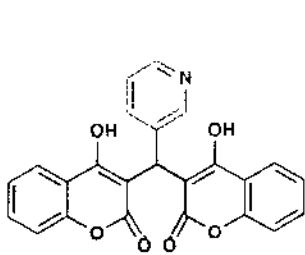
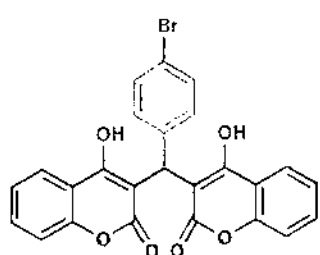
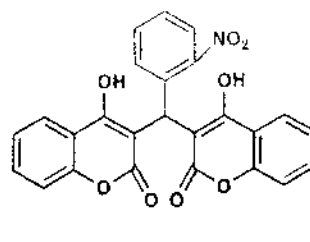
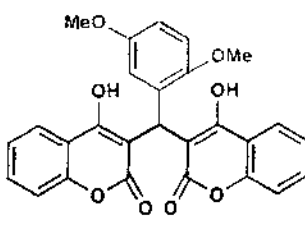
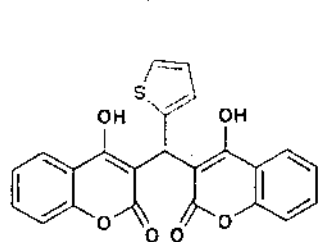
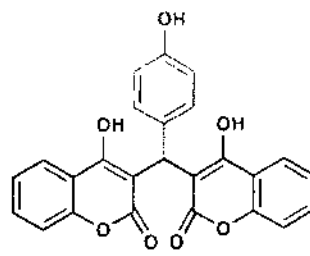
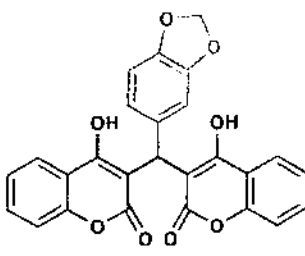
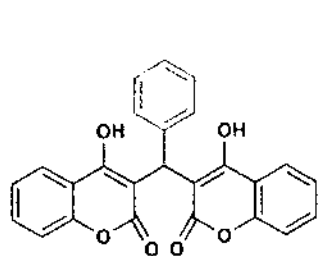
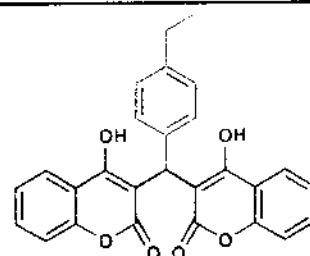
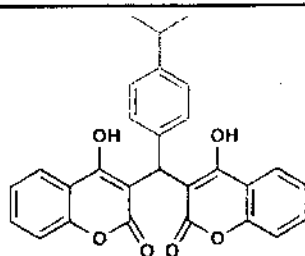
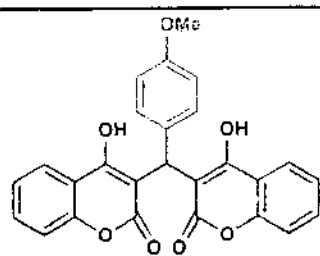
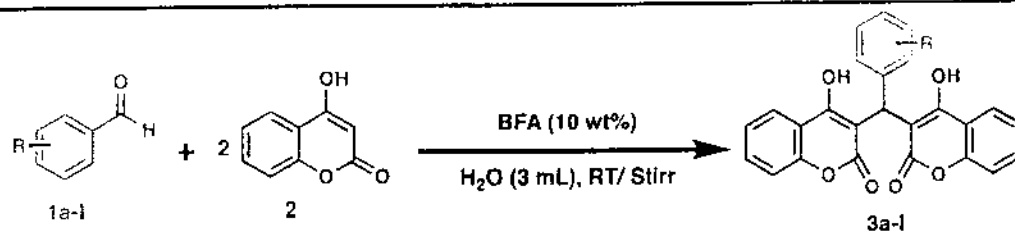
Table 2 Optimization of ashing temperature for preparation of catalyst

Entry	Ashing temp. (°C)	Time (min)	Yield (%) ^a
1	Without ashing	120	Nr ^b
2	200	120	Nr ^b
3	400	120	15
4	600	120	27
5	900	15	94

Reaction conditions: 4-methoxybenzaldehyde **1a** (1 mmol), 4-hydroxycoumarin **2** (2 mmol), bael fruit (10 wt%) and H₂O (3 mL) at RT

^aIsolated yield

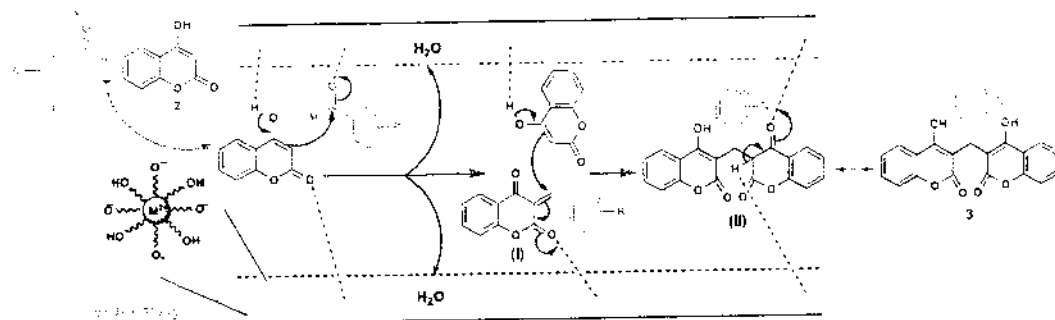
^bNo reaction

Table 3 BFA-catalyzed synthesis of biscoumarin derivatives (**3a–l**)

Reaction conditions: aryl aldehyde **1a–l** (1 mmol), 4-hydroxycoumarin **2** (2 mmol), BFA (10 wt%), H_2O (3 mL) at RT

Time in min

^aIsolated yield in %



Scheme 2 Postulated role of BFA catalyst in the formation of biscoumarins (**3**)

4-hydroxycoumarin **2** on activated aldehyde is followed by elimination of water molecules to generate Knoevenagel intermediate (**I**), which is further activated by Lewis basic and acidic sites of catalyst. The activated intermediate (**I**) undergoes Michael addition with second molecule of 4-hydroxycoumarin to afford the targeted biscoumarin product **3** through tautomerism of intermediate (**II**). As a result, the overall effect of our catalyst is a rate enhancement of the reaction.

Next, we identified the recovery and reusability of catalyst which is important for scaling up practical and industrial applications. A recycling experiment was conducted using the model reaction. After completion of the reaction, the product **3a** was extracted with EtOAc (2×10 mL) from the reaction mixture. The combined organic phase was washed with H_2O and dried (Na_2SO_4), as well as the solvent was removed under reduced pressure to afford a crude product. The recovered aqueous layer containing BFA catalyst was dried under vacuum and directly used for the next cycle with fresh reactants in H_2O . The result obtained in our experiment (Fig. 7)

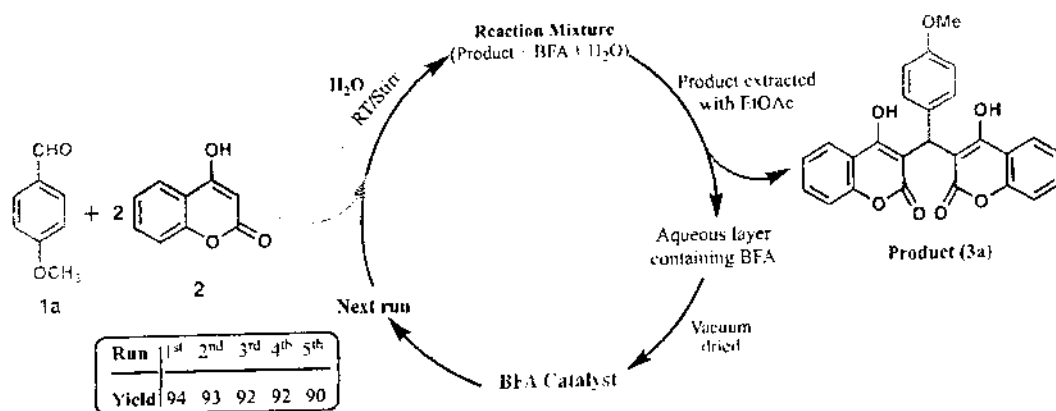


Fig. 7 Reusability of BFA catalyst

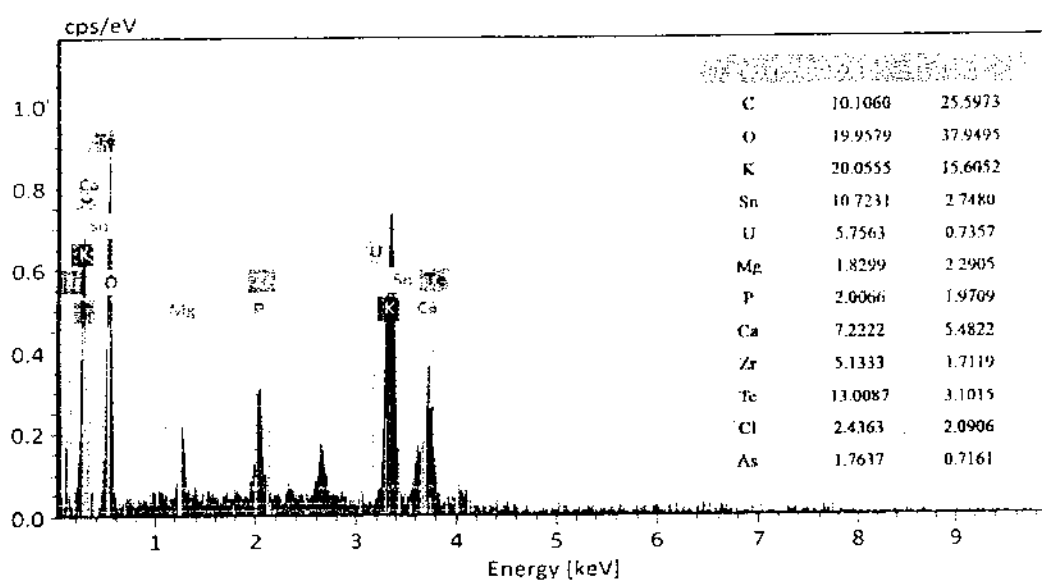
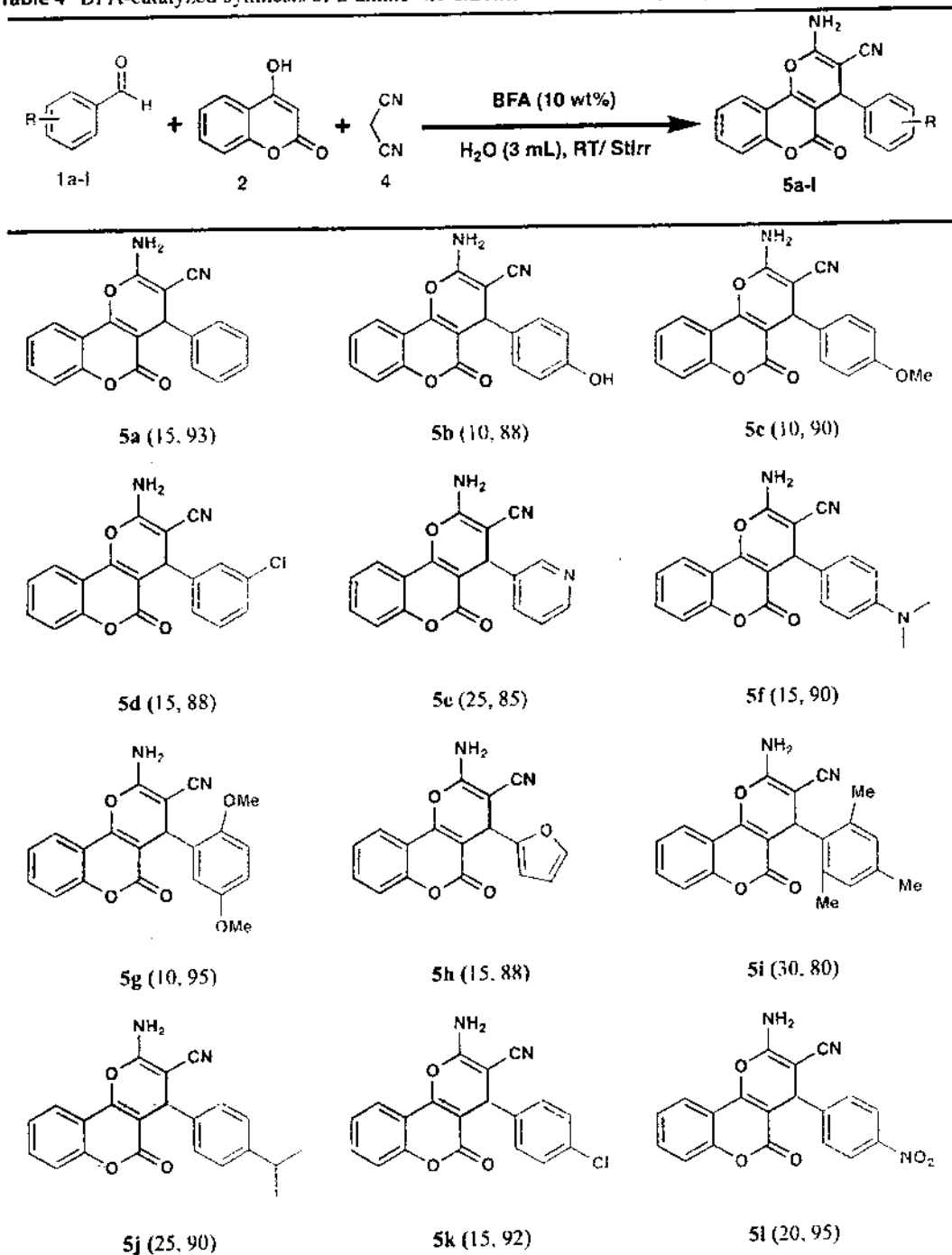


Fig. 8 EDX spectrum of recovered BFA catalyst

was confirmed that the BFA could be reused up to fifth run with only negligible loss of activity. The presence of active metal oxides responsible for its basicity in recycled catalytic system was evidenced by the EDX analysis (Fig. 8), which revealed no appreciable change in the chemical composition of catalyst even after the fifth cycle.

The successful application of BFA as catalyst in the synthesis of biscoumarins encouraged us to explore its compatibility in synthesis for 2-amino-4*H*-chromene derivatives under optimized reaction conditions, and the results are summarized in Table 4. The results indicate that aldehydes with electron-withdrawing substituent were found to be suitable for this transformation as the corresponding products were obtained in high yields than aldehyde with electron-donating substituent.

We compared the efficiency of our method for the synthesis of biscoumarin **3a** with other reported works (Table 5, entry 1–6). Each of these methods has its own advantages, but some of them suffer from disadvantages such as the employment of expensive catalysts, long reaction time, poor yield and none from natural sources. So the present method (Table 5, entry 7) furnishes the use of renewable feedstock, a green reaction medium, biodegradable and reusability of catalyst, with a shorter reaction time, while a small quantity of this inexpensive and readily available catalyst is sufficient to obtain good yield of the expected product.

Table 4 BFA-catalyzed synthesis of 2-amino-4*H*-chromene derivatives (**5a–l**)

Reaction conditions: aryl aldehyde (1 mmol) **1a–l**, 4-hydroxycoumarin (1 mmol) **2**, malononitrile (1 mmol) **4**, BFA (10 wt%), H₂O (3 mL) at RT

Time in min

^aIsolated yield in %

Table 5 Comparison of BFA catalyst with some previously reported catalyst for the synthesis of **3a**

Entry	Catalyst	Reaction condition	Time (min)	Yield (%)	References
1	Ash water extract	1 mL, 80 °C	40	62	[16]
2	FeNi ₃ -ILs	0.003 g, EtOH, reflux	26	73	[17]
3	CuO–CeO ₂	H ₂ O, reflux	25	90	[18]
4	DBSA	10 wt%, H ₂ O, 40 °C	60	82	[19]
5	Visible light	CFL bulb (22 W)	156	89	[73]
6	OBS	H ₂ O, reflux	25	88	[74]
7	BFA	10 wt%, H ₂ O, RT	15	94	[*]

*Present work

Conclusion

In conclusion, we have demonstrated an efficient and green method for the synthesis of biscoumarin and 2-amino-4*H*-chromene derivatives using BFA in water under air atmosphere at RT. We utilized bio-waste-derived catalyst that acts as synergetic material for the tandem Knoevenagel–Michael reaction. This protocol avoids chromatographic separation, use of expensive base, toxic solvents and high temperature. BFA catalyst is ecologically benign which excludes the possibility of any imminent disposal problem. The ability to scale up the protocol also makes it a competitive and convenient catalyst for industrially important organic transformations.

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Affiliations

Rupesh C. Patil¹ · Sachinkumar K. Shinde¹ · Uttam P. Patil¹ ·
Appasaheb T. Birajdar¹ · Suresh S. Patil¹

✉ Suresh S. Patil
sanyujapatil@yahoo.com

¹ Synthetic Research Laboratory, PG Department of Chemistry, PDVP College, Affiliated to Shivaji University, Kolhapur, Tasgaon, Sangli, MS 416312, India

Agro-Waste Generated Pd/CAP-Ash Catalyzed Ligand-Free Approach for Suzuki–Miyaura Coupling Reaction

Rupesh C. Patil¹ · Ashutosh A. Jagdale¹ · Uttam P. Patil¹ · Jeevan S. Ghodake² · Sawanta S. Mali³ · Chang K. Hong³ · Suresh S. Patil¹

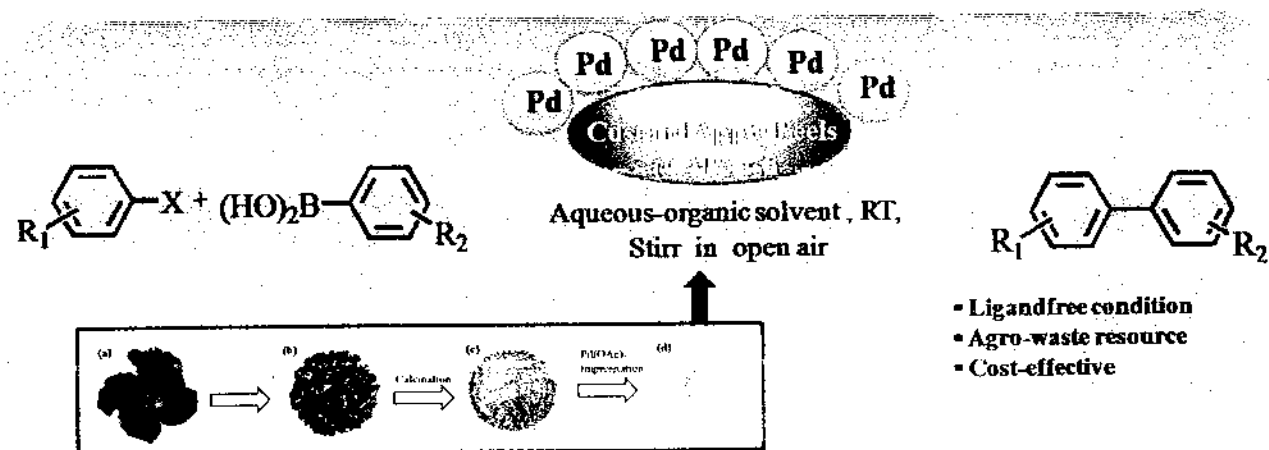
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Abstract

We converted agro-waste Custard Apple Peels (CAP) to ash via thermal treatment, on which Pd(OAc)₂ was immobilized easily that produced a low-cost, highly efficient Pd/CAP-ash catalyst. The prepared catalyst was fully characterized by using FT-IR, SEM, EDX, XRF, DSC-TGA, BET, HR-TEM, and XPS techniques. The Pd/CAP-ash catalyst was conveniently applied for the Suzuki–Miyaura coupling reaction under external base free and ligand-free conditions in an aqueous-organic solvent to produce biphenyls in good to excellent yields. The main attraction of our protocol an application of palladium-supported agro-waste material which is easily recoverable and recyclable provides mono and bis-coupled derivatives in a short reaction time.

Graphic Abstract



Keywords Agro-waste · Custard apple peels · Palladium · Suzuki–Miyaura coupling

Suresh S. Patil
sanyujapatil@yaho.com

¹ Synthetic Research Laboratory, PG Department of Chemistry, PDVP College, (affiliated to Shivaji University, Kolhapur), Tasgaon, Sangli, MS 416312, India

² Department of Physics, PDVP College, (affiliated to Shivaji University, Kolhapur), Tasgaon, Sangli, MS 416312, India

³ Polymer Energy Materials Laboratory, School of Advanced Chemical Engineering, Chonnam National University, Gwangju 500-757, South Korea

1 Introduction

Palladium being the most specific transition metal has one of the most versatile catalytic properties. Salts of Pd have already proved that they are highly efficient catalysts in making new carbon–carbon (Csp²–Csp²) bonds, which seemed to be very challenging scenario in the past. Eventually it was discovered that Pd salts have tremendous scope in synthetic chemistry as its advantages were revealed one by one. In

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combination with organoboranes, organostannanes, alkenes, acrylates Pd salts have succeeded in designing many of the vital organic molecules. It was observed that almost any two organic molecules can be coupled by Pd (salts) with the help of appropriate ligands. So it can be said that ligand help to enhance activity of Pd (salts) to great extent. This has led to establish coupling reactions like Suzuki, Heck, Sonogashira etc. as milestones in the field of synthetic organic chemistry [1, 2].

In the late of 20th century it was realized that the ligands used in combination with Pd salts have many disadvantageous characteristics like toxicity, highly expensive, availability, stability and tedious preparation methods and also the contamination of metal and ligands in the final products. Therefore it seemed to be an urgent need to develop ligand free methodologies in order to cut short human impact on ecology [3–5].

In 1989, Bunagin and et al. for the first time realized a palladium catalyzed ligand free Suzuki reaction of aryl halides in aqueous condition under an argon atmosphere [6]. During the last decade several groups described biphasic protocols for SM couplings commonly based on water soluble catalysts, including contributions by Beller [7], Plenio [8], Miyaura [9], Shaughnessy [10], Genet [11], Leadbeater [12] and Buchwald [13]. Lipshutz et al. demonstrated ambient temperature couplings in water utilizing nonionic micelle forming additives [14], phase-transfer catalysis [15] or water:organic solvents have been employed [16, 17]. Alternative approaches include heating by microwave irradiation [18, 19], or utilization of supported catalysts [20–23]. Yet, despite a variety of advantageous features, water mediated cross-coupling protocols typically necessitate co-solvents, high catalyst loading [24–26], elevated temperatures [27] and/or tedious product work-up by column chromatography [28].

Thus, with simple and economical methodologies, the exercise of “ligand-free” catalytic system, moderate basicity and wide compatibility has become the need of current manufacturing process to establish greener and sustainable strategy [29–32]. In fulfillment to the green chemistry principles, we decided to study in detail the use of an agro-waste stuff that significantly fulfills the desired expectation of safe reaction strategy. The Suzuki–Miyaura coupling reaction is highly dependent on the presence of external base and solvent [33–35].

In present-scenario researchers are interested in development of green protocols as sustainability has become a prior issue in every area of human activity [36, 37]. Among the principles of Green Chemistry, the use of naturally sourced green catalyst is a key aspect since it minimizes toxicity, hazard, pollution and waste treatment issues [38–42]. Suzuki–Miyaura coupling reaction involves the selective cross-coupling between aryl halide and aryl boronic acids to give symmetrical

and unsymmetrical biaryls in high yields. Synthesis of biaryl motifs has attracted considerable interest, as they are important building blocks for various natural products, herbicides, pharmaceuticals including antibiotic vancomycin and anticancer drug gossypol [43–45].

The survey of literature reveals that the careful selection of ligand can promote both first and last steps of the catalytic cycle [46]. Numerous electron-rich phosphine-based ligands [47–50], sterically crowded NHC [51], oximes [52, 53], imines [54], and palladacycles [55, 56] were developed and employed as catalyst precursors under both conventional organic or biphasic media. Although, these ligand assisting systems bear excellent activity, the principle drawbacks associated with them are availability, stability, air/moisture sensitivity and tedious preparation steps. In the most crucial stage of the mechanism, the transmetallation, transfer of the organo boron species to the palladium in the presence of external base occurs. However, added base often competes with many functional groups, and also causes protodeboronation with electron-deficient aryl boronic acids [57–59].

The immobilization methods to deposit the palladium metal on suitable solid supports [60], polymers [61], metal oxides [62, 63], clay [64] carbon nanofiber [65], montmorillonite [66] magnetic mesoporous silica [67, 68], and zeolite [69] have been reported for coupling reactions. However, as most of the aryl halides are hydrophobic in nature, the use of pure water medium for Suzuki–Miyaura coupling reaction often fails to furnish utmost efficiency [70]. Indeed, several reports mentioned the use of organic-water system, which aids in the complete dissolution of the organic substrates, and also in the stabilization of the metal. As a part of our ongoing efforts to develop sustainable protocols [71–73], we decided to revisit the Suzuki–Miyaura coupling reaction with the aim to make a protocol environmentally benign with eco-friendly catalytic system.

Herewith, we present a novel and highly green Suzuki–Miyaura coupling reactions using Pd/CAP-ash which was prepared from Pd(OAc)₂ and dead Custard apple peels that is thrown to rot/deteriorate/decay. CAP-ash obtained from agro-wastes is a better choice in certain conditions because of characteristics: they are low-cost materials and obtained from renewable resources. A large amount of solid wastes of peel, stones or seeds are formed in the processing of fruits like Custard apple which can be applied in organic transformation. CAP is a highly abundant agro-waste materials across the world and therefore its application in synthetic chemistry will attract tremendous interest from the point of environmental issues.

2 Experimental Section

2.1 General

Except CAP-ash, all chemicals used in study were purchased from *Sigma-Aldrich* and used without additional drying and purification. Proton and carbon-13 NMR spectra were recorded with a Avance-300 instrument in CDCl_3 and $\text{DMSO}-d_6$ as a solvent with tetramethylsilane (TMS) as an internal standard. Chemical shifts (δ) are reported in ppm and coupling constants (J) are expressed in Hz. Mass spectra analyses were recorded on Agilent gas chromatograph mass spectrometer. Fourier transform infrared (FT-IR) spectra were recorded on a Perkin-Elmer-Spectrum-100 spectrophotometer (KBr). Scanning electron microscope (SEM) images were obtained on FEI. NOVA, NanoSem 450 equipment. Energy dispersive X-ray spectroscopy (EDX) analysis was carried on Quanta 200 3D, FEI Scanning electron microscope. Measurement temp. 25 °C with step size 0.0170 [2° Th] and Differential Scanning Calorimetry-Thermogravimetric analysis (DSC-TGA) was performed on TA SDT Q600 V20.9 Build 20 instrument in nitrogen and at a heating rate of 10 °C min^{-1} . X-ray fluorescence (XRF) analysis was performed on X-ray fluorescence spectrometer (Pananalytical, USA). N_2 -adsorption-desorption isotherms were obtained with a BELSORP surface area and porosity analyzer. High resolution transmission electron microscopy (HRTEM) images and selected area electron diffraction (SAED) pattern were obtained by TECNAI F20 Philips operated at 200 kV. The surface elemental studies were analyzed using an X-ray photoelectron spectrometer (XPS) (VG Multilab 2000-SSK, USA, $\text{K}\alpha$) measurement were reported with a multi-channel detector, which can endure high photonic energies from 0.1 to 3 KeV. The progress as well as completion of reaction was monitored by TLC on Merck silica gel (60 F254) plates.

2.2 Preparation of CAP-Ash

During this study, Custard apple (*Annona squamosa*) peels were obtained from nearby agricultural farm. Initially agro-waste fruit peels (Fig. 1a) were washed with distilled water and sun-dried. They were manually broken

into small pieces (Fig. 1b) and crushed using mortar and pestle. After crushing, the raw powder (100 g) was heated at the rate 5 °C/min in Muffle furnace up to 900 °C and this temperature was maintained for 1 h. After Muffle furnace treatment, most of the organic materials were burnt out and got transformed into white soft ash (8.5 g) denominated as CAP-ash. This CAP-ash (Fig. 1c) obtained was further utilized as a support for Pd metal to produce a low cost catalyst.

2.3 Palladium Support in the CAP-Ash

To the 10 mL of $\text{Pd}(\text{OAc})_2$ solution in acetone (0.1 g/L), 500 mg of CAP-ash was added and the resulting mixture was stirred constantly at room temperature for 24 h. Finally, the resulting mixture was filtered and oven dried at 80 °C for 2 h and stored in a desiccator. The resulting catalyst (Fig. 1d) so obtained was nominated as Pd/CAP-ash and utilized for Suzuki–Miyaura coupling reaction.

2.4 General Experimental Procedure for Suzuki–Miyaura Coupling Reaction

All the Suzuki–Miyaura coupling reactions were carried out under air atmosphere in dried glassware. In a 25 mL round bottom flask equipped with a magnetic stirrer, aryl bromides (1.0 mmol), arylboronic acids (1.2 mmol), Pd/CAP-ash (5 wt%) and water:ethanol (3 mL) were placed. The resulting reaction mixtures were stirred at room temperature for appropriate time. The progress of reactions was monitored by TLC. After completion of reactions, the reaction mixtures were extracted with ethyl acetate (2 × 10 mL). The organic layers were washed with brine (2 × 10 mL). The combined organic layer was collected, dried over Na_2SO_4 and concentrated in vacuo. The residue was purified by silica gel column chromatography using n-hexane:EtOAc (9:1 v/v) to give the corresponding biaryl compound. The desired products were characterized by comparing ^1H , ^{13}C NMR spectral data with authentic samples.

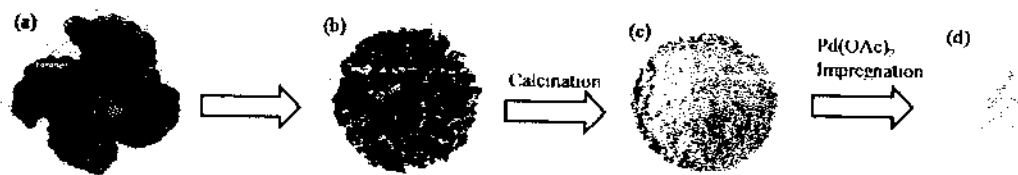


Fig. 1 Preparation of Pd/CAP-ash a dry custard apple peels, b small pieces, c CAP-ash, d Pd/CAP-ash

2.5 General Experimental Procedure for Double Suzuki–Miyaura Coupling Reaction

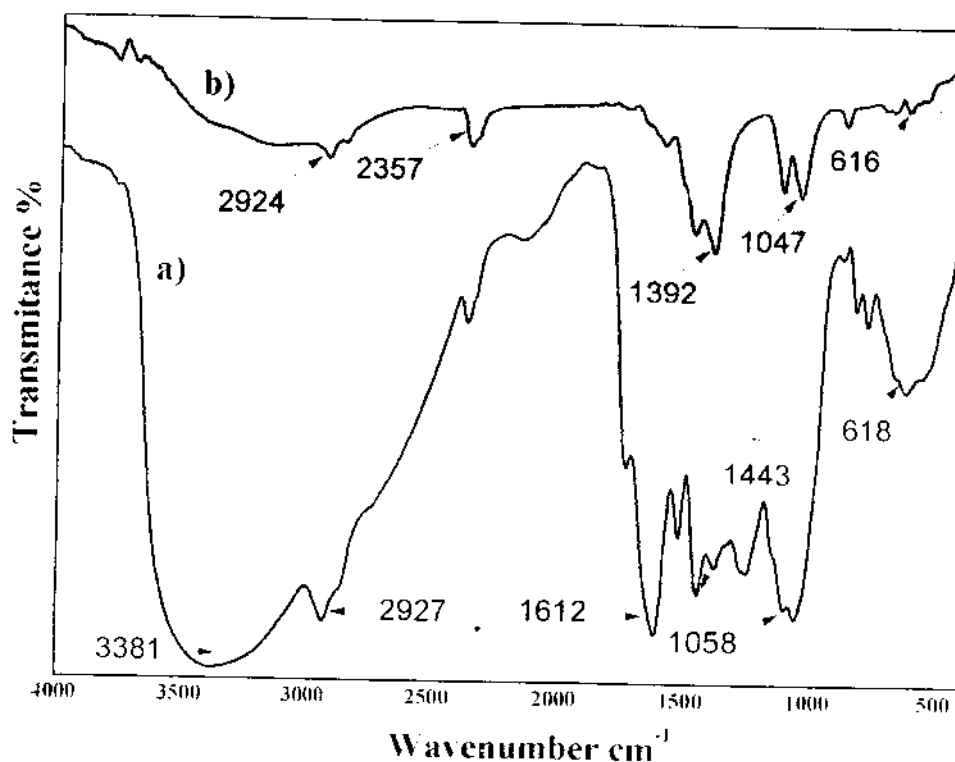
In a 25 mL round bottom flask equipped with a magnetic stirrer, aryl dibromides (1.0 mmol), arylboronic acids (2.4 mmol), Pd/CAP-ash (5 wt%) and H₂O:DMF (3 mL) were placed. The resulting reaction mixtures were stirred at room temperature for appropriate time. The progress of reactions was monitored by TLC. After completion of reactions, the reaction mixtures were extracted with ethyl acetate (2 × 10 mL). The organic layers were washed with brine (2 × 10 mL). The combined organic layer was collected, dried over Na₂SO₄ and concentrated in vacuo. The residue was purified by silica gel column chromatography using n-hexane:EtOAc (9:1 v/v) to give the corresponding biaryl compound.

3 Results and Discussion

3.1 Characterization of Pd/CAP-Ash

Herein, we report our preliminary research on the combustion of agro-waste CAP to ash, which can be used as palladium support CAP-ash to produce good catalytic system. The Pd/CAP-ash was analyzed by FT-IR, SEM, EDX, XRF, DSC-TGA, BET, HR-TEM and XPS technique. Moreover, an attempt was also made to investigate the catalytic property of the Pd/CAP-ash employing Suzuki–Miyaura coupling reaction.

Fig. 2 FT-IR of a CAP-ash, b Pd/CAP-ash



3.1.1 FT-IR Analysis

FT-IR analysis performed as preliminary tool (Fig. 2) to obtain information about the existence of functional groups in Pd/CAP-ash. It shows that both CAP-ash and Pd/CAP-ash have bands attributed at 618, 1058, 1443, 1612, 2927, 3381 cm⁻¹ and 616, 1047, 1392, 2357, 2924 cm⁻¹ respectively. A sharp stretching band is observed at 3381 cm⁻¹ in CAP-ash indicates the presence of hydroxyl group (-OH) due to trapping of moisture, which is not observed in IR spectrum of Pd/CAP-ash indicates the formation of metal oxides. The observation of absorption band at 1392, 1047, 616 cm⁻¹ are characteristic peaks of metal oxides in Pd/CAP-ash supports metal oxides formation.

3.1.2 SEM Analysis

SEM micrographs (Fig. 3) of CAP-ash (Fig. 3a and b) observed the porous nature of catalyst, with the small particle size, smooth and soft surface area which upon Pd loading effectively applied for catalyzing the reaction. Pd metal can easily be spotted on the ash surface. (Fig. 3c and d) Impregnation of Pd on porous surface of the CAP-ash is confirmed by following SEM analysis.

3.1.3 EDX Analysis

The presence of elements as based on the EDX analysis of the CAP-ash is shown in Fig. 4a. The report reveals a

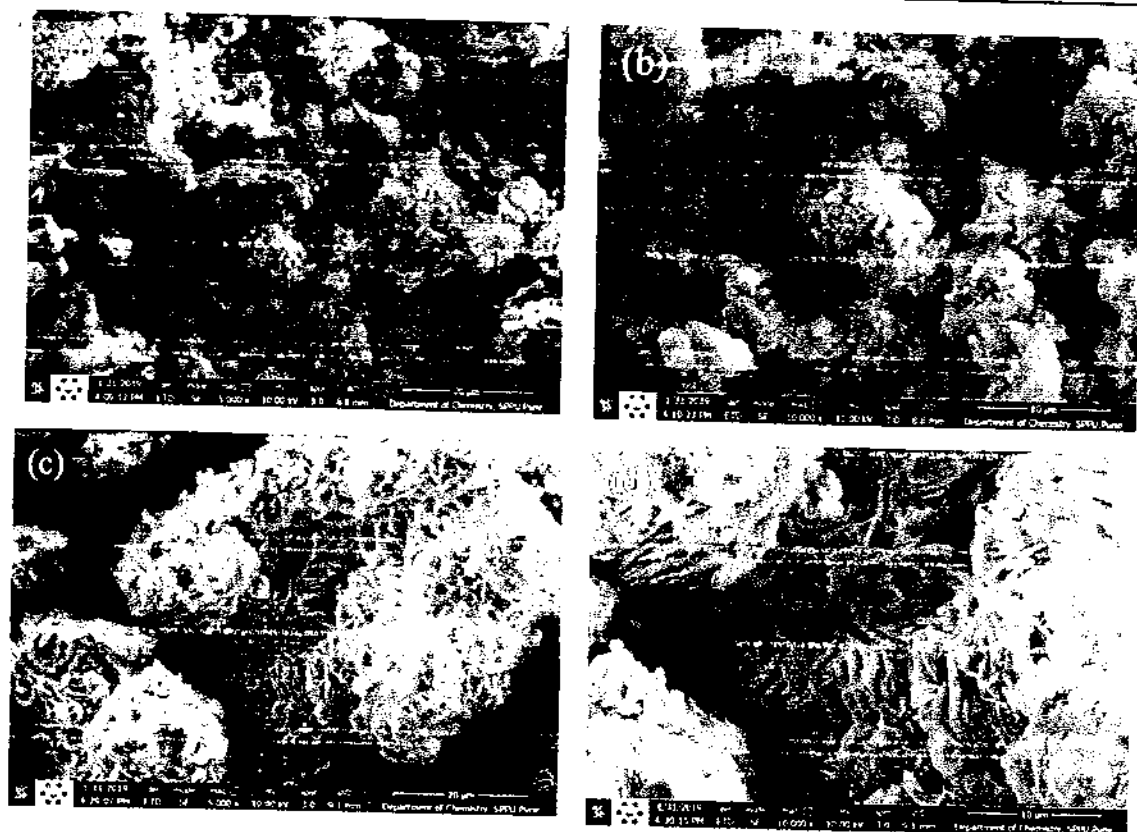


Fig. 3 SEM images for CAP-ash (a), (b) and Pd/CAP-ash (c), (d)

distribution of the oxides of K, Ca, Na, Al and Mg. This distribution is comparably higher than that of the waste biomass such as banana peels [74], rice straw [75], wheat straw [76] and *Eichhornia crassipes* [77]. EDX spectrum of Pd/CAP-ash (Fig. 4b) distinctively shows presence of Pd metal which supports the distribution of Pd metal on ash surface.

3.1.4 XRF Analysis

To investigate the particular chemical compositions of the inorganic phase of fresh CAP-ash, XRF analysis was performed and it presented that K_2O as the predominant component (% mass fraction 40.5%) while CaO, MgO, Al_2O_3 , P_2O_5 , SiO_2 have mass fractions 4.35%, 6.73%, 0.53%, 11.62%, 0.0011% respectively. Fe_2O_3 , Na_2O constituted the remaining ash.

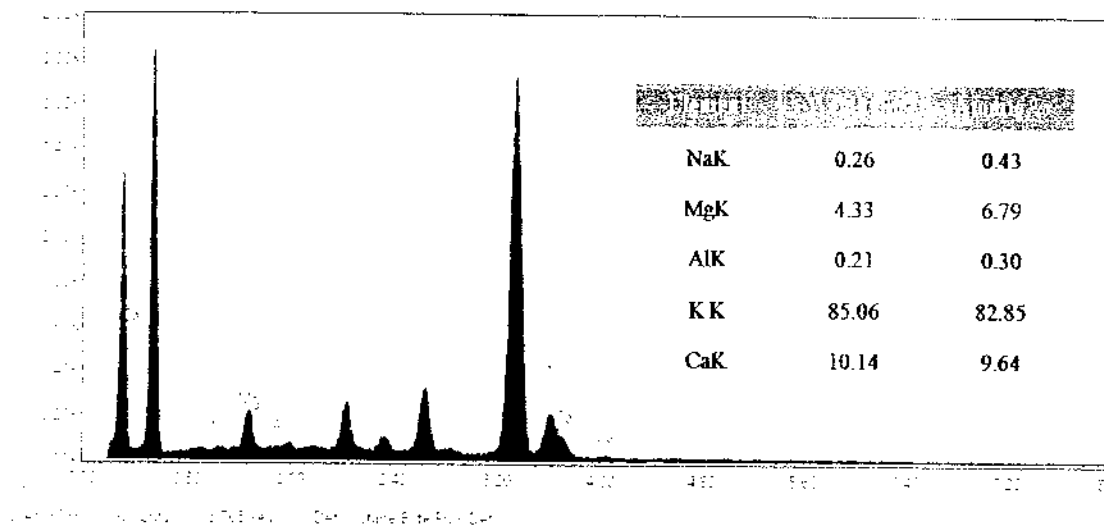
3.1.5 DSC-TGA Analysis

The thermogravimetric analysis (TGA) of custard apple peels powder and newly synthesized Pd/CAP-ash catalyst was carried out over the temperature range of 0–1000 °C at a heating rate of 10 °C/min under nitrogen atmosphere. We investigated the suitable ashing temperature with weight change of parent custard apple peels powder by DSC-TGA.

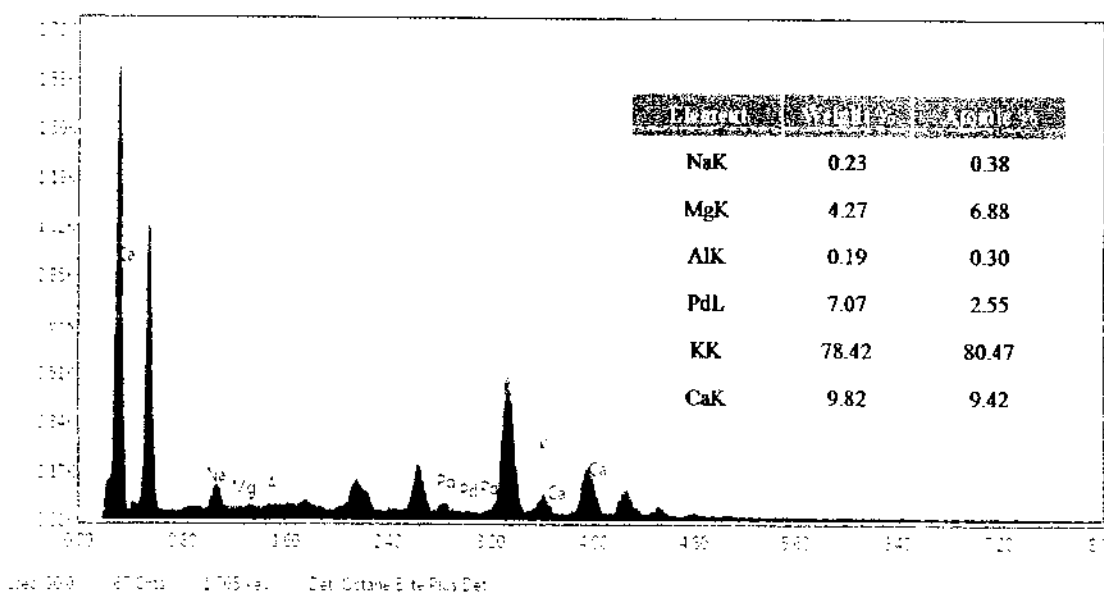
Three distinct stages of weight loss were observed in custard apple peels powder (Fig. 5a), initially weight percent loss of 12.05% below 184.73 °C that can be attributed to the evolution of moisture. The key weight loss of 37.50% up to 362.29 °C is attributed to combined weight loss for decomposition of organic compounds. The sharp exothermic peak exhibited by DSC at the temperature 508.58 °C could be assigned to the decomposition of carbohydrates. The third weight loss of 44.67% corresponds to the decomposition of metal carbonates up to 536.82 °C. Last two combined weight loss of around 82.17% at a temperature between 184.73 to 536.82 °C is due to hemicellulose, cellulose, and pectin degradation. At the end 4.79% weight of residue remains after 988.79 °C was due to the metal oxides. As the weight remains constant after 900 °C, this temperature suitable for complete conversion of peels powder to ash. TGA profile of Pd/CAP-ash shows that the catalyst is stable up to 399.73 °C (Fig. 5b).

3.1.6 BET Analysis

The catalytic activity of Pd/CAP-ash was determined by using BET surface area analysis. The surface area, pore volume and average particle size of prepared Pd/CAP-ash catalyst was determined using Brunauer–Emmett–Teller (BET) method. The surface area of the catalyst was found to be 4.04



a EDX spectrum of the fresh CAP-ash



b EDX spectrum of Pd/CAP-ash

Fig. 4 a EDX spectrum of the fresh CAP-ash. b EDX spectrum of Pd/CAP-ash

m^2g^{-1} while the pore volume and the pore radius are 0.044 ccg^{-1} and 29.05 nm respectively which is presented in Fig. 6 The pore-size distribution curve depicts mesopores of very uniform sizes. The isotherms of prepared Pd/CAP-ash were type III isotherm with a H4-type hysteresis loop.

3.1.7 HR-TEM

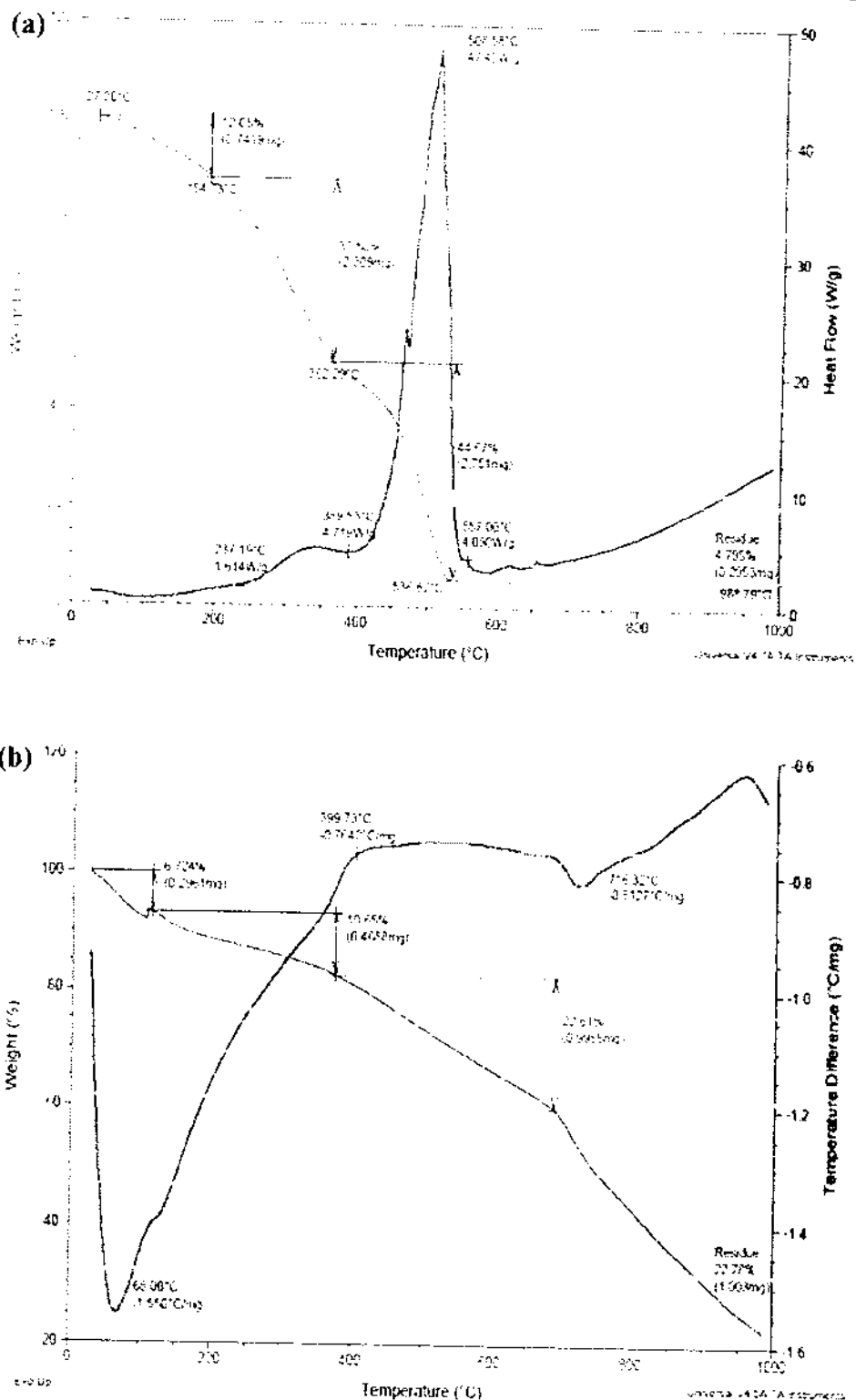
The structure of the prepared catalyst was also inspected by high resolution transmission electron microscopy (HR-TEM). TEM images (Fig. 7a–c) disclosed the uniform distribution of Pd nanoparticles on CAP-ash. The roughly

spherical Pd nanoparticles exhibit dimensions from 24 to 31 nm. The selected area electron diffraction (SAED) (Fig. 7d) pattern of the same confirms the crystallinity which was revealed from the presence of diffraction rings.

3.1.8 XPS Analysis

Chemical oxidation states of prepared catalyst was determined by X-ray photoelectron spectroscopy (XPS) technique. From XPS spectra (Fig. 8a) it is observed that peaks due to K, Ca, Mg, Na, C, O, and Pd displayed in the binding energy region from 0 to 1100 eV which confirms the

Fig. 5 DSC-TGA curves of a parent custard apple peels powder, b Pd/CAP-ash



Successful attachment of Pd on the surface of CAP-ash. Another interesting observation deriving from the XPS data (Fig. 8b) was the determination of the oxidation state of the catalytic activity site and the high-resolution Pd 3d XPS signals.

The characteristic peaks at 336.96 and 340.70 eV can be indexed to the Pd⁰ state and the other set of peaks at 337.95 and 342.02 eV are related to the Pd⁺² oxidation state [78, 79]. The XPS spectrum clearly shows that Pd⁰

Fig. 6. BET isotherm and pore-distribution curve of Pd/CAP-ash

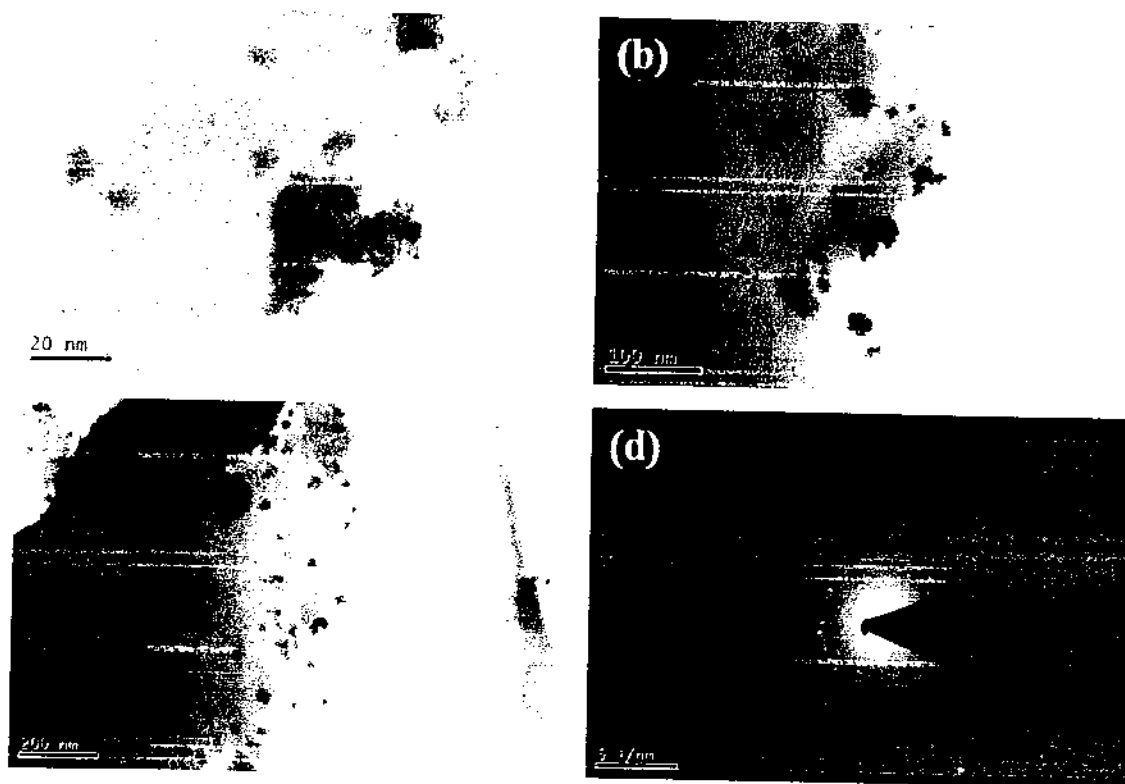
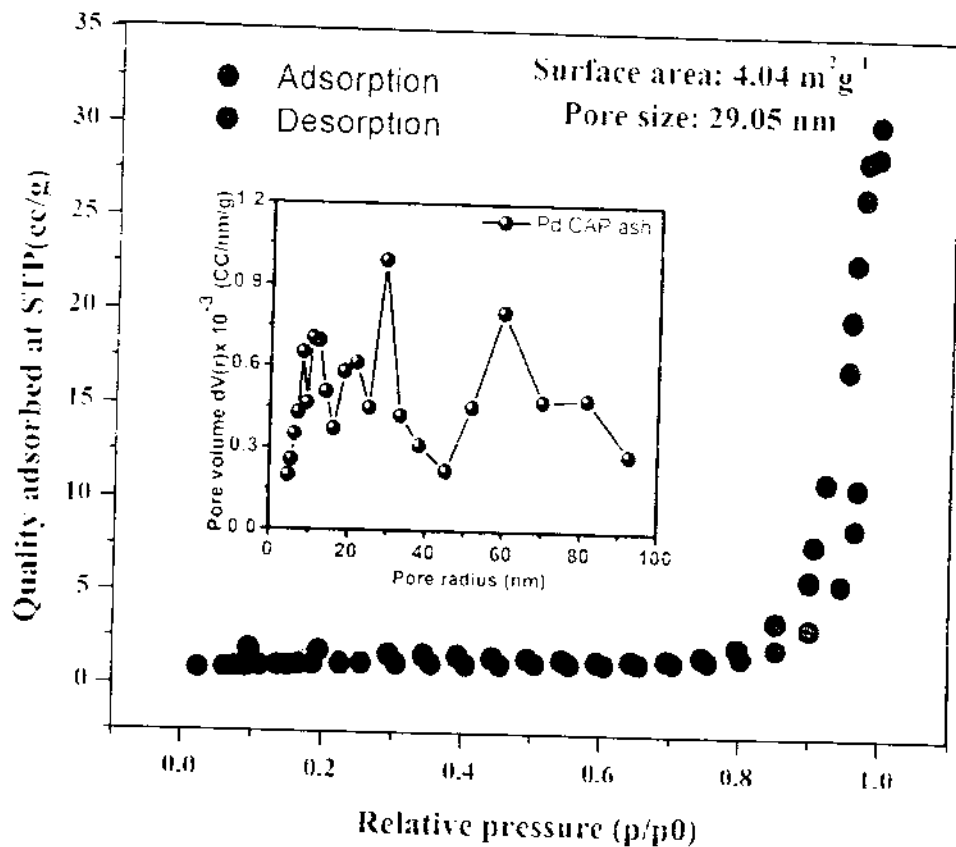
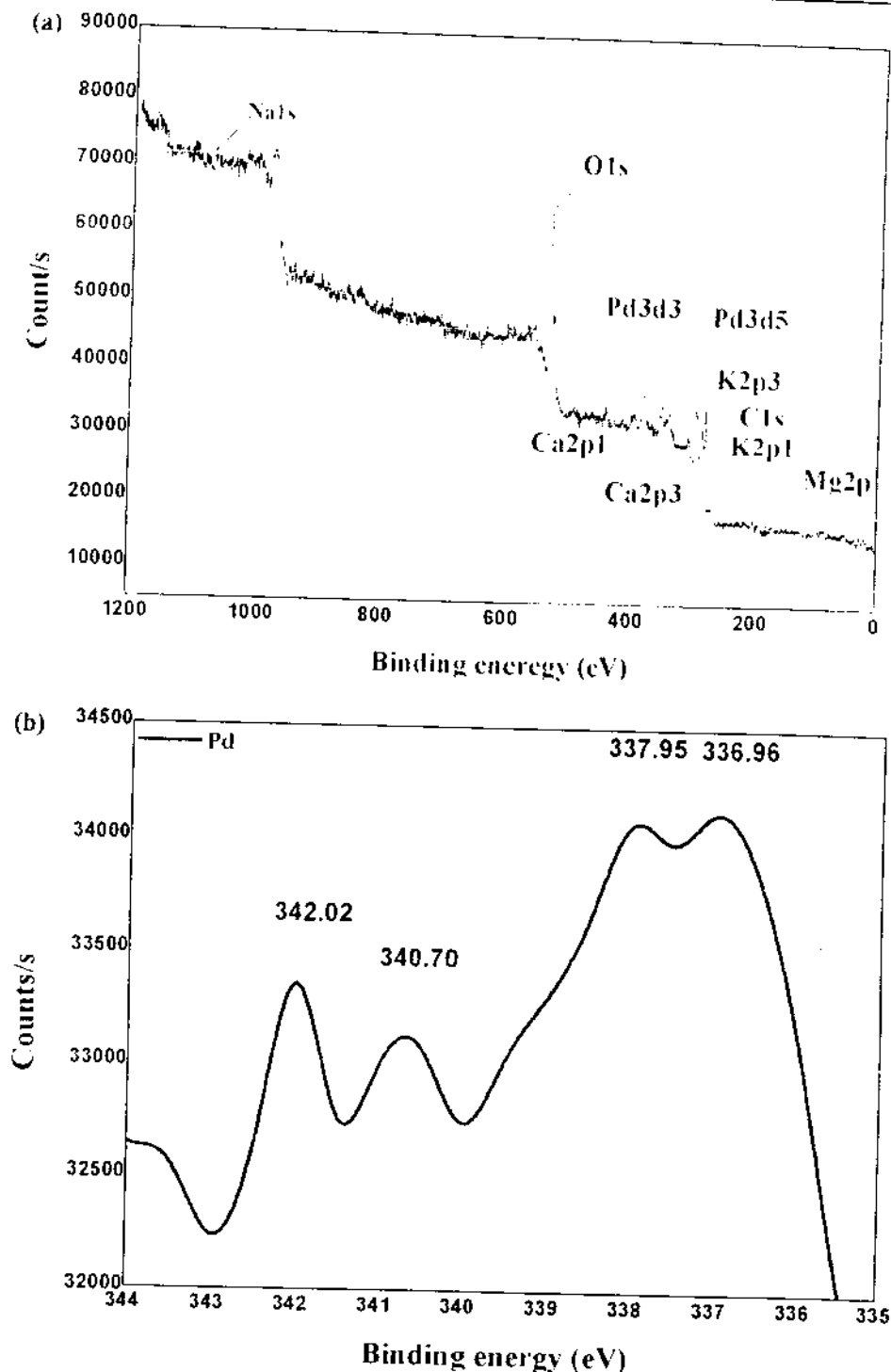


Fig. 7. a–c HR-TEM images and d SAED pattern of Pd/CAP-ash

Fig. 8 a Full-range XPS spectra of Pd/CAP-ash, b Pd 3d



is also present along with Pd⁺² oxidation state supports the reduction of Pd⁺² to Pd⁰ by metal oxides of CAP-ash.

3.2 Optimization of Reaction

To optimize the reaction conditions 4-bromobenzophenone was stirred with phenylboronic acid in presence of Pd/CAP-ash as a model reaction (Scheme 1) and results of the study

are summarized in table 1. Various solvents, catalyst amount and temperature conditions were screened in order to establish ideal coupling parameters.

Initially, 25 mL round bottom flask charged with 4-bromobenzophenone (1 mmol), phenyl boronic acid (1.2 mmol), Pd/CAP-ash (1 wt%) in water (3 mL) and the reaction mixture was stirred at room temperature. after 2 h low yield (30%) of corresponding product was observed on TLC

Scheme 1 Suzuki–Miyaura reaction of 4-bromobenzophenone and phenylboronic acid

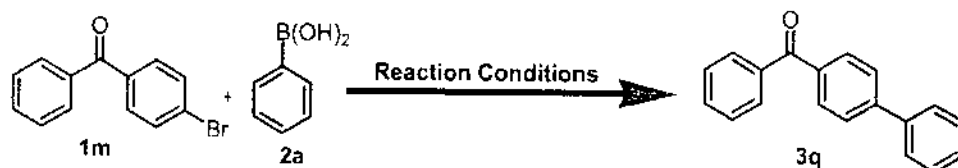


Table 1 Screening of amount of Pd/CAP-ash, solvent and temperature for Suzuki–Miyaura coupling reaction^a

Entry	Pd/CAP-ash (wt %)	Solvent (3 mL)	Temp. (°C)	Time (min)	Yield ^b (%)
1	1	H ₂ O	Rt	120	30
2	2	H ₂ O	Rt	120	36
3	3	H ₂ O	Rt	60	41
4	5	H ₂ O	Rt	30	43
5	10	H ₂ O	Rt	30	43
6	5	H ₂ O	80	30	87 (77, 83) ^c
7	5	MeOH	Rt	30	87
8	5	EtOH	Rt	30	91
9	5	DMF	Rt	30	88
10	5	DCM	Rt	30	43
11	5	THF	Rt	30	42
12	5	H ₂ O:EtOH (1:1)	Rt	10	98
13	Extract	EtOH	Rt	10	98 ^d
14	–	H ₂ O:EtOH (1:1)	Rt	60	Nr
15	5	–	Rt	60	Nr

^aReaction conditions: 4-bromobenzophenone (1 mmol), phenylboronic acid (1.2 mmol), Pd/CAP-ash (wt%) and solvent (mL) at room temperature

^bIsolated yields

^cYields of product at 60 and 100 °C temp

^dYields of product using CAP-ash water extract (3 mL) and Pd(OAc)₂ (0.5 mol%)

(Table 1, entry 1). On increasing catalytic amount (1 to 5 wt%), no significant improvement in the result was obtained after prolonged reaction time (Table 1, entries 2 to 5).

We continued our efforts for improvement in the result when model reactants were allowed to react at elevated temperature (80 °C), in presence of 3 mL water, after 30 min, surprisingly the product was obtained in 87% yield (Table 1, entry 6). Again, we were not satisfied with these results; therefore, we continued our efforts for better conversion of reactant into product. For this, we decided to examine the solvent system for improvement in the yield of the product. At first, to optimize a suitable reaction medium, the model reaction was performed in presence of different organic solvents such as MeOH, EtOH, DMF, DCM and THF as well as in H₂O:EtOH using catalytic amount of Pd/CAP-ash (5 wt%) at ambient temperature. To our utmost satisfaction, when H₂O:EtOH (3 mL, 1:1, v/v) was used as a solvent, a considerable enhancement in the conversion of reactants into the product was observed after 10 min with 98% product yield (Table 1, entry 12).

Moreover, when THF and DCM were used as solvents, product formation started but the reaction could not proceed

satisfactorily and it resulted into lower yield even after 30 min. (Table 1, entries 10–11). Furthermore, we also performed the model reaction directly in presence of water extract of CAP-ash (3 mL) in ethanol (3 mL), the result was equally good (Table 1, entry 13), but separation of catalytic residue from the product became a tedious. However, reactions were not performed at room temperature as well as at elevated temperature under catalyst-free and solvent-free conditions may be due to loss of homogeneity of reactant and catalyst (Table 1, entry 14, 15).

Furthermore, to investigate the scope and limitation of the current protocol, with high yielding conditions in hand, several test reactions were carried out using electronically diverse aryl bromide and boronic acid under the optimized reaction conditions (Table 2).

It was noticed that aryl bromides with electron-withdrawing substituents, like nitro, cyano, carbonyl groups at para-position, (Table 2, entry 3c–i) afforded the corresponding coupled products in excellent yield while in the case of meta-substituted electron-withdrawing groups the yield was very moderate (Table 2, entry 3j). It is important to mention that, generally, aryl bromides with electron withdrawing

Table 2 Suzuki–Miyaura coupling of aryl bromides and boronic acids in Pd/CAP-ash (3a–t)^a

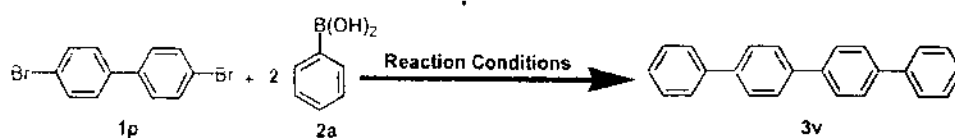
1a–n	2a–c	3a–t
3a ^b (10 ^c min, 96 ^d %)	3b (10 min, 90 %)	3c (5 min, 97 %)
3d (5 min, 94 %)	3e (5 min, 95 %)	3f (5 min, 92 %)
3g (10 min, 93 %)	3h (10 min, 90 %)	3i (5 min, 95 %)
3j (15 min, 88 %)	3k (15 min, 85 %)	3l (5 min, 94 %)
3m (10 min, 92 %)	3n (15 min, 85 %)	3o (10 min, 82 %)
3p (20 min, 78 %)	3q (10 min, 98 %)	3r (15 min, 96 %)
3s (10 min, 90 %)	3t (15 min, 88 %)	3u (10 min, 90 %)

^aReaction conditions: aryl bromide (1.0 mmol), arylboronic acid (1.2 mmol), Pd/CAP-ash (5 wt %), H₂O: EtOH (3 mL), room temperature in air, ^bentry, ^ctime, ^disolated yields

groups at the para position are much more reactive than aryl bromides bearing electron-donating groups. However, the reaction of aryl bromides with electron-donating groups, such as methoxy and amine, gave the coupling products with slightly lower yields (Table 2, entry 3k–l). No significant differences were observed in the yield with para as well as meta substituted electron-rich aryl bromides (Table 2, entry 3m). Further, to investigate the effects of the new catalytic system with sterically hindered substrate, we performed the reaction between 9-bromoanthracene and phenylboronic acid under similar reaction conditions. It was observed that 9-bromoanthracene gave superior product formation within

shorter reaction time (Table 2, entry 3n). No significant differences were observed in the yield when phenylboronic acid was replaced by naphthylboronic acid and 4-ethylphenylboronic acid (Table 2, entry 3a–b, 3q–t). The coupling with 5-bromo-1H-indole and phenyl boronic acid also occurs efficiently with low yield (Table 2, entry 3p).

Encouraged by these tempting results for coupling of aryl bromides with boronic acids for making biphenyls, we then decided to check the efficiency of Pd/CAP-ash catalytic system for double Suzuki–Miyaura coupling reaction under optimized reaction conditions (Scheme 2). Unfortunately after 1h very poor yield of the product was observed

Scheme 2 Double Suzuki–Miyaura reaction of 4,4′-dibromobiphenyl and phenylboronic acid


of H₂O when 1:2 molar quantities of 4, 4'-dibromobiphenyl reacted with phenyl boronic acid (Table 3, entry 1). A few methods are reported in the literature for double Suzuki–Miyaura reaction by the coupling of aryl dibromides with boronic acids employing various solvent systems such as DMF [80], DMSO [81], 1,4-Dioxane [82] and THF [83]. Therefore, we decided to optimize another solvent system for double Suzuki–Miyaura coupling reaction by keeping the same amount of catalyst.

For optimization study, the reaction between 4, 4'-dibromobiphenyl (1.0 mmol), phenyl boronic acid (2.4 mmol) in presence of Pd/CAP-ash (5 wt%) was performed in different organic solvents such as EtOH, CH₃CN, Toluene, DMF and results are summarized in Table 3. In case of EtOH, CH₃CN, and Toluene good to moderate yields of products were recorded (Table 3, entries 2–4) while DMF as a solvent gave quantitative yield after 60 min. Furthermore, it was observed that addition of water in DMF had a dramatic effect on reaction. When the reaction was carried out in H₂O:DMF solvent, the time required for reaction was drastically reduced to 15 min with excellent yield of the product (Table 3, entries 6–8). This effect is probably due to the fine dispersibility of CAP-ash in water and more solubility of organic substrates in DMF. As the drastic rate enhancement

was observed in a H₂O:DMF (4:1) (Table 3, entry 8), it was chosen as reaction solvent for further study.

From results demonstrated in Table 4 (entry 3u–w), it was observed that the double coupling also worked efficiently under this catalytic system with quantitative yields within stipulated time period.

3.3 Reusability of Catalyst

For any catalytic process, the reusability of catalyst is one of the most important aspects for possible application on commercial and industrial scale. In order to check recyclability of the catalytic system investigation of the reaction of 4-bromobenzophenone with phenyl boronic acid in presence of Pd/CAP-ash was done. After the first cycle, the reaction mixture was extracted with ethyl acetate (2 × 10 mL). The clearly separated organic fraction containing product has been removed from the system and the Pd/CAP-ash and aqueous layer remaining in the reactor were directly used for the next reaction run followed by addition of fresh reactants and ethanol. After 3 consecutive run the catalytic activity significantly decreases with a lower yield of cross-coupled product (Fig 9). The decrease in the yield of the model reaction on recycling was accounted to the fair dispersion of fine palladium particles into organic portion during the work-up process.

The catalytic activity of Pd/CAP-ash is currently not well understood. Although we did not investigate the reaction mechanism, a probable mechanistic rationale portraying the sequence of events for this cross coupling reaction is schematically shown by a conceptual picture (Scheme 3).

A carbon-carbon bond formation mechanism is very straight forward. The first step being oxidative addition of aryl halides to palladium metal which is supported on CAP-ash. This results in the formation of first organopalladium species. The organopalladium species on reaction with metal hydroxides present in CAP-ash are subjected to transmetalation with boronate complex. This leads to formation of second organopalladium species where both the aryl rings are attached to same metal. Finally this organopalladium

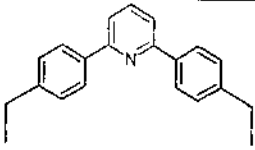
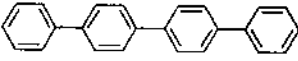
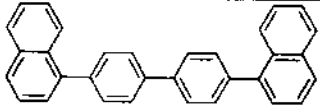
Table 3 Effect of solvent on double Suzuki–Miyaura coupling reaction^a

Entry	Solvent (3 mL)	Time (min)	Yield ^b (%)
1	H ₂ O:EtOH	60	41
2	EtOH	60	82
3	CH ₃ CN	60	80
4	Toluene	60	78
5	DMF	60	90
6	H ₂ O:DMF(1:1)	15	92
7	H ₂ O:DMF(2:1)	15	93
8	H ₂ O:DMF(4:1)	15	96

^aReaction conditions: 4, 4'-dibromobiphenyl (1.0 mmol), phenylboronic acid (2.4 mmol), Pd/CAP-ash (5 wt %) and solvent (3 mL) at room temperature

^bIsolated yields

Table 4 The Suzuki–Miyaura coupling of various aryl dibromides and arylboronic acids in Pd/CAP-ash (3u–w)^a

		
3u^b (15 ^c min, 92 ^d %)	3v (10 min, 96 %)	3w (10 min, 90 %)
^a Reaction conditions: aryl dibromide (1.0 mmol), arylboronic acid (2.4 mmol), Pd/CAP-ash (5 wt %), H ₂ O:DMF (3 mL), room temperature in air, ^b entry, ^c time, ^d isolated yields		

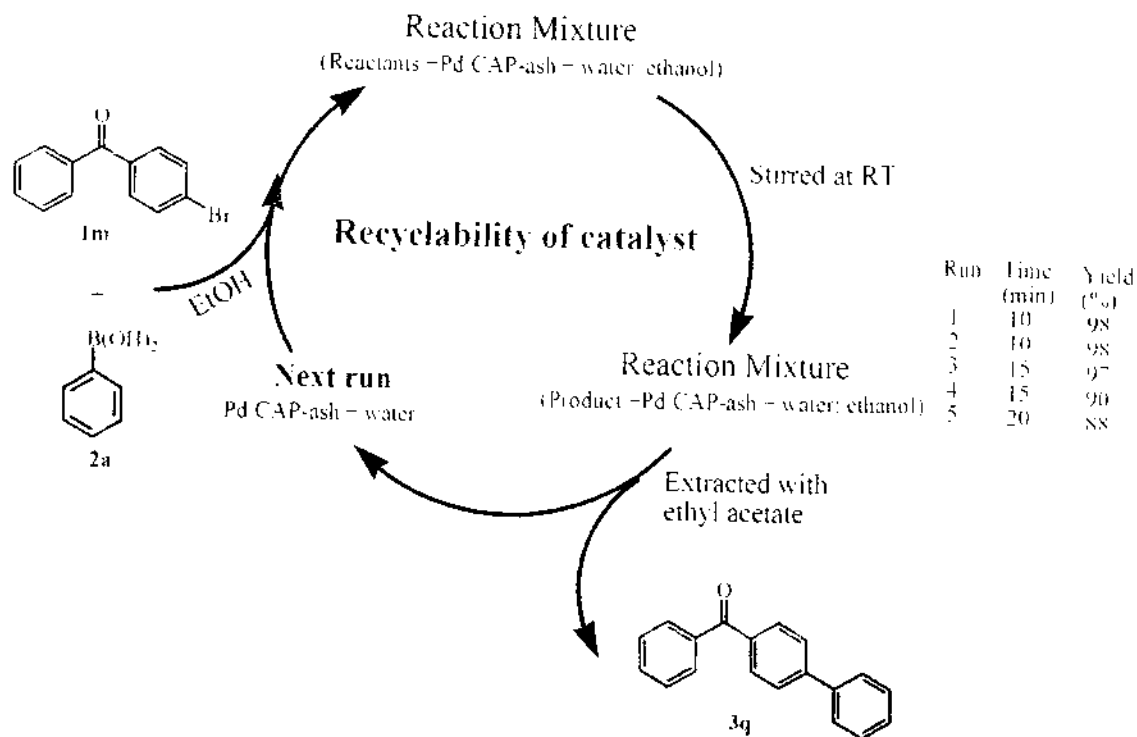
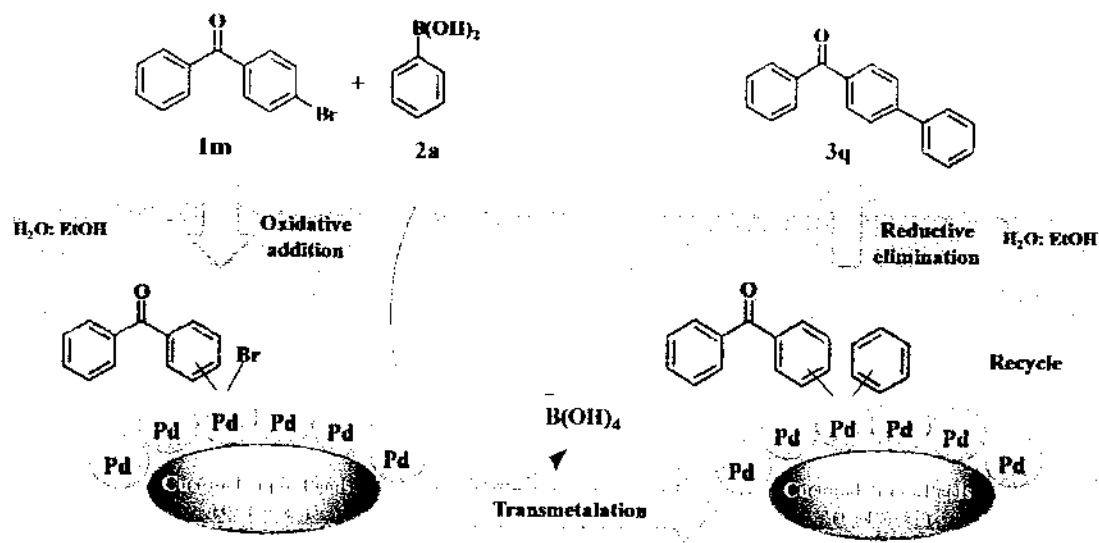


Fig. 9 Procedure for reusability of catalytic system



Scheme 3 Plausible mechanism of Suzuki–Miyaura coupling reactions in the presence of Pd/CAP-ash

species upon reductive elimination gives the desired biaryl derivatives.

The catalytic activity of Pd/CAP-ash was examined by comparing it with several reported catalysts (Table 5, entry 1–7) for Suzuki–Miyaura coupling reaction between 4-bromoanisole and phenylboronic acid. The comparison reveals that the most of the reported Pd catalysts acquired

high Pd loading, longer reaction time, use of base for the reaction. Pd/CAP-ash (Table 5, entry 8) is superior in terms of, external base-free, significantly avoids the necessity of an added ligand, non-toxicity, the low cost and eco-friendly reaction protocol that generates the product in very good yields.

Table 5 Comparison of Pd/CAP-ash catalyst with some previously reported catalysts for synthesis of **3k**

Entry	Catalyst	Water extract of agro waste ash (mL)	Co-solvent (mL)	Temp. (°C)	Time	Yield (%)	Ref
1	Pd(OAc) ₂ (1 mol %)	Rice Straw (3 mL)	–	RT	2 h	88	[81]
2	Pd(OAc) ₂ (0.5 mol %)	Banana peels (3 mL)	–	RT	5 min	99	[85]
3	Pd(OAc) ₂ (1 mol %)	Water Hyacinth (6 mL)	–	RT	3 h	88	[86]
4	Pd(OAc) ₂ (0.5 mol %)	Papaya bark (2 mL)	EtOH (2 mL)	RT	5 min	97	[87]
5	Pd(OAc) ₂ (1.0 mol %)	WEPA (3 mL)	EtOH (0.5 mL)	RT	5 min	99	[88]
6	Pd/RHA (0.5 mol% of Pd)	K ₂ CO ₃	EtOH (3 mL)	100	24 h	70	[89]
7	Pd/CCSF (0.5 mol %)	K ₂ CO ₃	EtOH	100	3 h	99	[90]
8	Pd/CAP-ash (5 wt %)	–	H ₂ O:EtOH (3 mL)	RT	5 min	93	Present work

4 Conclusion

In conclusion, we have developed cost-effective and a convenient greener protocol for Pd/CAP-ash catalyzed Suzuki–Miyaura coupling reactions under ligand free conditions in open air at room temperature. The absence of any additive/promoter, use of CAP-ash in aqueous organic solvent, wider substrate scope makes this protocol attractive pathway for Suzuki–Miyaura coupling reactions. The protocol greatly enhances the synthetic utility of biaryl products and adds a new dimension to chemistry of cross coupling reaction. The present protocol offers many advantages including high conversion in short reaction time, avoiding use of expensive and environmentally unfavorable organic ligands and external base, wasteful procedure using waste bio-mass for catalyst preparation, easily separated from organic product and recycling of catalyst system which carries a dramatic impact on the sustainability of the process. Further efforts to utilize present catalytic systems in other synthetic reactions are in progress in our laboratory, and we expect the methodology presented will find great utility in academic, research and industrial applications in the near future.

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1007/s10562-021-03597-6>.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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Variation in atmospheric air ion and its index of pollution during morning time (06:00 to 08:00 IST) in the sugarcane area at rural station Bhilawadi (16.5°N, 74.2°E)

Gajanan Patil*

Department of Physics,
Secondary School and Junior College,
Bhilawadi, 416303, Maharashtra, India
Email: gajananpatil2004@gmail.com

*Corresponding author

✓ **Subhash Pawar**

Department of Physics,
A.C.S. College,
Palus, 416310, Maharashtra, India
Email: supath345@gmail.com

Onkar Gurav

Department of Physics,
Yashwantrao Mohite College,
Bharati Vidyapeeth Deemed to be University (BVDU),
Pune, 411038, Maharashtra, India
Email: omgurav91@gmail.com

Jalindar Bhosale

Department of Physics,
Shikshan Maharshi Dr. Bapuji Salunkhe College,
Miraj, 416410, Maharashtra, India
Email: bhosalejl@gmail.com

Sonali Rananavare

Department of Physics,
Babasaheb Chitale Mahavidhyalay,
Bhilawadi, 416303, Maharashtra, India
Email: sonalir246@gmail.com

Abstract: The present paper reports the diurnal variation in -ve and +ve air ion concentration and pollution index in a sugarcane field [genus: *Saccharum* spp., variety: CO86032 (NAYANA)] in the vegetation area situated at rural station Bhilawadi (16.5°N, 74.2°E), India. It is a hybrid variety of CO62108 and CO671. The outcomes introduced in this investigation propose that the open ecological air or particularly the sugarcane zone shows enormous convergence of -ve air ions which are basic for human wellbeing. It is due to ionisation, photosynthesis, transpiration and radon exhalation process by sugarcane. The results presented in this study suggest that the open environmental air or especially the sugarcane area exhibits large concentrations of -ve air ions which are essential for human health. Though all living beings interact with the environment, only human beings have less interaction with the environment, so attempts should be made to use natural resources to have better health.

Keywords: air ions; sugarcane; radon; ionisation; transpiration; environment; pollution index.

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Biographical notes: Gajanan Patil is currently working at the Secondary School and Junior College, Bhilawadi. His research areas are air ions and atmospheric physics. He is a student of the Shivaji University, Kolhapur.

Subhash Pawar is currently working as an Associate Professor at the Arts, Commerce, Science College, Palus. He has ten national and international papers. He does research in biophysics, geophysics and medical physics. Their current project is atmospheric physics and biophysics.

Onkar Gurav is currently working as an Assistant Professor in the Department of Physics, Yashwantrao Mohite College, affiliated to Bharati Vidyapeeth Deemed to be University (BVDU), Pune. He completed his PhD in Space Physics from the Shivaji University, Kolhapur, MH, India. He also worked as a Research Associate at the Indian Institute of Geomagnetism (IIG), Mumbai. During his PhD research, he has visited the ISRO, VSSC Trivandrum, NARL Gadanki, JNU Delhi, IIT Roorkee, IUCAA Pune, etc. His research areas include ionosphere, ionospheric irregularities, geomagnetic storm, GNSS, total electron content in the ionosphere, gravity waves in mesosphere, air ion concentration, etc.

Jalindar Bhosale is currently working as an Associate Professor at the Shikshan Maharshi Dr. Bapuji Salunkhe College, Miraj. He has five research publications in international and two national publications. Two students were awarded PhD under his guidance. His research area is material science.

Sonali Rananavare is currently working as a Lecturer at the Babasaheb Chitale Mahavidhyalay, Bhilawadi. Her research areas are air ions and atmospheric physics.

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(30)

1 Introduction

All airborne particles in the environment with electrical conductivity and charge (+ve and -ve) are known as air ions. Air is a mixture of different gases. Natural air ions are generally produced in many ways such as gamma rays, natural radioactivity, cosmic rays, waterfalls and wind motions (Krueger and Reed, 1976). Ionisation, attachment and clustering are three phases for stable forms of ions. When an atom loses or gains electrons then it is said to be positively or negatively charged ion, respectively. This process is called ionisation. For an atom or molecule which is electrically neutral and balanced, it is said to have an equal number of protons and electrons. Losing an electron, atom or molecule becomes +ve ion whereas gaining becomes -ve ion. The concentration of such air ions (both +ve and -ve) in the atmosphere affects human health. Depending upon their proportion and concentration, they may be beneficial as well as harmful for humans. The discomforts like headache, fatigue, nervousness, high blood pressure, joint aches and decrease in work productivity are due to the presence of higher +ve ions in the air. On the other hand, -ve air ions have +ve effects on human health. The negative air ions are beneficial for human health in the context of their mind as well as immunity level. We feel happy, relaxed and breathe easy in the presence of -ve air ions. The chemical called serotonin present in the blood may get reduced under the exposures of negatively charged atmospheric air ions (Diamond, 1988). Ions have antibacterial effects which decrease allergens and a number of microorganisms in the air.

Several researchers in the past have studied the air ion concentrations, their variability and production rate. The diurnal air ion concentrations in the atmosphere, aerosols, ozone, etc. have been measured from Belgrade (44°50'N, 20°37'E) by Kolarz and Filipovi (2008). Their analysis shows that the air ions both +ve and -ve as well as ozone concentrations are directly proportional to each other. On the other hand, the aerosols have a strong opposite correlation with that of air ions. Pawar et al. (2010) studied the season wise as well as day wise variations in air ions using a Gerdien condenser during June 2007 to May 2008 at one of the rural places Ramanandnagar which is located in Sangli District and at urban place Pune which is a tropical region. Their study suggests that, the air ion concentrations measured at Pune station found to be increased from night time and reached maximum in the early morning. Pawar (2013) utilised Gerdien condenser air ion counter for measurement of air ions variation according to meteorological parameters such as temperature, relative humidity, etc. The air ions in the atmosphere can also be generated due to lightning during thunderstorms. Subramanian and Jagadesan (2014) measured air ion concentrations produced in Pudukkottai district (10.23°N, 78.52°E) of Tamil Nadu, India and found that the production of air ions during the occurrence of lightning and thunder has enhanced the process of photosynthesis (i.e., production of starch) by green plants and crops. The radon concentration is found to be maximum in the lower portion of the troposphere (0-5 km). The daily cycle of air ion variation is owing to the ionisation process triggered through cosmic waves as well as energetic minerals present in the atmosphere. However, some changes can also occur due to changes in radon concentrations. Sugarcane is the crop which needs more water for its cultivation. The radioactive gas which is naturally present or produced in air is nothing but ^{220}Ra . It is a daughter nuclide of ^{226}Ra . This radon can be drawn out through smaller pores of soil and ultimately exposed into the atmosphere.

The aim of the present paper is to measure air ion concentration in the sugarcane area at rural station Bhilawadi and study the effect of sugarcane field on the air ion production rate as well as pollution index.

2 Instrumental description

The air ion counter used in the present study is indigenously developed at A.C.S. College, Palus by Patil et al. (2019). A small air ions present in the atmosphere have been measured by Gerdien condenser during campaign observations. It is shielded from outside using a coaxial cylinder fixed with bakelite spacers. A brass sheet as well as chrome plate is used to make this condenser. A suction pump is fitted to a condenser via coaxial cylinder which sucks up the air particles in the atmosphere (Harrison, 1992). The rate of the air flow in the condenser is easy to vary by just adjusting the voltage of the suction pump. Anemometer (AM-4201) is a device used for the measurement of velocity of air molecules. This Anemometer is sensitive and has accuracy of 0.005 m/s. An operational amplifier (AD549JH) is utilised to transform current measured in the data logger (ref. Figure 2).

Now, the flow rate (\emptyset) can be given as,

$$\emptyset = v\pi(r_o^2 - r_i^2)$$

where r_o is the radius of the external cylinder and r_i is the radius of the internal cylinder. Now, air ion concentration denoted by N can be written as,

$$N = I / (e\emptyset)$$

In the above equation, I depicts the initial current given and e depicts the ion charge which is $1.6 \times 10^{-19}C$.

To measure air ion concentrations of the atmospheric species such as +ve and -ve ions, the polarity of the circuit can be changed. A personal computer with voltmeter and data logger is used to store the continuous data. Also, Rishcom software is used for data acquisition.

3 Measurement and methods

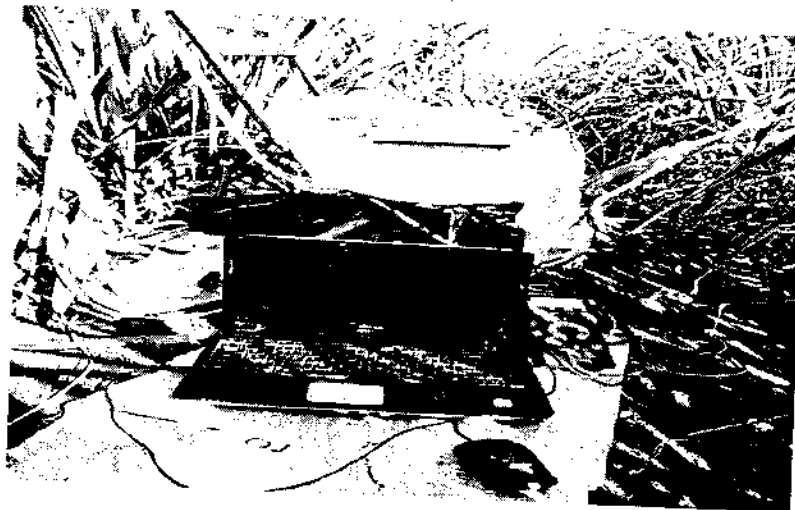
The campaign observations were carried out in a sugarcane field at Bhilawadi (16.5°N, 74.2°E) which is located in the rural area of Palus Tehsil and Sangli District in Maharashtra State. There is a river named 'Krishna' which flows ~3.5 km away towards the northwest side from the location. There is a 90 feet high mobile tower stationed at a distance of 0.5 km from the observation location. Also, 10 feet road having average traffic of 2 to 4 motor vehicles in half an hour were there. The variety of sugarcane field in which the measurement is carried out is CO86032 (NAYANA) which is mostly cultivated in rural areas in Maharashtra (refer Figure 1 for sugarcane field). It is a hybrid involving CO62198 as female parent and CO671 as male parent. The experimental setup (explained in the next section) is kept in the middle of the sugarcane field for the measurement of air ion concentration. The +ve and -ve air ions have been measured during the period from 15 Oct. 2018 to 29 Oct. 2018 with time resolution of 30 seconds.

The average ions on a daily basis were estimated from collected data. The soil at the observatory is a complete black soil. It has an arrangement of supply of river water through irrigation systems. The unipolarity factor viz. the pollution index is also calculated for the sugarcane field. The pollution index can be defined as the ratio of average +ve air ions to the average -ve air ions. If this index is higher than unity, then it is risky and the density of aerosol will be higher in the atmosphere. For healthy human life pollution index should be less than 1 (Grinshpun et al., 2005).

Figure 1 The photograph of sugarcane field (variety: CO86032) in Bhilawadi (see online version for colours)



Figure 2 Experimental setup installed in the sugarcane field during campaign observations in Bhilawadi (see online version for colours)

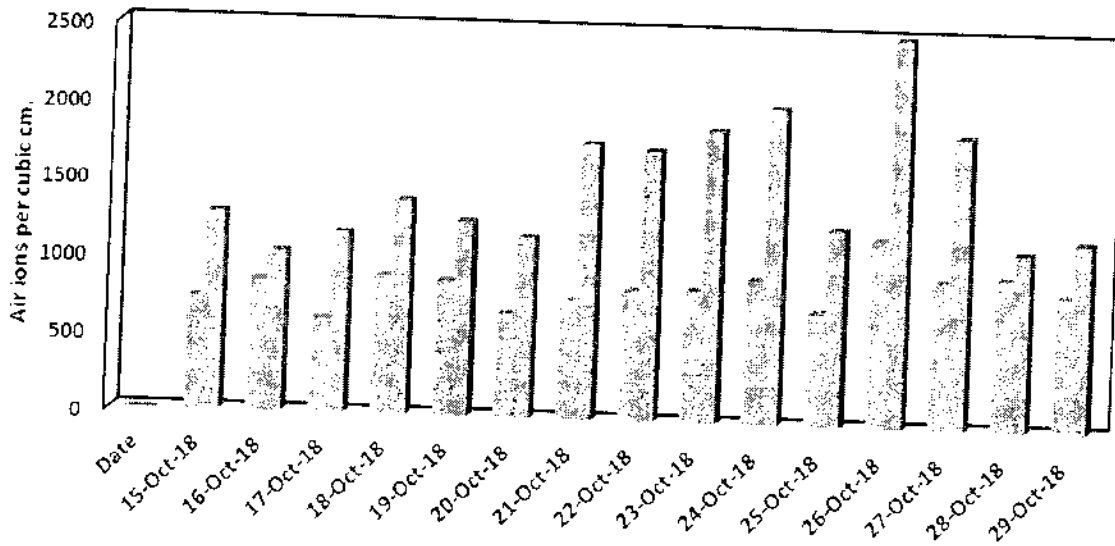


4 Result and discussion

The air ion concentration of sugarcane CO86032 is measured continuously during 15 October 2018 to 29 October 2018. The air ion variation and pollution index of +ve and -ve air ions have been measured. Figure 3(a) shows the average +ve (blue bars) and -ve

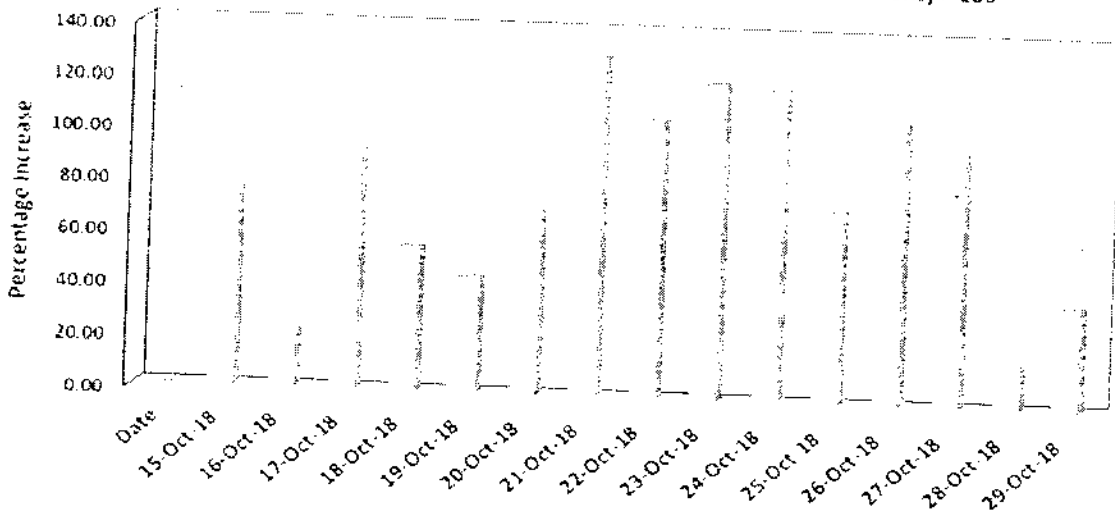
(red bars) air ions during 24 hours of each day of observations. It is seen that the average numbers of -ve as well as +ve ions are in the same proportion. The concentration of -ve air ion is more than that of +ve air ion. This can be attributed to the sugarcane field wherein -ve air ions are dominant. We have also calculated the percentage increase in -ve air ions w.r.t. +ve air ions as depicted in Figure 3(b). The formula for percentage increase is, percent increase = $[(-ve\ air\ ions - +ve\ air\ ions) / +ve\ air\ ions] \times 100$. This shows how -ve ions are varying w.r.t. +ve air ions in percent. It is seen that the percentage increase is dominant on 21st October 2018.

Figure 3 (a) Average +ve (blue bars) and average -ve (red bars) air ions during 24 hours of each day of observation (b) The green bars indicate the percentage in increase of the -ve air ions w.r.t. +ve air ions (see online version for colours)



(a)

Percent increase = $[(negative\ air\ ions - positive\ air\ ions) / positive\ air\ ions] \times 100$

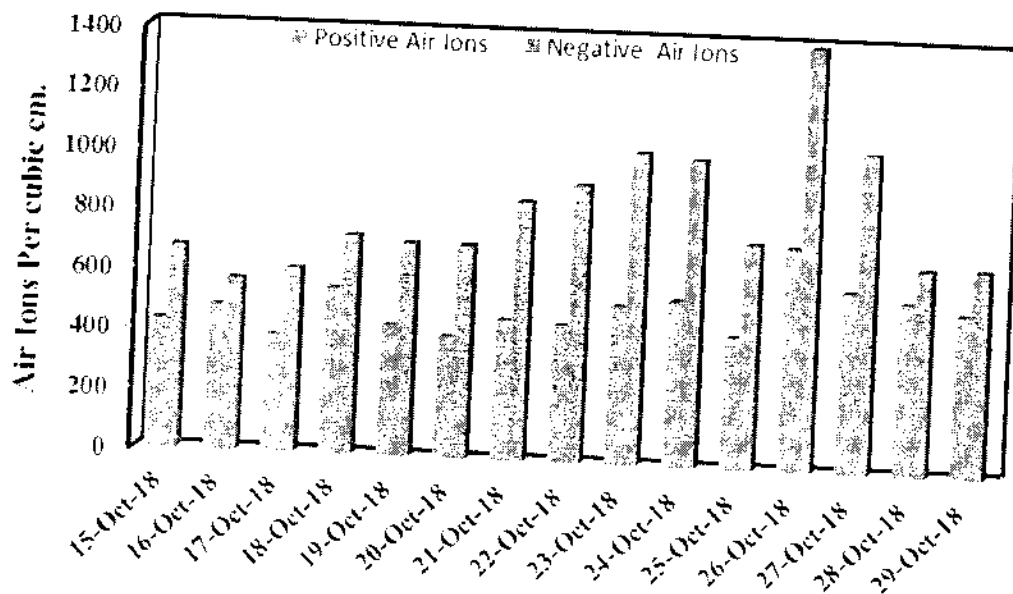


(b)

The average +ve and -ve air ions during 06:00 to 08:00 IST period are depicted in Figure 4 which also shows nearly the same increase in both the species. Actually, there is equivalence between +ve as well as -ve air ions throughout the day. Further, it shows that

numbers of +ve ions seem to be less with respect to the number of -ve ions. It also shows that the number of -ve ions increases with increase in +ve ions. In Figure 4, on 26 Oct. 2018, we can see the drastic increase in -ve ions unlike other days. This is due to the thunderstorms and small raining persisted on that day which results into the -ve air ion formation accompanied by corona effect. The strong electric field can be produced by applying voltage to a sharp ionising point to electrons which is used in corona ionisers. The +ve electric voltage accelerates free electrons towards a sharp ionising point (leaflet of sugarcane) in the atmosphere. These electrons are produced by decay of radioactive elements in air and soil. Due to collision between air molecules and electrons, number air ions were produced. When they lose electrons become +ve ions and by gaining electrons become -ve air ion. This is the corona effect which is dominant during thunderstorms. The daily maximum values of +ve and -ve air ions are plotted in Figure 5. It also shows a maximum peak of -ve air ion on 26 Oct. 2018. On the other hand, the minimum value of +ve air ions was noted on 17 Oct. 2018.

Figure 4 Average +ve and -ve air ions during 06:00 to 08:00 IST of each day of observation (see online version for colours)

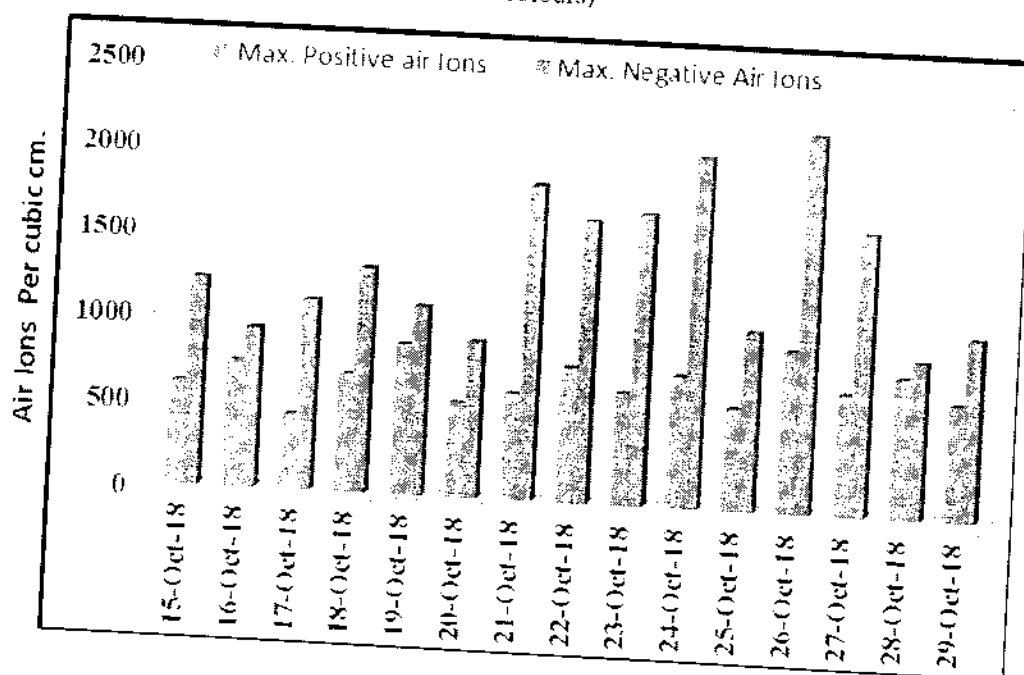


Radon gas gathers nearer to ground in a quiet atmospheric condition such as night time and also it is heavier than air (Jayaratne et al., 2011). The α -particle generated from Ra^{222} decay has energy of 5.4 MeV. This energy is adequate to generate 10^5 pairs of atmospheric air ions (Burcham, 1973). Thus, we can say that air ion density is directly related to the radon level. During dawn hours, the radon release expectancy is maximum in sugarcane vegetation. Due to which there is an increase in air ion concentrations in the sugarcane field.

In Figure 6, it is seen that the pollution index is below one which is best for human health and this indicates that the atmosphere in the sugarcane field is good for human health. In the morning period, we always see that workers, farmers and other field work labours have been working properly with energetic mood and freshness. The scientific reason behind this is that there are maximum numbers of -ve air ions are present during the morning period. This -ve air ions have +ve effects on human health such as delightful mood, peaceful sleep, more work productivity, etc. Also, it is beneficial to animals and

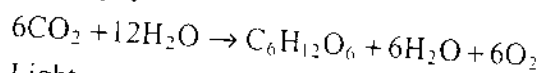
all living beings. The strong energy level as well as positive mood is accompanied by maximum concentrations of -ve air ions present in the atmosphere we breathe (Thayer, 1989). On the other hand, +ve air ions are responsible for discomfort, headache, high blood pressure, nervousness, etc. in human life. From analysis, the average pollution index for October month is found to be 0.59. The average count of +ve air ions was 845 ions per cubic centimetre and that of -ve ions was 1,505 ions per cubic centimetre. The upsurge in air ion concentration is associated with the plant transpiration of sugarcane area and also due to radon exhalation. From the present investigations, the sugarcane field is indeed found to be rich in -ve air ion concentration. During morning in most of the farms in rural area, we feel good and happy due to the large density of -ve atmospheric ions in the sugarcane field. They act as vitamins for humans. Photosynthesis is a process during which food material is synthesised from carbon dioxide and water in green plants with the help of chlorophyll in the presence of sunlight. CO_2 and H_2O act as raw materials. It is thus an oxidation-reduction process. This process involves many chemical and photochemical reactions. In this process, O_2 is given out.

Figure 5 Daily maximum and minimum +ve and -ve air ions during 24 hours of each day of observation (see online version for colours)



A simplified overall formula for photosynthesis is given by Brown et al. (1977) as follows:

Chlorophyll



Light energy

In the respiration process, O_2 is taken in and CO_2 is released in the air. But in the transpiration process, water is released in the form of water vapour which includes radon also. Due to the release of radon through stomatal or cuticle transpiration, there is a production of air ions in the vicinity of plants (e.g., sugarcane). The process of transpiration and photosynthesis increases with temperature. So it observed an increase in

the ions formation after 7:00 hours and so on. The effectiveness of plant transpiration of ²²²Rn and ²²⁰Rn is due to its concentration in the soil, gas and solubility in water. The water solubility of radon is higher at low temperature. ²²²Ra exhalation from soil and leaves of sugarcane fields have exponential growth. The radioactive decay sequence of ²²²Ra is given by Martell (1985) as follows:

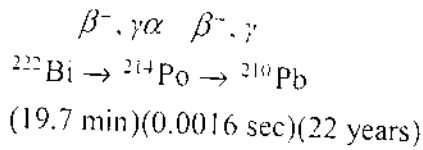
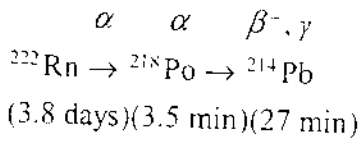
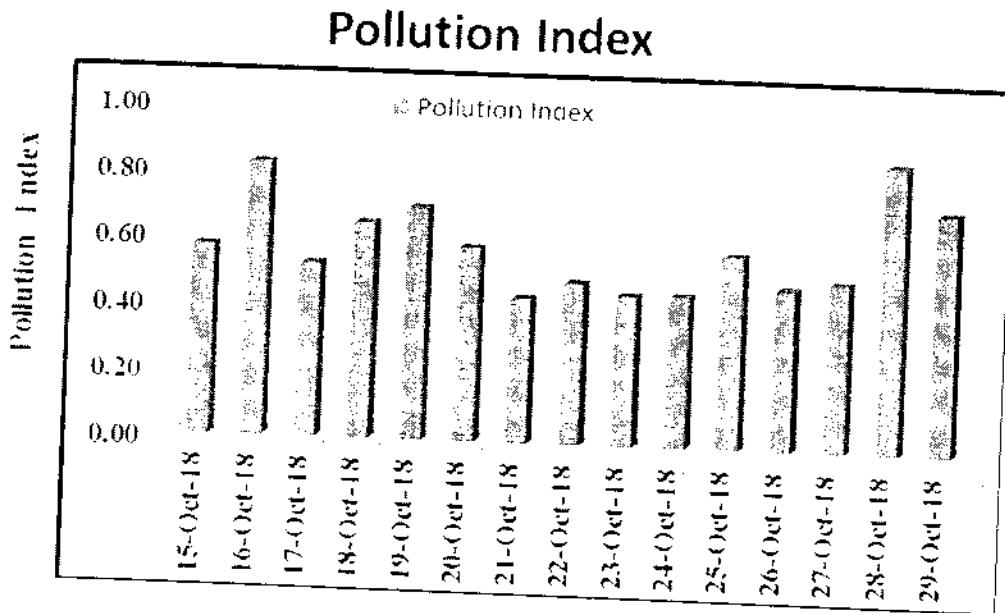
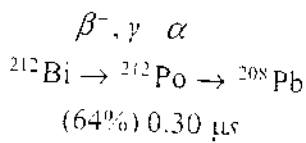
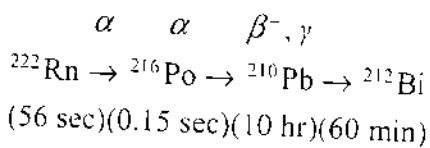


Figure 6 Pollution index calculated on each day of observation (see online version for colours)



Jesse and Sadaukis (1957) reported that the average energy necessary to generate one air ion pair for alpha particles is nearly 35 eV. And for beta particles, X-rays and γ -rays this energy is 33.8 eV. In ²²²Rn disintegration, 6.4×10^5 air ions are produced. The radioactive decay sequence of ²²⁰Ra is given by Martell (1985) as follows:



^{220}Rn and ^{216}Po undergo α -particle and β -particle emission till complete decay within the vegetation canopy. This is due to their very short half-lives. This production of air ions due to transpired radioisotopes is ten times more than the rate of air ion production by cosmic rays.

From this, it is clear that plant transpiration including stomatal as well as cuticle plays an important role in the increased value of air ion concentration. Also, radon generated in the Earth's crust produces air ions due to the radon exhalation process. In the photosynthesis process, sugarcane crops with increase in temperature produce air ions.

5 Conclusions

As air ions in the environment play an important role in human life so it is necessary to study air ion concentrations for different crops. We have measured +ve and -ve air ions by using indigenous ion counters. The average pollution index for the sugarcane field was found to be 0.59 at Bhilawadi during morning period 6:00 to 8:00 hours which indicates non-hazardous atmosphere. In sugarcane vegetation area, stomatal and cuticle plant transpiration plays vital roles for generation of air ions. Sugarcane area is a natural shower of -ve air ions. Hence, instead of using artificial air ionisers, it is always better to go in nature. We have observed remarkable enhancement in the air ion concentration in the sugarcane field in morning hours. Apart from development in numerous areas which is called as globalisation, the conservation of nature must be our moral obligation which will be beneficial to all living beings including humans and for future generations as well. The present study shows that the concentration of -ve atmospheric air ions in the sugarcane field is high during 06:00 to 08:00 in early morning hours. Generally, in the environment, sugarcane is an opportunity for air quality improvement and acts as a cash crop for farmers which are also useful for sustainable development. Basically, we observe that the farmers or workers are healthier than professionals and employers in urban or metro areas because farmers are in the vicinity of nature. They get fresh air which contains more -ve air ions. Indirectly, nature provides us healthy air full of -ve air ions associated with different vegetation. Thus, nature is a natural shower of air ions. Different crops give rise to different numbers of air ions at different time instances depending upon other meteorological conditions. Our future study is to measure air ion concentration in different vegetation areas and to find out which crop at what time exhibits healthier atmosphere for humans in the rural areas.

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ON THE OCCURRENCE OF *GINKGOITES* SP. FROM RAGHAVAPURAM FORMATION, ANDHRA PRADESH*

BY

V. M. Shendage*

Department of Botany; Arts, Commerce and Science College, PALUS – 416310 (MS), India

S. R. Manik*

Department of Botany; Sant Gadage Baba Amravati University, AMRAVATI – 444602 (MS), India

ABSTRACT

The upper Gondwana palaeofloristic deposits were found in the form of detached out crops in the coastal regions of Andhra Pradesh. Plant remains were richly fossiliferous made by the palaeofloristics floral evidences in the west Godavari district. Baksi, S. K. (1968) reported and identified the Pteridophyte members of *Cladophlebis* sp. The Gymnosperms were dominant, including orders of Bennittiales, Cycadales, Coniferales and Ginkgoales in the Raghavapuram Formation. Seward, A. C. (1919) reported *Ginkgoites crassipes* (Feistmantel) and Baksi, (1967) described *Ginkgoites feistmantelii* (Bose and Sukh-dev) in the Raghavapuram Formation of Godavari region. Sahni, B. (1928) described and published the palaeofloristics plant taxa of west Godavari district. Baksi, (1968) described *Dicroidium* sp. and Bennittiales members of *Ptilophyllum* flora from the region of Raghavapuram Formation. It suggests the palaeofloristic-climate and palaeo-environment by considering the dominance of this flora. Recently several plant impressions were collected from the localities in Raghavapuram area of west Godavari district of Andhra Pradesh. One of the promising specimens is described below as *Ginkgoites* sp.

Keywords: Ginkgoales, Impressions, Raghavapuram, West Godavari, Andhra Pradesh.

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* Correspondence Author: Dr. Rajeshkumar Wamanrao Soor

INTRODUCTION

Along the East Coast of India Upper Gondwana plant fossils are found in the form of series of detached out crops. In Andhra Pradesh, they are found in Raghavapuram Formation of West Godavari regions. The present work deals with the leaf impressions found at Raghavapuram in West Godavari district of Andhra Pradesh. Baksi (1967 & 1968) visited this locality and described the **Palaeofloristic** data of the area. We made an attempt to investigate the plant fossils impressions of this area and added some important members belonging to Pteridophyte and Gymnosperms. In this paper the Ginkgoales plant impressions found at the locations of Eddla Gattu near Raghavapuram have been described. Hence a lone member of Ginkgoales which was not described earlier (MAP No - I)

MAP No - I: Showing Fossiliferous locality Raghavapuram.

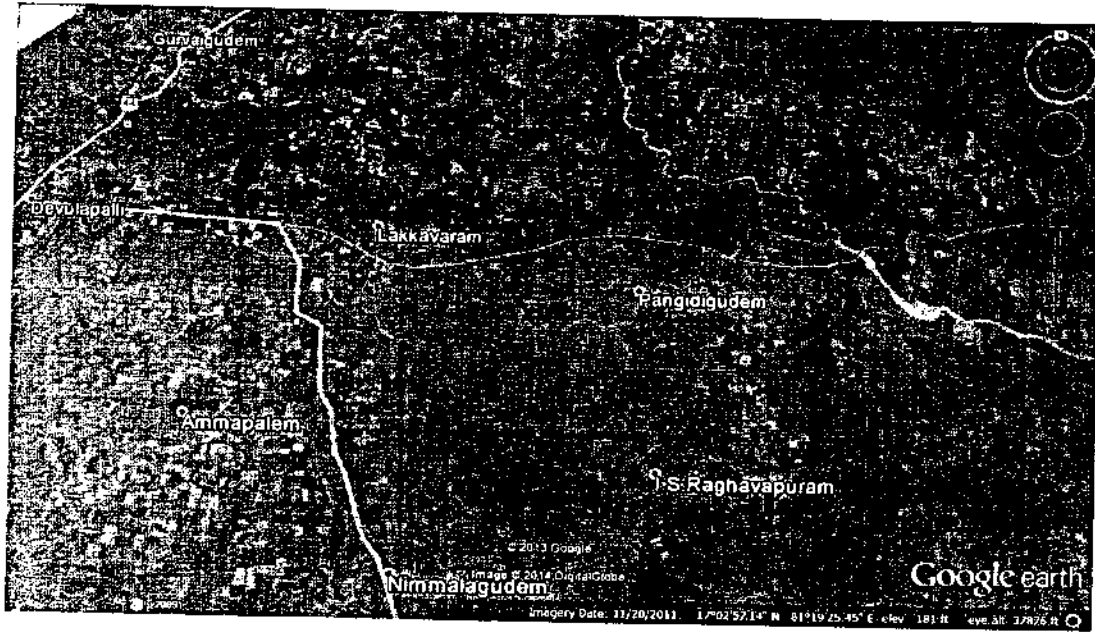


PLATE - 1



EXPLANATION OF PLATE FIGURE

1. *Ginkgoites* sp. X 2

DESCRIPTION

GINKGOALES

Genus - *Ginkgoites* Seward 1919

Ginkgoites sp.

It is a young leaf oval-elongate in shape and measures 1.2 cm in length and 0.8 cm in width, petiole not seen, number of veins 8, there is a notch on the upper margin. The veins show single dichotomy on upper part.

IDENTIFICATION AND COMPARISON

It is identified as *Ginkgoites* due to its venation pattern. It is compared with *Ginkgoites* sp. described by Baksi (1968) from Narsimha Meta near Raghavapuram. Present specimen is collected from Eddla Gattu in the nearby region. This supports the occurrence of *Ginkgoites* in this area.

Type - EDG/6/2013

Locality - Eddla Gattu, Raghavapuram Formation, West Godavari District, Andhra Pradesh Horizon & Age - Raghavapuram Formation, Early Cretaceous

DISCUSSION AND CONCLUSION

The paper deals with Palaeofloristic flora developed along the coastal regions of Andhra Pradesh. Here is a Ginkgoales plant fossil impressions found in the Raghavapuram region of west Godavari district. It is found that the upper gondwana flora of east-coast is somewhat distinct. We have been attempting to rediscover the fossil flora of Raghavapuram Formation. The flora is meagerly studied by previous workers. Hence, we have to study the different locations and describe the plant fossil impressions found there in. We have limited the observations for Cycadophytes and Ginkgoales members. A lone prominent member of Ginkgoales described here, these are indicators of palaeo-environment existed in the Mesozoic eras. It suggests that the warm and humid climate was prevalent as evidenced by the palaeofloristic vegetation that was growing on hilly places near the east-coast regions of Andhra Pradesh.

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PALAEOFLORESTIC DIVERSITY OF UPPER GONDWANA BEDS FROM ANDHRA PRADESH, INDIA*

BY

V. M. Shendage*

Department of Botany, Arts, Commerce and Science College, Palus- 416310, Maharashtra, India.

S.R Manik*

Department of Botany, Sant Gadge Baba Amravati University, Amravati- 444 602, MS, India.

Vagyani B.A. *

Department of Botany, Shivaji University, Kolhapur- 416004, Maharashtra, India.

ABSTRACT

The Mesozoic assemblage of plant fossils signifies the luxuriant growth of Gymnosperms that have an impact on origin of Angiospermic vegetation. The diversification of gymnosperms along with emergence of angiospermic floral plant remains also helps in deciphering the palaeoecological conditions prevalent in the area.

The Upper Gondwana deposits are exposed in Krishna- Godavari, Cauvery and Mahanadi basins. They are specially found in East Godavari, West Godavari, Prakasam and Mahanadi basins. They are well represented in East Godavari and West Godavari, Prakasam and Vishakhapattanam districts. The plant remains were collected from Vemavarum, Ommevarum, Uppugundur, Prakasam and other adjoining localities from Andhra Pradesh, India.

The detailed investigation revealed the occurrence of Cycadophytes, Coniferophytes, and Ginkgoales with predominance of Bennettitales and Coniferous assemblage. All the megafossils are preserved in the form of impressions on yellow and reddish white coloured sandstones and shales.

The floristic composition of the various geological formations can be assessed with respect to their dominance, similarities and diversity pattern. Thus, it is also important to know about the ecological conditions as evidenced by preservation of plant assemblages in various localities.

The plant fossils recovered from the new locality viz. Errayagudem preserved in white-grey coloured sandstones revealed the dominance of Ptilophyllum flora along with well preserved coniferous remains. Similarly, plant assemblage from Raghudevapuram and Kurukuru represented dominance of gymnosperms along with few members of pteridophytes.

The palaeofloristic composition of Godavari districts in Andhra Pradesh represents an occurrence of distinct floral elements with impact on determining the age and palaeoclimate during upper Jurassic-early Cretaceous period. Particularly, the locality Raghudevapuram in east Godavari district can be regarded as unique due to presence of angiospermic remains in intertrappean beds around Rajahmundry. The plant assemblages suggest the warm and humid climate on account of cycadophytes along with small patches of high-altitude harbouring conifers. The pteridophytes though

rare are indicative of moderate climate with good rainfall in East and West Godavari districts of Andhra Pradesh during upper Jurassic-early Cretaceous period.

Key words: *Godavari district*, *plant assemblage*, *gymnosperms*, *early Cretaceous*,

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* Correspondence Author: V. M. Shendage

INTRODUCTION

The Gondwana flora offers large scope due to its palaeofloristic diversity and rich components found in it. Hence in last 125 years several workers began studies on the flora. Fox (1931) used the term Gondwana system for the rock types. The system resumes from middle Carboniferous and last up to early Cretaceous covering the period of 120 million years. The Gondwana rocks are present in peninsular India. Gondwana system is classified as – i) Lower Gondwana ii) Middle Gondwana and iii) Upper Gondwana. Each division is represented by a characteristic flora, - 1) *Glossopteris flora* in Lower Gondwana, 2) *Dicroidium flora* in Middle Gondwana, and 3) *Ptilophyllum flora* in Upper Gondwana. The present paper deals with studies on Upper Gondwana beds, the palaeo-flora present on the east coast of India in Andhra Pradesh.

Along east coast the Upper Gondwana flora is exposed in Andhra Pradesh at Ommevaram in Prakasam district, Raghavapuram in West Godavari district and Raghudevapuram in East Godavari district. Among all these floral diversity Ommevaram shows rich contents and studied by several workers, namely Sahni (1928), Bose and Kasat (1972), Bose (1974), etc. As compared to these Raghavapuram flora is meagerly studied. Feistmantel (1879) made primary studies on the Raghavapuram Plant fossils. Later on, Baksi (1968) extensively studied it.

Hence, we have to study the Raghavapuram fossil flora to assess the richness. While studying the plant fossils a new locality was found at Errayagudem and its palaeofloristic diversity were studied. The work deals with palaeofloral diversity of Godavari region. The two localities are selected for the palaeofloristic diversity studies. Out of these, Raghavapuram is known earlier while another new locality is Errayagudem.

GEOLOGY AND TOPOGRAPHY OF THE AREA

The sequence of rock formation is given in Table – 1,

King (1880) and Baksi (1972)			
	GROUP	FORMATION	AGE
G O N D W A N A	UPPER GONDWANA GROUP	TIRUPATI SANDSTONE	CENOMANIAN PRE-DANIAN
		RAGHAVAPURAM SANDSTONE	NEOCOMIAN CENOMANIAN
		GOLLAPALLI SANDSTONE	PRE-BARREMIAN LR. CRETACEOUS
	LOWER GONDWANA GROUP	CHENTALAPUDI SANDSTONE	UPPER PERMIAN TO LOWER TRIASSIC

MATERIAL AND METHODS

The field trips to the localities were made in several years, during these field trips the fossiliferous areas were carefully selected and plant impressions were collected from them. The impressions were exposed by breaking the shales along the bedding plane. Some impressions are already exposed due to weathering and erosion. The selected impressions were photographed and their habit sketches were drawn. Finally the magnifications of specimens were introduced in the Text.

Locality 1 - Raghavapuram

The fossiliferous area of Raghavapuram is present in the form of flat topped hills. The formation is thick and consists of three parts. The basal is called as Dwarka Thirumala region, the middle part is called as Eddla Gattu and the upper part is Mosel Meta Sandstones. The impressions were collected from Barakonda which forms upper layer of the middle part. The formation of Eddla Gattu is rich in the fossils (Baksi 1967a, 1967b, & 1968). The plant fossils of Raghavapuram, the rock types and their proximity with the present shoreline suggest that in the Neocomian there was a longitudinal belt of marine area. Later on the bay evolved from coastal lagoon to open sea. Present situation resembles this pattern and show number of coastal lakes in this area. Map - 1;

Locality 2 - Errayagudem

The locality Errayagudem is present near Kannapuram; Plant fossils were collected from the material of canal excavation in this area. The fossiliferous rocks are white to gray coloured sandstones. The plant impressions were collected from this material. The preservation is of better quality and useful for identification.

Plate 1: Plant Fossils from Raghavapuram

(Plate 1, figures 1 - 7)

Cycadophyta

Cycadeoidales: (Bennettitales)

Cycadeoidaceae

Genus *Ptilophyllum* Morris 1840

1. *Ptilophyllum raghudevapurens* Mahabale & Satyanarayana 1979
2. *Ptilophyllum* sp. cf. *P. amarjolense* Bose 1953

Cycadales

Cycadaceae

Genus *Taeniopteris* Brongniart 1832

3. *Taeniopteris spatulata* McClelland 1850

Coniferophyta

Coniferales

Podocarpaceae

Genus *Elatocladus* Halle 1913

4. *Elatocladus plana* (Feistmantel) Seward 1919

Araucariaceae

Genus *Brachyphyllum* Brongniart 1828

5. *Brachyphyllum mamillare* Brongniart 1828

Araucariaceae

Genus *Pagiophyllum* Heer 1881

6. *Pagiophyllum spinosum* Sukh-Dev & Rajanikanth 1988

Genus *Conites* Sternberg 1833

7. *Conites* sp.

Plate 2 : Plant Fossils from Errayagudem

(Plate 2, Figures 1 – 15)

Cycadophyta

Cycadeoidales: (Bennettitales)

Cycadeoidaceae

Genus *Ptilophyllum* Morris 1840

1. *Ptilophyllum sahnii* Gupta & Sharma 1968b

2. *Ptilophyllum cutchense* Morris 1840

3. *Ptilophyllum rarinervis* (Feistmantel) Bose & Kasat 1972

Genus *Pterophyllum* Brongniart 1828

4. *Pterophyllum* sp.

Genus *Pterophyllum* Brongniart 1828

- 4A. *Pterophyllum* sp.

Genus *Dictyozamites* Oldham 1863

5. *Dictyozamites sahnii* Gupta & Sharma 1968a

Cycadales
Cycadaceae
Genus *Taeniopteris* Brongniart 1832
6-6A. *Taeniopteris spatulata* McClelland 1850

Coniferophyta
Coniferales
Podocarpaceae
Genus *Elatocladus* Halle 1913
7. *Elatocladus conferta* Sahnii 1928
Araucariaceae
Genus *Brachyphyllum* Brongniart 1828
8. *Brachyphyllum rhombicum* (Feistmantel) Sahnii 1928
Genus *Desmiophyllum* Lesquereux 1878
9. *Desmiophyllum indicum* Sahnii 1928
Genus *Araucarites* Presl
11. *Araucarites minutes* Bose & Maheshwari 1973b
Genus *Conites* Sternberg 1833
12. *Conites* sp. cf. *C. verticillatus* Sahnii 1928
Genus *Elatocladus* Halle 1913
15. *Elatocladus jabalpurensis* (Feistmantel) Sahnii 1928

Pteridospermophyta
Pteridospermales
Corystospermaceae
Genus *Pachypteris* Brongniart
13. *Pachypteris indica* (Oldham & Morris) Bose & Roy 1968

Pteridophyta
Equisetales
Equisetaceae
Genus *Equisetites* Sternberg 1833
14. *Equisetites* sp.

Palaeofloristic diversity of Upper Gondwana flora showing Table – 1
(Locality : 1- Raghavapuram and 2- Errayagudem)

Sr. No.	Type	Order	Genus	Species	Locality-1	Locality-2
1		Cycadophyte				
		Bennettitales	<i>Ptilophyllum</i>	5	2	3
			<i>Pterophyllum</i>	1	0	1
			<i>Dictyozamites</i>	1	0	1
		Cycadales	<i>Taeniopteris</i>	1	1	1
2		Coniferophytes				
		Conicrals	<i>Elatocladus</i>	3	1	2
			<i>Brachyphyllum</i>	2	1	1
			<i>Pagiophyllum</i>	2	1	1
			<i>Desmiophyllum</i>	1	0	1
			<i>Araucarites</i>	1	0	1
			<i>Conites</i>	2	1	1
			<i>Coniferocaulon</i>	1	1	0
		Ginkgoales	<i>Ginkoites</i>	1	1	0
3		Pteridospermophyta				
		Pteridospermales	<i>Pachypteris</i>	2	1	1
4		Pteridophytes				
		Osmundales	<i>Cladophlebis</i>	1	1	0
		Equestales	<i>Equisetites</i>	1	0	1
		Unclassified fern	<i>Shenopteris</i>	1	1	0
		Palaeofloristic species diversity		26	12	15

DISCRPTION

The Present work deals with study of Upper Gondwana beds developed along the Coastal part of Andhra Pradesh. Upper Gondwana flora of India is studied by several workers earlier namely Sahni, Bose, Bose and Banerji, and others. Extensive work is made on the floras of Rajmahal, Jabalpur and Cutch. Comparing to these floras Coastal Gondwana palaeofloristic diversity shows some distinct features.

Hence, the present work focused on the Upper Gondwana beds of the Andhra Pradesh. It is developed on the coastal part, among the coastal flora of Andhra Pradesh. Ommearum palaeofloristic diversity are studied in details while the flora of Raghavapuram and Raghudevapuram are studied by few workers. Hence the present study is focused on Upper Gondwana flora of Godavari region in Andhra Pradesh.

Present work includes study of plant fossils found in two localities namely-

1. Raghavapuram, 2. Errayagudem, in West Godavari district.

1) FLORA OF RAGHAVAPURAM

Baksi (1967a, 1967b, 1968) studied it extensively and found the elements of Cycadophytes, Conifers, Ginkgoales, Pteridosperms and pteridophytes.

Cycadophytes are known by three species of *Ptilophyllum* and one of *Taeniopteris*. The interesting finding of *P. raghudevapurensis* a new species described by Mahabale and Satyanarayana (1979) from East Godavari district is reported by us at Raghavapuram. It is a new addition to the earlier work and suggests wider distribution of the species in Godavari region. Secondly *Taeniopteris spatulata* of Cycadales here suggest close relation to Rajmahal flora, this is helpful in assigning Early Cretaceous age to Raghavapuram flora.

Conifers are represented by five members, *Elatocladus* representing Podocarpaceae, *Brachyphyllum* and *Pagiophyllum* representing Araucariaceae and the *Conites* is a fructification. Another member *Coniferoaulon rajmahalense* described by Gupta (1984) from Rajmahal hills shows close relation with the Rajmahal flora. Presence of *Ginkgoites* is somewhat rare and not found in other places of our studies. *Conites* is found in floras of Raghavapuram and Errayagudem while *Coniferoaulon* is present in Raghavapuram only.

Pteridosperms are present in both the floras represented by *Pachypteris indica*. The Pteridophytes are somewhat rare in Raghavapuram and represented by *Cladophlebis srivastavae* Gupta and *Sphenopteris raghudevapurensis* sp. nov.

2) FLORA OF ERRAYAGUDEM

It includes 15 plant impressions belonging to Cycadophytes, Conifers, Pteridosperms and Pteridophytes.

Cycadophytes represents six members namely,

Ptilophyllum – 3 species, *Pterophyllum* – 1 sp, *Dictyozamites* – 1 sp, and *Taeniopteris* – 1 sp.

Conifers are richer than Cycadophytes represented by 7 members as,

Elatocladus – 2 species, *Brachyphyllum* – 1 sp, *Pagiophyllum* - 1 sp, *Desmiophyllum* – 1 sp, *Araucarites* – 1 sp, and *Conites* – 1 sp.

Presence of *Ginkgoites* is quite notable because it is absent in other floras except Raghavapuram. Finally it appears that the Raghavapuram flora is closely related to Rajmahal flora indicating the Early Cretaceous age.

Comparing to these groups, other groups shows scanty presence namely,

Pteridosperms representing a single member of *Pachypteris* Brongniart

Pteridophytes representing a single element *Equisetites* Sternberg

DISCUSSION

The present work focuses on the reassessment of previous flora by earlier workers and found the addition of new palaeofloristic evidences from Upper Gondwana floras in Andhra Pradesh. While

studying Raghavapuram area the new locality namely Errayagudem in west Godavari district was sighted by us. The palaeofloristic diversity from Errayagudem was studied and compared with other localities in this area. This has resulted in understanding the overall scenario of Palaeofloristic diversity of the area under investigation.

The palaeofloral plant diversity shows that Cycadophytes and Conifers form the major chunk while the Pteridosperms and pteridophytes are quite meager.

The overall findings suggests dominance of Gymnosperms whereas Ginkgoales and Pteridosperms are rare. The Pteridophytes represent a minor part of the floras. Finally, it appears that the floras of two localities representing 27 plant impressions belonging to Gymnosperms, Pteridosperms and Pteridophytes. The studies include 17 genera and 26 species in this palaeofloristic diversity.

The data suggest warm and humid climate, on account of Cycadophytes having small patches of high altitude, harbouring Conifers. Pteridophytes though rare indicate good rainfall and moderate climate. The Raghavapuram and Errayagudem floras suggest the neighborhood of the sea. Finally it is proposed that palaeofloristic assemblage in these beds suggest the age ranging between Upper Jurassic to Early Cretaceous.

CONCLUSION

The locality Raghavapuram is earlier studied by King (1880), Feistmantel (1877a) and Baksi (1968). After this there is a hiatus of floristic work on Raghavapuram hence revisiting and finding out additional data resulted in the occurrence of 12 plant fossil species belonging to Gymnosperms and Pteridophytes. The area is rich in plant remains of leaf impressions but devoid of petrified woods except a single account of *Dadoxylon agathioides* by Baksi (1967b). This may be due to environmental changes occurring in that period.

Our work on a new locality Errayagudem is quite important because it is in the same area of Raghavapuram and yielded palaeofloristic assemblage. The present investigation described 15 species belonging to Pteridosperms, Pteridophytes, Cycadophytes and Conifers. Hence, work on Errayagudem extends the limits of fossil flora of Raghavapuram in West Godavari district.

Finally, these localities and their floristic diversity suggest that the area is near the sea shore and suggest marine environment determining the Upper Jurassic to Early Cretaceous period.

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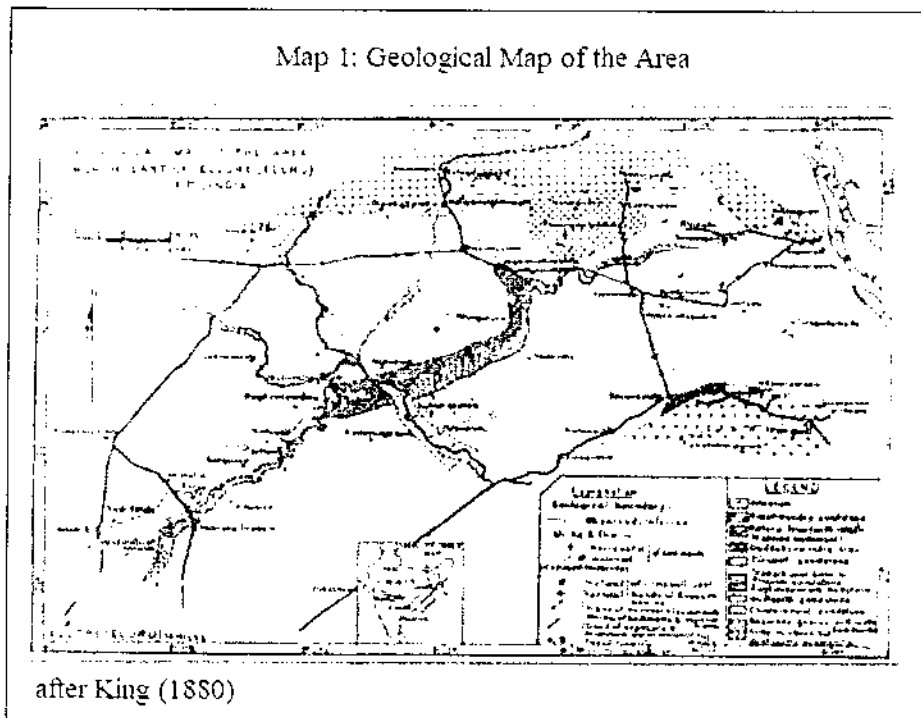


Plate 1: Plant fossils from Raghavapuram

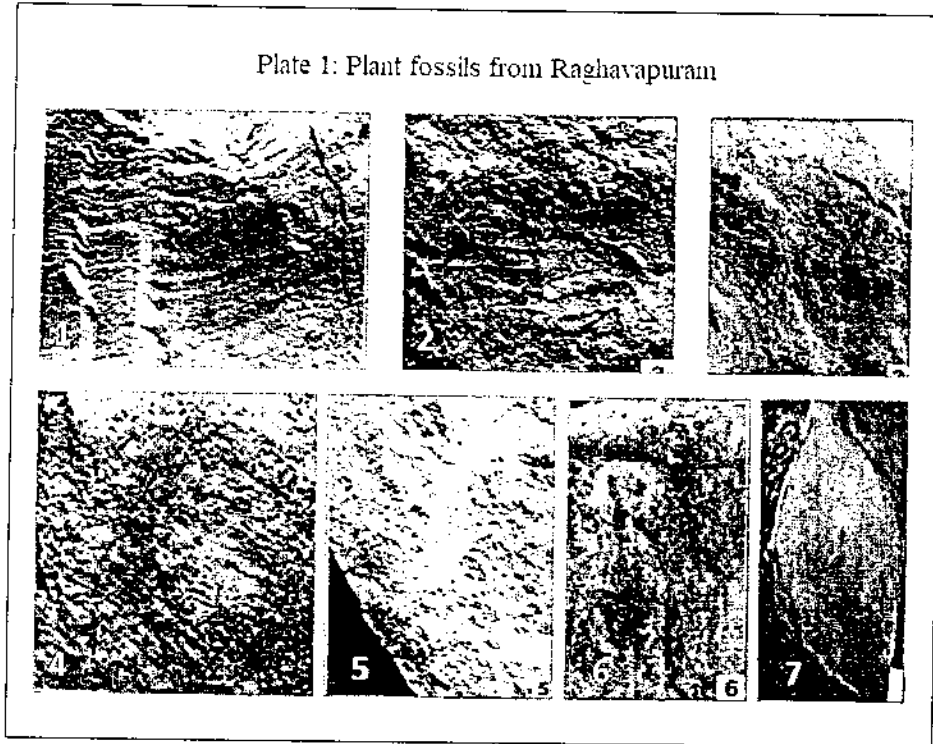


Plate 2: Plant fossils from Errayagudem

