

ESTD. 2010

Crossian Resonance

A Multidisciplinary Research Journal

(A refereed Biannual Published in June and December)

ISSN 0976-5417

Vol. 13 No.1 June 2022

HOLY CROSS COLLEGE (Autonomous)
(Centre for Multidisciplinary Research)
Nagercoil

TAMIL NADU, INDIA



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Crossian Resonance, the biannual, multi-disciplinary peer-reviewed and refereed national journal launched in June 2010, strives to reach research scholars from all directions and various cross-sections of society providing a platform to resonate scientific finding. It aims to foster the spirit and aspirations of the academics and to promote a research culture among the erudite. The sustainability and success of the research journey is a step ahead in the 50th milestone of our institution playing a strategic role and nurturing the fruitful service of quality and need-based education.

The journal has provided an opportunity and space to the Crossian scholars, Professors and research guides of our institution and other institutions at national and international levels. This little, yet, vibrant reverberation of intellectual sharing will definitely generate new knowledge and ignite and unleash power to re-search within the visionary researchers.

Crossian Resonance strives to keep up the standard from the first issue and all the papers published in this issue were assessed by competent referee editors and were recommended for publication. This journal is committed to the development and regeneration of the nation with the scope of providing an open and common platform to launch a united vision and empowerment of innovative knowledge.

May this endeavour grow and remain evergreen like an olive tree to create renewed awareness, dimensional consciousness and enlightenment.

- Editors

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பாரதிதாசனின் உரைவளம்

முனைவர். செ. தேன்மொழி

உதவிப்பேராசிரியர், தமிழ்த்துறை,
திருச்சிலுவைகல்லூரி(தன்னாட்சி), நாகர்கோவில்.

முன்னுரை:

'தமிழைத்தன் உயிராக்கி உணர்வை தன் மதியாக்கி' புரட்சிக்கவிகள் பாடியவர் பாரதிதாசன். 1891ஆம் ஆண்டு பாண்டிச்சேரியில் பிறந்து தமிழாசிரியராகப் பணியாற்றிய கனகசுப்புரத்தினம் பாரதியாரிடம் கொண்ட பற்றினால் தன் பெயரை 1918ஆம் ஆண்டு பாரதிதாசன் என்று மாற்றிக் கொண்டார். அன்னைத்தமிழ் மீது அளவற்ற பற்று கொண்டதால் 'தமிழுக்கு அமுதென்றுபேர் அந்தத்தமிழ் இன்பத்தமிழ் எங்கள் உயிருக்கு நேர்' என்று கேட்போர் செவி இனிக்க பாடுவோர் வாய் இனிக்க பாட்டி சைத்தவர் பாவேந்தர். எழுபத்தி மூன்று ஆண்டுகள் இவ்வுலகில் வாழ்ந்த புதுவைக் குயில் பாரதிதாசன் கனியிடை ஏறிய சுளையும் முற்றல் கழையிடை ஏறிய சாறும்' என்ற இவை எல்லாம் இனியன என்பேன் எனினும் தமிழை என்னுயிர் என்பேன் கண்டீர் எனதமிழைச் சுவைத்தவர். தமிழை ஆயுதமாக்கி கவிதை, கட்டுரை, காவியம், நாடகம் எனப் பலதளங்கள் வாயிலாகத்தன் பகுத்தறிவு கருத்துக்களை பரப்பி மக்களின் வாழ்வைச் செம்மைப்படுத்த முயன்ற புரட்சியாளர். இனிமையும் எளிமையும் கருத்துச் செறிவும் மிக்க கவிதைகளைப் படைத்த மிகச் சிறந்த கவிஞர் பாரதிதாசன். பலர் அவர்கவி இன்பத்தை மட்டுமே பருகி உள்ளனர். ஆனால் அவர் கவிஞர் மட்டுமல்ல அங்கதமும் ஆழமும் ஆவேசமும் மிக்க கருத்துகளால் இச்சமூகத்தில் புரட்சிகரமான மாற்று சிந்தனைகளை விதைத்த சிறந்த கட்டுரையாளருமாவார்.

பாரதிதாசன்கட்டுரைகள்:

பாரதிதாசன் 1930 முதல் தன் இறுதிக்காலம் வரை தொடர்ந்து பலகட்டுரைகளைப் புதுவைமுரசு, குயில், சுதேசமித்திரன், காலைக்கதிர், குடியரசு போன்ற பத்திரிகைகளில் எழுதினார். கலைமாமணி பேராசிரியர் மு.சாயபுமரைக்காயர் தொகுத்த பாரதிதாசனின் 53 கட்டுரைகளைப் பாரதிதாசன் கட்டுரைகள்' என்னும் பெயரில் கங்கை புத்தகநிலையம் வெளியிட்டுள்ளது.

பேராசிரியர் இளங்கோ தொகுத்த எழுபத்தி மூன்று கட்டுரைகள் 'மானுடம் போற்று' என்ற பெயரில் பூம்புகார் பதிப்பகத்தால் புத்தகமாக வெளியிடப்பட்டுள்ளது.

சமுதாயத்தில் இருந்த சாதி மத கொடுமைகளைத் தூள்தூளாக்கி, பெண்ணடிமையை நொறுக்கி, கடவுள் மறுப்பை வலியுறுத்தி, மூடப்பழக்கவழக்கங்களைத் தகர்த்தெறிந்து, பகுத்தறிவை விரிவாக்கி, தமிழ்ப்பற்றைப் பொங்கியெழுச் செய்து மக்களிடையே பெரியமாற்றத்தை ஏற்படுத்தியது பாரதிதாசனின் கட்டுரைகள்.

கடவுள்மறுப்பு:

கடவுள் மறுப்பை வலியுறுத்திய பாரதிதாசன் பாரதியாரைச் சந்திக்கும்வரை தொடக்ககாலத்தில் பக்தி கவிஞராக இருந்தார். கடவுள் நம்பிக்கை கொண்ட பக்திபாடல்களை எழுதிவந்தார். 1926ஆம் ஆண்டு அவருடைய முதல் நூலாகிய 'மயிலம் சுப்பிரமணியர் துதியமுது' வெளிவந்தது.

பாரதிதாசன் இதுகுறித்துக் கூறும் போது 'பாரதி இல்லையென்றால் ஓய்வுபெற்ற தமிழாசிரியராகி எங்கேனும் கோயில்களில் ஆன்மீகச் சொற்பொழிவு செய்து கொண்டிருந்திருப்பேன். அதை மாற்றி சீர்திருத்த துறைபக்கம் என்னை திசை திருப்பியவர் பாரதியார்தான்' என்று கூறியுள்ளார்.

பாரதிதாசனின் கடவுள் மறுப்பு கொள்கைக்குப் புதுவை முரசு பத்திரிகையில் 1930 இல் வெளியான 'கடவுள்ஒன்றுதான்' எனும் கட்டுரையை முன்னுதாரணமாகக் கொள்ளலாம். அக்கட்டுரையில் பாரதிதாசன் பின்வருமாறு எழுதுகின்றார் 'ஒவ்வொரு கோயிலில் உள்ள விக்கிரகங்களும் சிலைகளும் ஜோதிகளும் அபாரசக்தி உடையவை என்று சொல்லப்படுகிறது. பல்லாண்டாக இவைகள் இந்திய மக்களால் போற்றப்படுகின்றன. இச்சாமிகளிலோ முக்தி கொடுப்பவையுண்டு, சக்தி கொடுப்பவையுண்டு, பாவம் தீர்ப்பவையுண்டு, எதிரிகளை அழிப்பவையுண்டு, கனவில் வந்து போவன உண்டு, எதிரில் வந்து பேசுவது உண்டு, கல்லைப் பொன்னாக்கியவை உண்டு, சூரியனை கண்டித்தவர் உண்டு சந்திரனைப் பல்உடைத்தவர் உண்டு, உலகத்தை உண்டாக்கியவை உண்டு, காத்து வருபவை உண்டு, விழுங்குபவை உண்டு, வேல் பிடித்தவை உண்டு, தடாயுதம் பிடித்தவை உண்டு. இச்சாமிகட்கெல்லாம் இந்நாள் மட்டும் இந்தியர் செய்து வந்த பூசனைகட்குக் குறைவா? திருவிழாக்களில் குறைவா? பிள்ளைக்குப் பால் வாங்கி கொடுப்பதில் தவறினாலும் இந்தக் கடவுள்கட்குப் பாணை பாலால் அபிஷேகம் செய்யாமல் இருந்ததில்லை. இப்படியெல்லாம் இந்தியர் நடத்தி வந்திருக்க, இந்தியர் மாத்திரம் இன்றைக்கு இக்கதிக்கு உள்ளாவானேன்? மற்றநாடுகளில் எல்லாம் சுதந்தரத்துவம் பறக்க, நம்நாட்டில் மட்டும் அடிமைபள்ளம் இருப்பானேன்? மற்ற நாடுகளெல்லாம் இன்புற்று இருக்க, நாம் மாத்திரம் துன்புற்று இருப்பானேன்? நாம் ஒற்றுமை அற்றிருப்பானேன்? நாம் சிந்தனை சக்தியின்றிச் சொந்த உழைப்பில் நம்பிக்கையின்றி பிறநாட்டினர்களால்

காரியுமிழ்ப் படுவானேன்? நமது கோயில் கடவுள்கள் இப்படி செய்யுமா? செய்யும் என்றால் அவை கடவுள்களா? என்று கேள்வி எழுப்பி எள்ளல் சுவைததும் பதன் கடவுள் மறுப்புக் கருத்தை முன்வைக்கின்றார் பாரதிதாசன். 'கடவுளுக்கு பரிந்து பேசும் மூடர்களே! நீங்கள் காணாத கடவுளுக்காகக் காட்டும் பரிவின் வேகத்தைக் கண்ணெதிரே காணும் உங்களைப் போன்ற எளிய மக்களிடத்தில் காட்டாமலிருக்கிறீர்களே உங்களுக்குமானம் இல்லை, வெட்கமில்லை, அறிவில்லை' என்று மனிதனின் மூடநம்பிக்கைகளை சாடுகின்றார் பாவேந்தர். 'சனியனை வணங்குவது சரியா' என்னும் அவரது மற்றொரு கட்டுரையில் மக்களைத் துன்புறுத்தும் சனி ஈஸ்வரனை வணங்குவது மடமையும் பகுத்தறிவுற்ற தன்மையுமே ஆகும். ஆகவே சனியனைக் கண்ட இடத்திலெல்லாம் சாணிகரைத்து அபிஷேகம் செய்து விரட்டி விரட்டி மூச்சுதிணற அடிப்பதன் மூலமாகத் சனியன் கடாட்சத்திலிருந்து விடுபடலாம். அதை உணர்ந்து நடவாமல் எண்ணெயும் எள்ளையும் கொண்டு அவரைப் பூசித்துக் கொண்டுதிரிவது அவரை வலிய வீட்டுக்கு அழைப்பதே ஆகும்' என்று கூறுகிறார். கிறுக்கன் என்ற புனைபெயரில் இக்கட்டுரையை எழுதிய பாவேந்தர் 'சனியன் என்று ஒரு கடவுள் இல்லை. ஒரு வேளைச் சனியன் இருந்தாலும் நான் சனியனைப் போற்றுபவன் அல்லாததால் சனியன் என்னிடம் வாலாட்ட முடியாது' என்கின்றார் ஒவ்வொரு வரியிலும் எள்ளல் சுவை இழையோடுவதைக் சுவைக்கும் அதே வேளையில் நம் சிந்தனையைத் தூண்டவும் அவர் தவறவில்லை. கிறுக்கன் என்ற புனைபெயரில் புதுவைமுரசில் எழுதிய 'பரமண்டலத்தில் இருக்கும் பரமசிவனுக்கோர் பகிரங்க கடிதம்' எனும் கட்டுரை அவரின் அங்கத சுவைக்கு சிறந்த சான்றாகும். கட்டுரைகளின் மொழிநடை படிப்போருக்கு ஆர்வ மூட்டுவதாக உள்ளது. புதுமைப்பித்தன் சிறுகதைகளில் கையாண்ட அங்கத சுவையைப் பாரதிதாசன் தன் கட்டுரைகளில் கையாண்டுள்ளார் இவர் கட்டுரைகளில் இவ்வளவளல் சுவைமிகுந்து காணப்படுகின்றது. பாரதிதாசனின் கடவுள் மறுப்பு கொள்கைக்கு இதுபோன்ற பலசான்றுகளைக் அவர் கட்டுரைகளில் காணமுடிகிறது. மூடநம்பிக்கை பற்றிகூறும் போது மக்கள் யார் எதைச் சொன்னாலும் பகுத்தறிவு கொண்டு சிந்தித்து பார்க்க வேண்டும். கண்மூடித்தனமாக மூடநம்பிக்கை கொள்ளக்கூடாது. ஏன் என்ற கேள்வி கேட்காமல் மூடநம்பிக்கைகளை மக்கள் ஏற்றுக் கொள்வதை அவர்களுக்கு உணர்த்த எண்ணிய பாரதிதாசன் ஒருமுறை உரையாற்றிக் கொண்டிருக்கும் போது திடீரென கூட்டத்தினரைப் பார்த்து 'அதோ! பின்னால் பாருங்கள்' என்றார். கூட்டத்தில் இருந்த அனைவரும் ஆவலோடு திரும்பிப் பார்த்தார்கள். பார்ப்பதற்குரிய ஒருகாட்சியும் அங்கே நிகழவில்லை. உடனே கூட்டத்தினரைப் பார்த்து இப்படிதான் யார் எதைச் சொன்னாலும் அவர்கள் சொல்கிற படிஎல்லாம் நடந்துவிடுகிறார்கள். அதனால் நன்மையா? தீமையா? என்று சிந்திப்பதே இல்லை.

நாம் ஏமாளியாக இல்லாமல் எதையும் சிந்தித்து செயல்பட வேண்டும் என்று மூடநம்பிக்கையைக் பகுத்தறிவின் மூலம் உணர்த்தி விலக்கியவர் பாவேந்தர்.

பெண்ணுரிமை:

பெண்ணடிமைத் தனத்தை நொறுக்க எண்ணிய பாரதிதாசனின் பெண்ணுரிமை பேசும் கட்டுரைகளில் புதுவை முரசில் 1930 இல் வெளியான பெண்களின் சமத்துவம் எனும் கட்டுரை குறிப்பிடத் தக்கது. இறந்தவர்களுக்கு ஈமச்சடங்குகளை மகள் செய்தாலும் குற்றமில்லை என்று சமுதாயம் ஏற்றுக்கொள்வது வரை ஆண்பெண் சமத்துவம் உண்டாகாது என்கிறார் பாரதிதாசன். பெண்களுக்குச் சொத்துரிமை இருந்தால்தான் அவர்கள் இறுதிகாலத்தில் மதிப்புடன் நடத்தபடுவார்கள் என்று பெண் சொத்துரிமைக்காகக் குரல் கொடுத்தவர் புரட்சிகவி. பெண்கல்விக்கு ஆதரவாகப் 'பெண்கள் கல்விகற்றால் அறிவுபெற்று திகழ்வார்கள். வாழ்க்கை துணை அவர்கள். மேலும் அறிவுடையவள் பிள்ளையைப் பெறுவாள். பயன்படுத்தாத நிலத்தில் கோரைதான் முளைக்கும்' என்று கூறும் பாரதிதாசன் 'பெண்கள் படித்து அங்கவஸ்திரம் போட்டுக் கொண்டு வெளியூர் சென்று புரட்டிவிடப் போகிறார்களா?' என்று பெண்கல்விக்கு எதிராக கேட்கும் ஆணாதிக்கம் கொண்டவர்களைப்பார்த்து 'ஆமாம் ஆடவர் மாத்திரம் படித்து, அங்க வஸ்திரம் போட்டுக் கொண்டு, வெளியூர் போய், புரட்டியதன் பயனாய், அதுவும் ஆயிரக்கணக்கான ஆண்டுகளாய் புரட்டிய தன் பயனாய் இன்று இந்தியர் என்றால் காறியுமிழாத பிறநாட்டினர் உண்டா?' என்று நையாண்டி செய்கின்றார். பெற்றோர் பெண்ணுக்குக் கல்வி வழங்குவதுடன் வெளியுலக அனுபவம் பெறுவதற்கான வாய்ப்பை அளிக்க வேண்டும். இவ்வாறு செய்வதன் மூலம் உருப்படாதவனை மாப்பிள்ளையாக்கும் எண்ணம் பெற்றோருக்கும் ஏற்படாது. காலமெல்லாம் தன் பெற்றோர் தகாதவனைத் தனக்குத் தேடினார்கள் என்று பெண்கள் பழிக்கவும் இடமிருக்காது. பெண்கள் தனக்கு விருப்பமானவனை மணமுடிக்க பெண்கல்வி அவசியம் தேவை என்று பாரதிதாசன் வற்புறுத்தினார். விதவைகளுக்கு மறுமணம் செய்து வைக்கவேண்டும் என்றும் பெண்கள் கலப்பு மணம் புரிந்து கொள்ள முன்வர வேண்டும் என்று வலியுறுத்தும் பாரதிதாசன் 'மாதர் தம்மை இழிவு செய்யும் மடமையைக் கொளுத்துவோம்' என்னும் பாரதியின் பாடலை மேற்கோள் காட்டுகின்றார்.

பெண் சமத்துவம் பேசும் அதே வேளையில் பெண்களிடம் இருந்த தவறுகளையும் குறைகளையும் குற்றங்களையும் மூடப்பழக்கங்களையும் சுட்டிக்காட்டவும் பாரதிதாசன் தவறவில்லை. புதுவை முரசில் 'ஸ்வராஜ்யம் வேண்டும்' என்னும் தலைப்பில் பெண்கள் கோலம் போடுவது, பச்சை குத்துவது, பூவைப்பது, நகைகள் மேல் மோகம் கொள்வது, இறந்த வீட்டில் ஒப்பாரி வைப்பது, அதிக எண்ணிக்கையில் பிள்ளைகளைப் பெறுவது, சாஸ்திரம் பார்ப்பது, மூடநம்பிக்கைகள் போன்றவற்றைக் கிண்டல்காரன் என்ற புனைப்பெயரில் கிண்டல் செய்து எழுதியுள்ளார்.

பாலிய விவாக எதிர்ப்பு:

அக்காலத்தில் வழக்கத்தில் இருந்த பால்ய மணம் அதாவது குழந்தை மணம் பற்றி பெண்களின் சமத்துவம் கட்டுரையில் பாரதிதாசன்

கடுமையாகக் கண்டிக்கிறார். இதனைப் பற்றி 'பால்ய விவாக கொடுமை' என்ற கட்டுரையில் விரிவாகப் பேசுகின்றார். பால்யமணம் நடத்துவதால் அப்பெண்களின் கற்பு விஷயத்தில் சந்தேகம் ஏற்படாது என்னும் மனநிலை மக்கள் மனதில் காணப்பட்டதையும் அதனைப் தெய்வ மணமாகக் கருதியதையும் தன் கட்டுரையில் பதிவு செய்துள்ள பாரதிதாசன் கொடுமையான இப்பழக்கத்தால் சிறுவயதிலேயே பெண்கள் விதவைகளாகத் துன்பப்படுவதையும் சுட்டிக்காட்டி பால்யமணம் சமூகத்திற்கு ஏற்பட்ட இடையூறு என்கின்றார்.

சாதிக்கொடுமை:

மனிதர்களுக்கு இடையே மிகப்பெரிய ஏற்றத்தாழ்வை உருவாக்குவதில் சாதி முக்கிய பங்கு வகிக்கின்றது. இதனைப் பற்றி பலகட்டுரைகளில் பாரதிதாசன் குறிப்பிட்டுள்ளார். புதுவை முரசில் 1931ஆம் ஆண்டு எழுதிய சாதிசண்டை எனும் கட்டுரை குறிப்பிடத்தக்கது. புதுவை கடற்கரைக்கு ஜெர்மன் நாட்டின் எம்டன் கப்பல் வந்தது. அங்கிருந்த மக்கள் அனைவரும் கப்பலிலிருந்து குண்டுபோடுவார்கள் என்று அஞ்சி உயிரை காக்க பத்து பதினைந்துமைல்களுக்கு அப்பால் தஞ்சமடைந்தனர். அதில் கூனிச்சம் பட்டு கிராமமும் ஒன்று. வந்தவர்களை மக்கள் ஆதரித்தனர். இருதரப்பினரும் சாதிபற்றி சிந்திக்கவே இல்லை. மறுநாள் எம்டன் கப்பல் புறப்பட்டு சென்றதை உறுதி செய்த புதுவை மக்கள் புறப்படத் தயாராயினர். அப்போது வயதான பெண்மணி ஒருவர் இந்த எம்டன் கப்பலால் சாதி ஏற்றத்தாழ்வு பார்க்க முடியாமல் போனதை எண்ணி இழிவாகப் பேசியதைக் கேட்டதும் தாழ்த்தப்பட்ட சாதியைச் சேர்ந்த பெண் தட்டிக் கேட்கபின் அது கலவரமாக வெடித்தது. இறுதியில் பலர் காயப்பட்டனர். சிலர் உயிருக்குப் போராடினர். ஒருவர் கொல்லப்பட்டார். ஜெர்மனியின் சண்டை கப்பலான எம்டனிடம் இருந்து தப்பித்தாலும் சாதிகொடுமைகளில் இருந்து தப்பி பிழைக்க இயலாததை இக்கட்டுரையில் சுட்டிக்காட்டி சமுதாயத்தில் புரையோடிக் கிடக்கும் சாதிகொடுமையின் ஆபத்தை உணர்த்துகின்றார் பாரதிதாசன்.

தமிழ்ப்பற்று:

தமிழைத் தன் கவித்திறத்தால் கொண்டாடிய பாவேந்தர் பாரதிதாசன் தன் கட்டுரைகள் வாயிலாகத் தமிழ் மொழி, தமிழினப் பற்றை மக்கள் மனதில் ஏற்படுத்த முயன்றார் என்பதற்குத் தமிழ், தமிழ் வளர்ச்சி, தமிழும் சர்வகலாசாலைகளும், தமிழின் வெற்றி எங்கிருக்கிறது, தமிழன் யார் போன்ற பலகட்டுரைகள் சான்றாகின்றன. தாய்மொழியைப் புறம் தள்ளிவிட்டு பிறமொழியைப் பரப்பும் மொழி வெறியர்களைப் பலகட்டுரைகளில் சாடியுள்ளார். தமிழின் வெற்றிதமிழரின் அசைக்க முடியாத ஒற்றுமையில்தான் உள்ளது என்று கூறும் பாரதிதாசன் தமிழ்நாட்டை தாய்நாடாகவும் தமிழைத்தாய் மொழியாகவும் தமிழர் ஒழுக்கத்தை தன் ஒழுக்கமாகவும் பெற்றவனே தமிழன் என்று தமிழன் யார் என்ற கேள்விக்கு முற்றுப்புள்ளி வைக்கின்றார்.

தமிழ் வளர்ச்சி பற்றி விளக்க பாரதிதாசன் தன்நண்பர் வெண்ணெய் வாழை பற்றிகூறியதைக் குறிப்பிடுகின்றார். 'வெண்ணெய் வாழையின் பழம் ஒன்று முக்கால் முழநீளம் இருக்கும். பச்சைநாடன் நிறம். அதை

வாழைப்பழம் என்று சொல்வதற்கில்லை. அதன் தோலை உரித்து கீழே போட்ட பின்னையில் வெண்ணைதான் மீதமிருக்கும். அந்தபழத்தைச் சுடு சோற்றில் போட்டால் உருகிவிடும். இனிப்பில் தேன். ஒருவித நறுமணம்' என்று வெண்ணை வாழையின் சிறப்பினைக் கூறிய நண்பர் ஐந்தாறு இலைகளை உடைய ஒரு வாழையைக் காட்டினார். இதுதான் வெண்ணெய் வாழை என்றார். வீட்டில் சுண்ணாம்பு கற்கள் உள்ள தரையில் நடப்பட்டிருந்த வெண்ணை வாழை வளர்ச்சி அடையாமல் வருடங்களாக அப்படியே நிற்பதைக் சுட்டிக் காட்டினார். அவ்வெண்ணெய் வாழை உயர்தரமானதாக இருந்த போதும் நடப்பட்டிருந்த இடம் சரியில்லாததால் குலை தள்ளிபலன் அளிக்காதது போன்றுதான் உயரிய மொழியான தமிழும் வளர்ச்சி அடையவில்லை. மக்களுக்குப் பலன் அளிக்கவில்லை. ஏனென்றால் அதை நாம் நட்புருக்கும் இடம் தீயது. சாதி, மதம், மூடப்பழக்கவழக்கங்கள் ஆகிய சுண்ணாம்பு கற்கள் உள்ள தரையில் நட்புருக்கின்றோம். அவ்விடத்திலிருந்து அதை பெயர்த்து வேறு இடத்தில் நட்பால் தமிழும் தரையோடு தரையாய் ஒட்டிக்கொண்டிராமல் வளர்ச்சி அடையும். மக்கள் நலம் அடைவார்கள் என்று தமிழ் வளர்ச்சிக்குத் தடையாக இருப்பனவற்றைச் சுட்டிக்காட்டுகின்றார் பாரதிதாசன்.

முடிவுரை:

இவ்வாறு பாரதிதாசன் தன் கட்டுரைகளில் மதத்தின் பெயராலும் சாதியின் பெயராலும் தர்மத்தின் பெயராலும் நீதியின் பெயராலும் துன்புறுத்துபவர்களையும் ஏமாற்றுபவர்களையும் சுரண்டுபவர்களையும் சாடுகின்றார். எளிய நடையில், அங்கதச்சுவையுடன், பகுத்தறிவுச் சிந்தனைகளையும், புரட்சிக் கருத்துக்களையும் கட்டுரைகளில் படைத்து 'எங்கள் வாழ்வும் எங்கள் வளமும் மங்காத தமிழ்' என்று தமிழை தன் வாழ்வாக்கியவர் புரட்சிக்கவிஞர் பாரதிதாசன். பார்வை நூல்கள்

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Enhancing Communication Skills of the First Generation Learners Through Interactive Course Materials – A Critical Study

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ABSTRACT

This paper reports an action research conducted for the First Generation learners of B.A. English Literature in Holy Cross College, Tiruchirappalli. Although English is taught as a second language in the school for twelve years, the learners are not able to communicate in English properly. Twenty hours of interactive course is designed to enhance the communication skills of the learners. The study focuses on the enhancement of speaking and writing skills of the learners. Importance is given to the expression of persona, wherein listening and reading skills are taught incidentally. The typical characteristic of multi-sensory teaching methods was employed in order to get a higher success rate. The result was highly encouraging.

Introduction

English is considered as the global language. Linguists consider that it is no longer the language of England but of the whole world. Braj Kachru (1985) classified three concentric circles of the language namely, “inner circle” countries are those who have English as their mother tongue; “outer circle” includes countries where English is taught as a second language and lastly, the “expanding circle” constitute of those countries where English plays no role in their history. It is used only as a foreign language. Therefore, it is evident that learning English is more important. Most of the people try to learn English and some of them succeed and many of them fail due to faulty approach of the learners or teaching or methodology or even the materials.

Status of English teaching and learning in India

Though India is a multi – lingual nation, English occupies the position of official language. English is taught from Standard I in states like Tamil Nadu. But the saddest part is that the learners are not able to communicate in English even though they learn it for twelve long years. In some of the schools and colleges, English is taught through the mother tongue. First Generation Learners (FGL) don't have opportunities to use English at home. The next problem is the attitude of the learners especially with those of the rural background. They

have formed a prejudice against English. They prefer to learn their subjects in their mother tongue. In some cases, they think that Part II language (here English) is not important.

Need for the study

The need for the study is that teaching and learning of English is a dearth of situations. All the four skills (LSRW) are not given equal importance. Therefore, it is the duty of the teachers to expose the learners to the language. Also the part of the learners is to make use of the opportunities provided. This study focuses on creating opportunities for the learners to use the language (here speaking and writing).

Material development

Material development refers to the production of new materials or modifying the existing ones. Most of the teachers prefer to stick on to the existing materials due to the lack of time. But the existing materials may not suit the needs of the learners. Learners need to keep changing as time goes by. So, there is a need for adapting to modifying the existing materials.

Teacher as material producer

Teachers must be able to produce their own materials. The prescribed materials may not be employed as it is in the real classroom. Sometimes it may require some changes. In that case, the teachers must be competent enough to produce their own materials. Teachers and researchers try to help the learners to be independent in their learning and think critically. Learners have to be autonomous. Self – access materials provide learners to a large number of language learning resources, information and materials.

Significance of the project

The target group is first Generation learners and so they do not have an opportunity to use the language at home. The learners are from regional medium schools which is again a drawback wherein they were taught English (communication) as a subject and not as a skill. Moreover, the medium of instruction is their mother tongue and not the target language. It holds good for any country which has English as a second language.

Research questions

- Can the proposed materials help the learners to enhance their oral and written fluency?
- To what extent will an interactive course be effective on the learners?

Hypothesis

If interactive course materials are combined with effective teaching, communication skills of the learners will be enhanced.

General Objectives

- To enhance the learners to speak on a given topic.
- To enable the learners to write short paragraphs.
- To motivate the learners to participate in the classroom activities.

Specific Objectives

- To increase the Mean Length of Utterance (MLU) of the learners.
- To lengthen the noun phrases and verb phrases of the learners.
- To reduce the number of pauses, back tracking, etc. (negative indicators of fluency) while they speak.
- To enable the learners to write sentences with proper subject – verb agreement.

Description of the cohorts

The cohorts chosen for the study are I year Undergraduate Students of English Literature. They are First Generation learners, who are also socially, politically, economically and linguistically disadvantaged.

Methodology

Krashen's (1987) "*comprehensible input*" and Swain's "*comprehensible output*" are taken into consideration before preparing the materials. The learners in the study are provided with opportunities to produce the language. The researcher believes in the production of the language rather than gaining knowledge by being mere passive listeners. There are a few obstacles that prevent the learners from communicating. They are

- Lack of opportunities and exposure,
- Low self-esteem,
- No proper motivation/inspiration
- Fear of ridicule

Questionnaires are administered to the learners to know the state of existing materials and their expectations of the materials. The course materials of the intervention programme have been designed based on the needs analysis. Pre – test is given to identify the current level of the learners and post – test is given after the intervention programme of 20 hours.

The broad topic chosen for study is “Expression of persona.” The topics are introducing oneself, expressing one’s likes and dislikes, interests, interviewing somebody and describing something. Songs and video clips are also used in order to kindle the interests of the learners.

Expression of persona

The learners are taught how to introduce themselves in a group, to talk and write about their interests and likes. The learners are given a template of a profile and are asked to write their details. They are also asked to write about themselves. Then topics like “My favourite food,” “My favourite leader,” “My hobby” and “My favourite movie” are given to the learners and they are asked to speak and write the same.

Interviewing a celebrity

The learners are asked to read about a businessman and prepare questions that they would like to ask them. Pair work is given to the learners wherein one of them assumes themselves as the businessman and the other as a journalist. The ‘journalist’ has to interview the ‘businessman.’

Songs and video clips

Songs help learning in a relaxed way and are used to enhance the pronunciation of the learners. Songs is a method to overcome an affective filter that promotes language learning. Saricoban and Metin (2000) have found that songs can develop four language skills with the weak affective filter.

Video clips are screened and the learners are allowed to enjoy those clips. Then they are asked to give a running commentary of those clips. “Wh” questions are asked to provoke thinking. Application of the senses includes what they see, hear and feel are encouraged.

Picture and face description

Learners are shown different pictures and they are asked to describe the picture both physically and metaphorically. Learners are exposed to various emoticons used in SMS and social networking sites and are also taught where and how to use them.

Findings

- The findings of the study are listed below:
- Socio – economic background of the learners affect language learning to a great extent. It is because the learners are not exposed to the language at home.
- The learners are not given enough opportunities to use the language at school/college.
- The learners are not motivated to use the language.
- The learners are afraid of ridicule because of their low self – esteem.
- Learning takes place in a non-threatening atmosphere.
- All the four skills should be given equal importance.
- Speaking should be taught by speaking.
- The learners can be given inputs on basic grammar.
- Learners have to be involved in the teaching – learning process.
- Variety in terms of materials and methodology.
- Feedback should be given immediately.
- Errors should not be laughed at; instead it should be viewed as a sign of learning.

Conclusion

Learning to communicate is a very important part of learning a language. Though much research has been done on material production and enhancing speaking and writing skills, it is important to carry out those researches since the aptitude, attitude and personality of the learners are changing from time to time. The medium of instruction to teach English must be in the target language and not in the mother tongue. It is identified that learning should be of some fun to the learners. Teachers must create a conducive atmosphere for learning. Teachers must employ variety in teaching methodology.

The study confirms that learning takes place when the materials are interesting and engaging to the learners. Interactive course materials with optimum teacher talking time (TTT) enhance language learning. Thus, the intervention programme enabled the learners to stretch their Inter-language.

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Gaming Activities to Cultivate Writing Skills

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ABSTRACT

Writing is one of the four integrated skills and is a productive skill. The ability to write is important. The pictorial depiction of speech is writing. A lot of things are made quicker by digital technology. At present, it is easier than ever to neglect writing skills with all new technologies and social media. This paper explores different ways of enhancing writing skills to be cultivated via gaming activities. It also discusses several innovative modalities to be adopted by instructors in a language learning classroom atmosphere.

Key Words: *writing, learners, approach, thinking, instructor.*

Introduction

Writing is an essential aid for expressing one's ideas, thoughts, and feelings in a more lasting way. Writing is a demanding process that involves extremely complex cognitive processes and a small child does not naturally possess the skill. Some of the teaching methods of handwriting involve kindergarten method, tracing method, free imitation method and F.G.French method. According to F.G. French's approach, beginners should not be taught to write letters straight. Instead, learners can be taught to do some hand movements either with their fingers in a sand pan or with chalk. After learning hand movements, pupils are taught to draw strokes, semi circles, loops. Distinctiveness, proper spacing, uniformity, legibility, simplicity and reasonable speed are all qualities of good handwriting. Writing has to be instilled in students from an early age.

Writing is the fundamental criterion by which one's intelligence and learning are assessed and effective writing in English has become mandatory for academic success both at the secondary and tertiary levels. Students are assessed, evaluated and graded mostly by their written work which signifies the importance of writing skills. Writing is an important skill and essential for academic success and career growth but in the language classroom it has become mechanical and exam-oriented rather than creative and imaginative.

The various aspects of writing include vocabulary, grammar, spelling, sentence structure, coherency of sentences and punctuation. Pre-writing, writing and publishing are the

three stages of writing. Writing is considered as a product in the expression of language. The phase to complete a writing activity involves conceiving the idea, planning to execute writing, actual writing, reviewing, editing and final drafting. The two types of writing are formal writing and informal writing. Writing skill provides us with communication and critical thinking abilities. Frustration and reluctance in writing activities include lack of vocabulary, spelling, grammar and handwriting skills. Factors affecting teaching of writing skill are time constraint, syllabus completion, classroom management, and less effective teaching methods. “The skill of writing well in a second language is important and needs separate and special attention” (Brookes & Grundy,1). Poor writing creates a terrible first impression and makes readers respond negatively right away if they spot spelling or grammatical errors. Vocabulary, connectives, openers of sentences and punctuations promotes efficiency in the writing abilities of students.

The acquisition of writing skill is based on several factors such as the motivation of the learners, a positive and engaging environment conducive for writing, and teacher-student relationship. Some of the approaches adopted by teachers to teach writing skills are

- ❖ Product approach
- ❖ Process approach
- ❖ Genre approach
- ❖ Eclectic approach

Writing in the second language is significantly more challenging. It matures over time with practice. Introducing gaming activities boosts the effective obtainment of a skill. Gaming activities lowers the affective filter. It encourages creative and spontaneous use of language. Gamification of activities promotes communicative competence, builds class cohesion, foster whole class participation and reinforce learning. The teacher’s role is limited to that of a facilitator.

Some of the activities that develop writing skills are listed below. Multiple activities are described so that the teachers can successfully implement them in a language classroom to help students develop their writing competence.

Association game

Association games help to promote thinking. This individual activity is the best suitable for primary and secondary learners which will result in enhancing the writing skill of the learners. The teacher has to write a word on the board and the students are instructed to

create an association chain for the given word. If the word given is ‘beach’, the chain can be beach- fun- party- night- stars and so on. Each word has to be connected with each other and after producing the association chain, teachers can ask the students to create and write a story with the words presented in the chain. Teachers can provide a time limit to make it interesting. The instructor can reward the best story and motivate the students. This activity is excellent to improve vocabulary and sparks creative thinking.

Pass around Story-Writing

This is an interactive group activity which involves writing a story. It is the ideal way to make story a less one-sided pursuit and encourage students to practice their story writing skills. The main objective of Pass around story-writing is flexible thinking and creativity. It is a suitable activity for secondary learners.

Divide the class into groups with six to eight students each. The teacher has to write the first sentence of a story on the board. The learners hope to come up with a continuation sentence to build the story. To ignite the activity, after two minutes, the students are requested to pass their paper to the next student and ask them to continue the story for next two minutes. The paper is circulated in the same manner for a few times until all students get their turn. The teacher can ask the learners to read the unique and interesting stories that come about from this game. It provides enjoyment, broadens the knowledge of the learners and helps in team building.

Comic strip Dialogue Writing

Dialogues are an important part of a story. This is a fabulous creative writing activity for primary and secondary learners. Dialogue is basically a conversation between two people.



Figure 1.1 (comic strip)

The given figure 1.1 depicts a comic strip with blank speech bubbles. The teacher has to provide the students printed comic strips with blank speech bubbles. The students have to fill out the blank dialogue bubbles in the comic strip. The learners can use pens and crayons to make the cartoon strips more attractive. This activity makes the learners engage with thinking, creating and writing. It develops a higher level thought process and a perfect avenue to cultivate writing skills.

Telephone Pictionary

Pictionary is a guessing game in which players attempt to identify words from pictures drawn by other players. This is an interesting game which will spark the creativity in the students while encouraging them to write. Divide the class with ten students in each group and provide a time limit for each student. Student A writes a sentence on the sheet and passes it. Student B draws what the previous student has described in a sentence and folds the top of the sheet so that only the drawing is seen. The sheet is passed to the next student to write a sentence describing the drawing and fold the sheet such that only their sentence is seen. The sheet gets circulated. Once all the students participate in the activity, open the sheets and compare original sentences with final drawings and notice the transformation. It is effective for students with artistic ability as it provides an act of creating something from imagination. This activity makes students actively participate and enhance writing.

Advertisement writing

The usage of advertisements is effective in teaching English writing. This activity enriches learners' creative ideas flowing. The instructor can give the freedom of choice of subject to the students. The learners may choose to write an advertisement for their favorite candy, things, movies etc. The teacher has to display some advertisements for the learners and instruct them to write an entertaining advertisement to sell the product. This activity can also be played as a team. Advertisement writing is an excellent activity for primary and secondary learners. This activity can be applicable for tertiary learners too by assigning them to design brochures, leaflets or even a hoarding style advertisement.

Written Debate

Debate is a discussion between people in which they express different opinions about a particular idea. Debate is an excellent activity for language learning because it engages students in a variety of cognitive and linguistic ways. Debate writing is similar to dialogue

writing, but has an argumentative tone. This writing activity will help in enhancing their conversational and presentation skills.

Divide the class into groups with four students each. The instructor can provide a debatable topic for the learners according to their age group. Student 'A' has to write down their first argument and student 'B' is supposed to reply to the argument; putting forth their points. It goes on like a debate in a written format.

Writing instructions

This activity helps in developing the writing skills of the learners as they are expected to write instructions in full sentences. This activity aids in learning direct speech.



The image shows a writing template titled "How to Brush Your Teeth". The title is centered at the top in a decorative box. Below the title, there are four numbered steps, each followed by a large empty rectangular box for writing. The steps are labeled "Step 1:", "Step 2:", "Step 3:", and "Step 4:". At the bottom of the template, there is a small URL: "www.WritingTemplates.net".

Figure 1.2 (Writing instructions)

The mentioned figure 1.2 is an instruction writing material. The instructor has to provide instruction writing worksheets before the activity begins and can teach learners some useful vocabulary to enrich their writing. The learners have to write an elaborate instruction on the provided topics in detailed steps. The style of writing must be communicative and simple to follow. This is an individual activity. It can also be played in groups by making the topics more complex. This activity can be opted for all type of learners. Tertiary learners can also be claimed to develop an instructional brochure design. This activity eventually helps in professional and academic endeavors.

Classroom graffiti

Graffiti is words or drawings scribbled on a plain surface. Classroom graffiti is an interesting activity. The instructor has to set up chart paper stations around the classroom with the following titles; conflicts, character traits, settings and themes. Divide the class into four groups and have each group go on to one of the stations. The group members work

together to graffiti the page with potential conflicts, character traits, settings and themes that could emerge in a fiction taught in the class. The instructor has to circulate the learners to the next station and repeat the process. Upon completion of the process, the learners can choose one character trait, one conflict, one setting and a theme from the graffiti pages to develop unique passages. This activity is suitable for secondary and tertiary learners. This activity enriches the learners writing skill along with their subject knowledge.

Students are not interested in writing as it involves knowledge in various aspects in order to produce a good piece of work. To write a good piece of work, the learners need to know punctuation, grammar, vocabulary, spelling and sentence structure. Each student may face different challenges in writing. Teaching writing skills is quite challenging. Students from different strata are grouped together in the same classroom. This is another issue that teachers encounter while teaching writing skills. The instructor has to choose the best possible approach to teach writing skill by giving feedback and guidance.

Various aspects of writing skills have been discussed above to foster writing skills and several activities are explored with their strengths and weaknesses to cultivate the same among enthusiastic learners. It is imperative on the part of curriculum designers, and syllabus setters to have a wide range of materials which boosts up the skills of writing. The activities pertaining to writing discussed in a detailed manner proves to be an eye opener for instructors to implement them in a classroom so as to make it effective and impressive for the learners.

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The World Heritage Sites of Tamilnadu

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ABSTRACT

The United Nations Educational, Scientific and Cultural Organisation, shortly known as UNESCO is an organization that protects our rich cultural and historical lineage and spreads peace throughout the world. This specialized organization takes immense measures in protecting some of the most valuable man-made treasures across the world. And in India UNESCO has listed 29 World Heritage sites, in which four are from Tamilnadu. Besides these, the Northern Mountain Railway is also recognized as a Heritage site.

Keywords: *Monuments, destination, heritage, dravidian, explore, experience, Thanjavur, Darasuram, Mahabalipuram, Nilgiris*

Introduction

Tamil Nadu is a renowned state in India and has been held in high regard by many ancient poets. This is the place where Tamil language ripened many centuries ago and is a main commercial centre in the southern zone. The architectural style here is greatly admired by all. Monuments are the mouthpieces of our ancestors; every block of these impeccable arts has bundles of stories to tell, each pillar of these top-notch buildings has top secrets to share. Tamil Nadu monuments are marked by unique Dravidian architecture; they are emblazoned with intricate patterns that are one of their kinds. These marvellous monuments are still now an engineering wonder.

Tamil Nadu is a blend of both- the modern and the ancient, which makes it a beautiful destination to explore and experience our past cultural heritage with all the amenities of the present. The UNESCO monuments of Tamil Nadu and other UNESCO world heritage sites in Tamil Nadu are Brihadeeswarar Temple at Thanjavur (1987), Gangai Konda Choleeswaram (1987), Airavatesvara temple at Darasuram (1987), Group of Monuments at Mahabalipuram (1984) and Nilgiri Mountain Railway.

Brihadeeswarar Temple, Tanjore

Brihadeeswarar temple which is also known as the Tanjore Big Temple or Peruvudaiyar Kovil is world-renowned for its incredible architecture. This colossal shrine will make every beholder awestruck. Brihadeeswarar temple is a Hindu temple dedicated to

Lord Shiva located in the South bank of river Kaveri in the Thanjavur district of Tamil Nadu, India. Being the ardent devotee of Lord Shiva, King Raja Raja Chola I built this temple with his utmost passion and brilliant architectural Style. Every nook and cranny of this colossal temple speaks of Raja Raja Chola's fame. The deity was first named as the "Rajarajeshwar". Later during the reign of Marathas, the deity was called as the Brahadeswar or the great Ishwara. According to the temple facts, the main sanctum was built purely with granite stones. It is believed that more than 130,000 tons of granite had been used in the construction of this specific building. This temple is located at the centre of a big open courtyard of about 500 feet length and 250 feet width. There is a 'Linga' about 17 feet high upon the 'Audaiyar' structure. It was called 'Rajarajeshwara Lingam'. But now it is called by the name 'Brihadeeswara Lingam' or 'Peruvudaiyar Lingam'.

The Vimana i.e the main sanctum is six stories high and measures about 66m height. It was built about a height of 216 feet. It is known as 'RajaRajan Dakshina Meru'. It means the Vimana looks like South Himalaya. Because the Vimana of Lingaraja temple (160 feet) of Bhubaneswar in Orissa is the highest Vimana in North India. A St. Mary Church in Orshisudar only has the height equal to the Tanjore temple. But the area of this temple is 2/3 that of the Tanjore temple. And the main vimana is a hollow tower above with a huge boulder. The 'Thumuli' of the Vimana has 12 feet height Golden 'Kalasa'. The beautiful sculptures are more attractive than the architecture. Brahadeeshwarar temple is the only temple that has this kind of structure among the temples of Tamil Nadu. Even the construction of the walls of the main sanctum is unique. It is built using interlocking bricks and to our wild guess, it is built without using any binding materials. Yet another totally outlandish fact is that the shadow of the main sanctum never falls on the ground, be it any time of the day. The lovely paintings in the walls of the big temple and the numerous inscriptions that were found around bear ample testimony to this fact.

Gangaikonda Cholapuram Brihadeeswara Temple at Jayankondam

Gangaikonda Cholapuram is a town located in Ariyalur, Tamil Nadu. It became the capital of the Chola dynasty in 1025 A.D. during the reign of Rajendra Chola I, and served as the Chola capital for around 250 years. As of 2014, the ancient city exists as a heritage town in Tamil Nadu, India. The name 'Gangaikonda Cholapuram or Choleeswaram' is named after the title of the king, signifying his conquests and successful expedition up to the Ganga. In other opinions, the name 'Gangaikonda Cholapuram' means 'the town of the Chola who took

over Ganga (water from Ganga) or who defeated the kings near Ganga. It is now a small village. Its past eminence is only remembered by the existence of the Great Siva Temple.

Rajendra Chola I, son of Rajaraja Chola wanted to build a temple in his capital Gangaikonda Cholapuram with the same main features of Tanjore Brihadeeswara temple. So he built a temple in 'Chittur' near 'Kudanthai' in 1035 AD. It is smaller in area and height than Tanjore temple. Its area has 340 feet length and 110 feet width. There are 150 pillars with beautiful ornaments. It was the role model for the latter thousand pillar mandapam. Every pillar was built upon a four feet height platform. The grand colossal Nandhi is carved out and positioned in the same way as in Brihadeeswarar temple. After the victory over the Ganga dynasty, Rajendra Cholan built this incredible piece of art at his headquarters Gangaikonda Cholapuram. Now the Gangaikonda Cholapuram town is located in Jayankondam in the district of Ariyalur, in Tamil Nadu. The five shrines of this temple and a lion well, which is said to be added during the 19th century. Apart from these, there are around 50 odd sculptures around the walls of the sanctum, in which the sculptures of Nataraja, Saraswathi and Lord Shiva, a devotee with a garland, are the most prominent.

Comparison

Gangaikonda Choleeswaram Temple has Vimana which resembles the Tanjore temple Vimana in structure. Both have square shape at the base; Pyramidal shape at the centre and hemispherical shape at the top. Tanjore temple has thirteen stages in vimana. But Choleeswaram temple has only eight stages. Tanjore temple has straight lines on its outer side, but Choleeswaram temple has curved lines. Percy Brown says that Tanjore temple is the best example for art skill, but Choleeswaram temple possesses a richness and beauty of its own. But both were constructed on the basis of spiritual life. When we compare these two temples on the basis of ornamentation, Choleeswaram temple is better than Tanjore temple.

Airavatesvara Temple at Darasuram

Airavatesvara Temple is a Dravidian architecture temple located in the town of Darasuram, near Kumbakonam in Thanjavur District in the South Indian state of Tamil Nadu. Airavatesvara Temple is a Hindu temple dedicated mainly to Lord Shiva. This temple is referred to as the Great Living Chola Temple by UNESCO and was declared as the UNESCO heritage site in the year 2004.

Darasuram is a small hamlet in Kumbakonam known worldwide for the incredible Airavateswarar temple. This temple is not only a place of worship but also a part of the

UNESCO world heritage site. The Airavatesvara temple at Darasuram was built by the great Chola king Rajaraja II (1143-1173 CE), and it is placed third, after the two famous Chola temples of Thanjavur and Gangaikondacholapuram. Despite being smaller than the other two, Airavatesvara temple holds sculptural masterpieces that make it stand separately, exemplifying the great heights achieved in the field of art, sculpture, and architecture, during the Chola reign. Built by Raja Raja Cholan II in the 12th century, this temple is yet another feather in the hat of Cholas. The Airavatesvara temple of Darasuram is also called Rajarajeswara after Rajaraja II; it is built on a pedestal conceived as a compromise between the Imperial Chola style and the Imperial Pandya Style. Kulothunga III built the Tribuvanaviresvara which is similar to the Darasuram temple. The different Bharatanatyam poses are represented in the temple. The vimana of this temple is a conical pyramid of six tiers. This incredible piece of art comprises exquisite carvings, Chariot shaped Mandapams, huge Vimana and extraordinary artworks. The presiding deity here is Lord Shiva.

Airavatesvara, as the name tells us, is believed to have been derived from Airavat, Indra's elephant, who had prayed in this temple. According to legends, Airavat, a white elephant who had emerged during the samudra manthan, had turned black after being cursed by rishi Durvasa. It is here, after praying and bathing in the temple tank that Airavat regained his lost colour. According to another story, Yama (the god of death) was cursed by a rishi that made him suffer from a constant burning sensation. He got rid of this curse by praying here and taking a bath in the temple tank, which is known as Yama Teertha.

While entering the temple, one sees a large gopura a little away from the nandi mandapa and bali-peetha, whose upper part is completely destroyed. However, its grandeur can be imagined from the smaller gopura that stands inside and remains completely preserved. From various records it is seen that the temple once held seven walled tiers that were subsequently destroyed during invasions by the Delhi Sultanate armies, led by Malik Kafur (1311 CE), Khusrau Khan (1314 CE), and Muhammad Bin Tughlaq (1327 CE), the remnants of which are still visible in bits and parts from the scattered ruins around .

The prakara or the wall that runs around the temple has beautifully sculpted couchant bulls visible from outside the gate too. The smaller gopuram that forms the entryway shows pillars in a row decorated with pretty ganas, surasundaris, and other motifs. In front of it are a large nandi mandapa, and a smaller bali-peetha showing beautiful carvings of lotus petals. The bali-peetha has musical stairs that are now locked and covered with an iron grill to stop people from walking on it. The staircase of the baali-peetha is in sync with the sculpted

panels seen all over the temple that are adorned with miniature dancing figures. Music and dance form the basic theme of this temple's ornamentation: a state of perpetual joy and entertainment.

Airavatesvara temple has a sanctum that holds a shiva-linga, without the circumambulatory path around it. The front hall or agra-mandapam is unique, as it had been designed to look like a chariot on wheels (the Tripurantaka ratha), complete with wheels, spokes, and hubs (in relief), pulled by leaping horses. The mandapa pillars show ornamentation depicting stories from the epics and Puranas, such as, burning of Manmatha, Parvati performing penance, Shiva's marriage, birth of Skanda/Kumara, Shiva's fights with the asuras, etc. Another interesting feature of this temple are the miniature panels with inscriptions that tell stories associated with the 63 Nayanmars (Shaiva saints), showing the Chola connection with Shaivism. Interestingly some of the panels also depict scenes from daily lives, such as women in yoga postures, a woman giving birth to a child with the help of female attendants, etc. There is also a separate sanctum for the Devi (Devanayaki Amman shrine), which is of a later period. The front mandapa has a beautiful dhwaja stambha in front, and the two ganas, padma nidhi and sankha nidhi, are seen on two side niches facing the entrance gate. The base of the outer pillars of the agra mandapa have gaja-yalis with curled trunks and tails. The second mandapa has four niches at the side of the doorway. In the first niche is seen a devi with a lotus and kalasha (an inscription says she's devi Ganga; however, there are various arguments that say she could be Annapurna or Bhuvaneshwari or Mohini). In the second niche stands Nandikesvara with hands in anjali mudra; the third one has bhakta Kannappa standing, wearing his signature leather sandals and carrying a bow; and the last one has a seated Saraswati. The prakara (wall) goes around the paved courtyard and around the temple holds pillared cloisters inside with cells in between the deities. At the four corners these cloisters are made large and turned into mandapas. Carved on a balustrade of one of the staircases that lead to the pillared cloister stands the famous 'Rishaba Kunjaram' sculpture, where we see the conjoined heads of a bull and an elephant but each having separate bodies. The buildings around the Darasuram temple were built at the time of construction of the main temple. The mandapa of this temple were built in the form of a chariot with artificial wheels and elephants as they drew the Chariot. The temple sanctum remains closed from 12 pm to 4 pm.

Group of Monuments at Mahabalipuram

The monuments at Mahabalipuram are situated on the Coromandel Coast of the Bay of Bengal, in Kancheepuram district of Tamil Nadu, India. It has nearly 40 sanctuaries, including the largest open-air rock relief in the world. These monuments include: the Pancha Rathas of Dharmaraja Ratha, Arjuna Ratha, Bhima Ratha, Draupadi Ratha, Nakula Sahadeva Ratha, and also Ganesha Ratha. It was tagged as a World Heritage site in 1984.

Facts about Group of Monuments at Mahabalipuram:

1. Mamallapuram was a sea-port during the time of Periplus (1st century AD) and Ptolemy (AD 140).
2. The towns of Mamallapuram were found 2000 years ago.
3. It was a very big port, bringing many traders to India.
4. This was the second capital of great Pallava ruler Narasimhavarman-I (AD 630-68).
5. The monuments at Mahabalipuram are situated on the Coromandel Coast of the Bay of Bengal, in Kancheepuram district of Tamil Nadu,India.
6. There are several temples at the Mahabalipuram i.e. Krishna Cave Temple, Mahishasuramardini Mandapa, Araha Cave Temple, Panchapandava Cave Temple and structural temples include the Shore Temple and the Olakkannesvara Temple.
7. The monuments at Mahabalipuram got the status of UNESCO'S World Heritage Site in 1984.
8. The Union Ministry of Tourism and Culture is taking care of the conservation work at this site.
9. The Ministry of tourism is running a project namely "Integrated Development of Mamallapuram" for its preservation.

Shore Temple

The Shore Temples at Mahabalipuram, a coastal village 50 km south of Madras, was constructed during the reign of Rajasimha in the 7th century. The temple with its beautiful polygonal dome saved the statues of Lord Vishnu and Shiva. These beautiful temples were damaged by wind. This temple has been declared as a world heritage site since 1984.

Mahabalipuram also known as Mamallapuram is known for its charming seashore and incredible rock sculptures. The Group of Monuments at Mamallapuram is a collection of 7th and 8th century CE religious monuments in the coastal resort town of Mamallapuram in Tamil Nadu, India and a UNESCO World Heritage Site. It is on the Coromandel Coast of the Bay of Bengal, which is 60 kilometers south of Chennai. A visit to this lovely place will rejuvenate all your worn-out cells and fill you with fresh energy. Nook and cranny of this place are dotted with numerous remarkable artworks.

The sculptures of Mahabalipuram are a piece of cake for all the archaeologists and architecture lovers. This small strip of land is more charismatic than any other place in Tamilnadu, the lovely waves dashing against the rocks and the beautiful rock sculptures anchored sublimely on the shores is a spectacular sight to behold. Arjuna's penance is the magnum opus of Tamil Nadu artist; this mid-seventh-century art is the world's largest bas-relief. Its bulky size will make everyone wish for thousand eyes to capture this incredible art as a whole. This piece of art has lots of sculptures of Arjuna, Lord Siva, huge elephants, and whatnot. This place is surely worth a visit, these whole carvings are based on the folklore of Mahabharata. Other monuments are based on varied god and goddesses of the Hindu religion. Few Buddha sculptures are found here. The noteworthy monuments are Pancha Rathas, the shore temple, Varaha temple, and Descent of the Ganges. Most notable Cave Temples of Mahabalipuram are Varaha Cave Temple, Krishna Cave Temple and Panchapandava Cave Temple.

Nilgiri Mountain Railway (NMR)

Few of the mountain railways of India are listed under the UNESCO site namely Darjeeling Himalayan Railway, the Nilgiri Mountain Railway and the Kalka-Shimla Railway. In which the Nilgiri mountain railway is located in Tamilnadu. In the year 2005 Nilgiri Mountain was added to the UNESCO world heritage list. The Nilgiri Mountain Railway is a 1,000 mm meter gauge railway, built by the British in 1908, and is operated by the Southern Railway and is the only rock railway in India. The railway relies on its fleet of steam locomotives. NMR switched to diesel locomotives on the section between Coonoor and Udthagamandalam. NMR uses 'X' Class steam rack locomotives manufactured by the Swiss Locomotive and Machine works of Winterthur in Switzerland, on the rack and pinion section of its tracks. The X Class locomotives are six to eight decades old. These locomotives give NMR a distinct charm, taking scores of passengers to Coonoor and Udthagamandalam crossing 45.8 kilometres (28 mi), 108 curves, 16 tunnels and 250 bridges.

Local people and visitors led a campaign to return to steam locomotives in this section. This is one of the key attractions of the popular hill station Ooty in Tamilnadu that make the ride a most memorable one is its picturesque scenic surroundings. A ride in this lovely train will surely chill down the spine and will be one of the most unforgettable journeys in everyone's lifetime.

Conclusion

The United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites are important places of cultural or natural heritage as described in the UNESCO World Heritage Convention, established in 1972. There are 38 World Heritage sites located in India. Out of these, Brihadiswara Temple at Tanjore, Gangaikonda Cholapuram Temple at Jayankondam, Airavathesvara temple at Darasuram, Group Monuments at Mahabalipuram and Nilgiri Mountain Railway are situated in Tamilnadu also recognized as World Heritage sites. Rajarajeswaram temple or Brihadeeswara temple was constructed by Raja Raja Chola I at Tanjore. It is the highest and biggest temple of all Indian temples. This temple is the greatest temple which shows the toppest view of the South Indian Architecture. It is the best example for all South Indian Temples. Gangaikonda Cholapuram Brihadeeswarar Temple is just a replica of the masterpiece Tanjore Big temple also. The temple was constructed by Rajendra Chola I (1014-44 CE), the son of the famous Chola king Raja Raja Chola I, who built the Brihadeeswarar Temple at Thanjavur. In the later Chola temples, Airavatesvara temple has the beautiful architecture which can be compared with Tanjore temple and Choleeswaram temple. Nilgiri Mountain railway is a meter gauge railway built by the British in 1908 A.D. is operated by the Southern Railway. It is the only rack and rock railway in India. These remarkable sites are added in the World Heritage Sites and Monuments by UNESCO to protect them forever for the upcoming generations. People should be aware of these monuments and take care of these sites from natural and artificial dangers and exploitations.

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Connection between Fishermen for Sea and Land in Kanyakumari District

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ABSTRACT

Humans have been associated with the coast since time immemorial. The sangam literature points out that Tolkappiyam belongs to the quintessential classification of the weaving land as the coastal environment. The sea and the marine environment of the sea meet the biological and social needs of human beings. Due to this, not only the fishermen who depend on the marine fish resources of the coastal environment today, but also the industrial development and urbanization are taking place. The length of the coastline of Tamil Nadu is about a thousand kilometers and it stretches from Palaverkadu Lake in the north to Kanyakumari district in the south. Covering an area of 1648 sq. km, Kanyakumari district is rich in various resources such as forest resources, fresh water bodies and marine resources. The length of the coastal area of the district is 68 km. There are forty-four fishing villages along the present day coastline. Coastal areas are rocky, sandy and marshy areas. Fishermen are those who are directly involved in the fishing industry at sea. The marine fishing industry is considered to be the most important industry. Fishermen have been employed as teachers, drivers and chiropractic directors for a little while at home and abroad by various educators. The fishing industry cannot be considered as a year-round income generating industry. This is because fish availability is rare when fishing is declining. Their income will be very low. The fishermen of Kumari district are uniquely skilled in launching vessels and fishing in various modes. And the fish they get using their traditional knowledge is unmatched anywhere else. Fishermen depended on the sea for their livelihood, the sea on one side, the land on the other. The relationship status of these two is essential. The sky is above both sea-sea life and land-land life. It is possible to see that fishermen have a kind of relationship between the sea, the land and the sky in terms of occupation and their cultural life. Knowledge of the ocean is a basic requirement for the ocean is a basic requirement for fishermen in the fishing industry. Without this knowledge one cannot go to sea and catch fish. The article explains very clearly the relationship between sea, land and fishermen.

Keyword: Fishermen, environment, coastal, Kanyakumari, marine, knowledge, industry

Introduction

Fishermen sea weed is well understood as it is used daily. They go fishing up to 30 km in the sea. Therefore, their sea area is 30 square kilometers. Their knowledge of this sea is found at a depth of 20 and 25 meters, 4km south of the coast. Beyond 4km, the seabed slopes downhill and descends vertically. Up to 1km from the shore, the sea floor is covered with sound. Up to 3 km up to 1 km is a rough area of rocks, sand and light rocks. Beyond that, the

ground is covered with rocks and small stones. Many plants grow in the sea most of which are algae “kottam” algae can be found flooding in the water beyond 2 km in the sea. “Chattam rock” is an algae that grows in the ocean. It looks like a safe that is enclosed with a drawstring that coastal people use. It looks like a sack that is enclosed with a drawstring and is used for cosmetic purposes. A type of green algae grows on small pieces of wood is called thatta paru. In prehistoric times hunting and fishing were the earliest occupations of human society and hunting was much older than agriculture. This is the reason why most civilizations. Become depend on rivers as man had to depend on water levels while fighting for his livelihood. The people who rule the land and cultivate the land should not be compared to these people who rule over the sea. Mother earth will not test her beneficiary in any other way even if the sky is not clear for the yield of the land. Going into business in the deep environment is always a sign of challenge.

Many do not know that there is a separate world at sea where the land – based people will not know the suffering of the people he is fighting for. The lives and burials of the workers in that fishing was the main occupation of a section of the people during the emergency of civilization fishing was the main occupation of the people.

Weather and currents

The nature of the ocean is not constant every day. They stand on the shore and look at the sky and tell what the current is in the sea. Some weather forecasts are used as evidence that fishermen take into account the clouds and stars south of the shoreline. The stars in the sky are shining brightly when the nebula appears. They predict the currents in the southern stern direction to nittaram. The ocean is believed to be calm and without currents. Even if there is a bright circle around the moon, it is believed that there is a strong current in the ocean. Fish are not available at this time. Fishermen say that when the bright circle around the moon disappears, the current decreases and more fish are found.

Wind

Wind is one of the natural forces that play an important role in the fishing industry. Wind is beyond man’s power. Fishermen usually head in the direction of the wind rather than in the opposite direction of the sea. The wind blows during the months of karthikai and markazhi. The sea is calm when the wind blows and it is not possible to say for sure that the wind and currents mentioned here will be stable during the above mentioned months. Sometimes there is an air conflict as well as a strength dispute. When

two winds collide with each other, it is called an air conflict. The boatmen unload the mat, fight with the mind, and paddle ashore. Sometimes there is a boat capsized. There is a close relationship between the current and the wind. Thus parallel wind currents correspond to the direction in which they travel. This can be seen from the table below:

Wind	Current
Chollava kattu	Sonuvadu
West > East	West > East
Chollava kara kattu	Sonuvadu karavalu
South west > North East	South west > north east
Chollava summer wind	Sonuvadu ummarincu valuvu
Northwest > south west	North west > south west
Vadai kattu	Vanu vadu
East > west	East > west
Vadakondal	Vanuvadu kara valu
South east > north west	South east > north west
Vada kodai	Vanuvadu ummarincha valuvu
North east > south west	North east > south west
Kurinchi kattu	Nerai kariyatti valuvu
South > north	South > north
Neru kodai	Nerai ummarincha valuvu
North > south	North > south

Stars and Pisces

Certain stars believe that certain fish will come to their surface when their light hits the ocean when the moon is rolling. The stars of the Governing Body and the crowded Friday will roll in the months of Avani and Purdasi when the stars roll, a fish called jumping comes to the surface of the sea. When it rolls, it comes to the surface of the water. The star "erinchan vetri" appears in the months of Audi and Avani. When the star rises, the anchovies come to

the surface. During this time the fishermen would go fishing so that some of the fish would be in contact with the moon and the stars.

Fisherman's contact between sea and land

Fishermen depend on the sea for their livelihood. The relationship between the sea on one side and the land on the other is essential. Sea-sea life, land-land life the sky is above these two. It can be seen that there is a kind of relationship between the sea, the land and the sky that fishermen have in terms of occupation and their cultural life. Knowledge of the ocean is also a basic requirement for fishermen in the fishing industry. Without this knowledge one cannot go to sea and catch fish. The proof is that the food or economy they need depends on the ocean. They can go to this ocean anytime but they do not go to sea in the course of their mind. There is a regulation regarding going to sea which can go at any time and can come back at any time. There are few accounts like these that will be fishing at any time. Based on these, they go to sea for fishing.

Although it is their belief that kadalamma will always cater to the needs of the fishermen. So we can see that there is a sense of equality. That ocean that is the source of production is enough to provide everything they need for their living. That is why the sea is simulated as a woman. Fishermen consider the sea sacred and motherly, in common parlance, the sea, refers to the mother of the sea, katalamma. Farmers create the land as Bhumadevi and Nilamakal. The simulation of land as a women arose on the basis that human production were interdependent. Thus the land and the sea, which are examples of production, are associated with the woman who is the source of human production. If someone dies at sea or commits suicide the mother of the sea will be angry. It is also believed that the waves hit the corpses until they reached the shore. It is also believed that putting a dog's body in the sea will increase the sea's anger.

Land can be seen to be the direct opposite of the sea. But the product produced outside the sea and the man involved in the production have to return to the land. In the society, the land belongs to the woman. The woman is actively involved in all the savings, economy, management, family relations, business relations, etc. there are no major responsibilities related to the management of the house by the man. In relationships the male is often seen as an independent human being. So we can see that all the relationships of the land-based fishermen are female- centric. Prior to the introduction of nylon nets, women worked behind the mall to make folds. Women also played a role in the creation of such

“ethanam”. But the incense thus created is carried out and rituals have been performed. Those women are not allowed to touch those many after the rituals are done. Although the work thus created takes place with the contributions of women to the land, Ethan is transformed by some rites into a seafaring male outgrowth. The women have no right over it after the male has been exposed.

Conclusion

The world's first occupation was hunting. Fishermen are still engaged in the occupation. Fishing with lanterns (Ps.67: 6-9), the fact that the sign of Mars is known by the direction (Purananuru 60-1) and the father giving his child the traditional knowledge of the caste industry (Aka: 30.4) are found. Fishermen use raft, boats, and barrages as a means of transportation. They also fish using manpower. There is a difference between fishing culture and other social cultures. Each fishing village is governed by a panchayat selected by the fishermen according to the principle of self-government. A fishing villages has public property. Fishermen use their genetic knowledge to catch fish. For fishermen, genetic science is passed on from grandfather to father, from father to son, from son to grandson, and then to fishermen. According to the Tamil Nadu government, there are 608 fishing villages along 1076 km of coastline. The average distance between one fishing village and another fishing village is 1.5 km. Although the fisherman's habit is close to the sea, they are proud to be there.

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Income and Expenditure Pattern of Different Sized Goat Farms in Kanniyakumari District of Tamilnadu

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ABSTRACT

The goat farming system is known to enhance sustainable livelihood of farmers because it has been considered as one of the activities aimed at alleviating poverty, unemployment and nutritional related problems especially in rural areas. In the present study a brief review of literature was made. The profile of Kanniyakumari district was also pictured. The methodology of the study was also tailored. The socio economic conditions of goat farmers and their income and expenditure were analysed and some suggestions were also put forth.

Keywords: Goat farming, Investment, Expenditure, Income

Introduction

Goat meat is widely preferred and mostly consumed in the country. Demand for goat milk and products for domestic consumption and export is also rising. Goat farming gives hope for employment generation, nutritional security and prosperity to millions of small and marginal farmers in the country. Goats are the poor people's confidential livelihood source. Goat plays an important part in generating supplementary income and livelihood to poor farmers and landless labourers of rural India. Goat production is a commercially viable enterprise as proved by hiking curiosity of starting entrepreneurs to get out knowledge and skill in this species. In many small herd goat enterprises, meat is often the main product. Along with meat the sale of breeding stock may be an important income source.

In the livestock sector, poultry and egg production are most easily mechanized followed by sheep, pork, dairying, and beef production. Higher production levels are being attained with fewer and a smaller farm population [1]. Sheep-farming as a traditional occupation is already on the way out, and it has become a lucrative business in the district, especially with the progressive farmers [2]. Proper control of reproduction processes and the related husbandry practices are important for profitable livestock farming and cross-breeding is a main tool for rapid improvement of wool and mutton production [3]. Livestock constitutes a major source of income, employment and food. Goat farming is very common to the households of this zone as it provides additional income to beneficiaries [4]. There is huge potential to develop livestock resources in this district thereby increasing income and employment of the households and reduction in poverty can be accomplished

simultaneously. Goat is a multi-purpose animal producing meat, milk, hide, fiber and manure. Goats have very few demands of housing and management. Goats can be raised by landless agricultural labourers, ladies and children as it can be profitable occupation for a farmer and can fit well into mixed farming. Goats can give more production per unit of investment [5]. Goat husbandry is getting good momentum in India due to its ability to provide meat, milk, skin, manure, etc. and considerable income generation, and food safety. Goat farming may add to the income of farmers. Any person with little or no experience can go into this venture. Goat farming may work as insurance during times of crop failure [6].

Study Area

Kanniyakumari District is named after the goddess Kanniyakumari. This is one of the world famous tourist places. This district lies at the southernmost tip of Peninsula India where Indian Ocean, Arabian Sea and Bay of Bengal conflate. This district was formed out of the former princely state of Travancore, Cochin under the linguistic. This district was divided into two revenue divisions, Padmanabapuram and Nagercoil having the headquarters at Thuckalay and Nagercoil respectively. There are four taluks and six blocks. Totally there are 56 town Panchayets and 99 village panchayats. The district covers an area of 1,684 km² as per 2011 census, total population is 1.87million people live in Kanniyakumari district. 17.67 percent population of Kanniyakumari district lives in rural areas. The total Kanniyakumari district population living in rural areas is 3, 30,572 of which males and females are 1, 64,938 and 1, 65,634 respectively. This main landmarks are Kanniyakumari Beach, Nagaraja temple at Nagercoil, Padmanabapuram palace etc.

Table 1: Kanniyakumari District Livestock population 2018 – 2019

Sl.No.	Classification	Numbers
1	Cattle (Male)	26587
	Cattle (Female)	53480
	Total	80067
2	Sheep (Male)	17303
	Sheep (Female)	37024
	Total	54327
3	Goat (Male)	21130
	Goat (Female)	54694
	Total	75824

Source: Statistical Hand Book

Objectives

1. To examine the income and expenditure pattern of goat farmers in the study area.
2. To analyse the socio economic conditions of different sized goat farmers in the study area.

Methodology

The study was based on primary data. The researcher has visited Parakkai Animal Husbandry University in Kanniyakumari district and collected the details of persons who got training regarding farming of goats. Nearly seventy persons have been trained and they were selected as respondents. The researchers used personal enquiry through interview schedules to collect the information.

Results and Discussions

Table 2: Socio Economic Background of the Respondents

Variables	Frequency (n=70)	Percentage
Age (in year)		
15-19	10	14.28
20 - 29	17	24.28
30-44	21	30
45-59	15	21.44
more than 60	7	10
Sex		
Male	44	62.85
Female	26	37.15
Education		
Illiterate	9	12.85
Primary	5	7.15
Middle	37	52.85
High School	19	27.15
Religion		
Hinduism	54	77.15
Christianity	16	22.85
Social Group		
BC	45	64.28
MBC	6	8.57
SC/ST	19	27.15
Marital Status		
Married	38	54.28
Un Married	24	34.28
Widowed/Divorced	8	11.44
Type of family		
Joint	15	21.43
Nuclear	55	78.57

Source: Primary

Table 2 shows the socio economic background of the goat rearing. 30 percent of the respondent's age is 30 - 44, 62.85 percent of the respondents are male. 52.85 percent were completed their middle school education. 77.14 were Hindus and 64.28 percent were BC. 54.25 percent of respondents were married and 21.43 percent of the respondents were living in a joint family.

Anova: Single Factor for Age Groups

Summary

Age Groups	Count	Sum	Average	Variance		
15-19	2	45.3	22.65	63.845		
20 - 29	2	42	20	23.65		
30-44	2	56	28	98		
45-59	2	40	20	50		
more than 60	2	18.7	9.35	11.045		
ANOVA						
Source of Variation	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	368.89	3	122.9633	2.206709	0.229789	6.591382
Within Groups	222.89	4	55.7225			
Total	591.78	7				

The P value 0.229789 of the age group of the goat farmers and probability of obtaining F statistic of 2.206709 larger when the null hypothesis is true. Since the p-value is greater than the specified alpha of 0.05, the null hypothesis is rejected.

Duration of goat rearing

The duration of goat rearing varies from farmer to farmer. The following table shows the duration of goat rearing.

Table 3: Duration of goat rearing

Duration(in years)	No. of goat farmers	Percentage
Below 5	22	31.42
5 to 10	17	24.28
10 to 15	18	25.73
15 to 20	13	18.57
Total	70	100

Source: Primary

31.42 per cent of the farmers have been rearing goats below 5 years, 24.28 per cent of the farmers were rearing 5 to 10 years, 25.73 per cent of the farmers were rearing 10 to 15 years, and 18.57 per cent of the farmers were rearing 15 to 20 years.

Gross investment in Goat Farms

For the development of any sector investment is very important. Gross investment includes the amount spent for sheds and purchase of goats. In this table small farms are those which have investment up to Rs.50, 000; Medium farms are those which have investment from Rs.50,000 to Rs. 1,00,000 and large farms have investment above Rs. 1,00,000.

Table 4: Gross investment in Goat Farms

Categories of the Goat Farms	Frequency	Percentage
Small farms	32	45.72
Medium farms	23	32.85
Large farms	15	21.43
Total	70	100

Source: Primary

Among the goat farmers 45.72 per cent owned small farms, 21.43 per cent owned large farms and 32.85 per cent owned medium farms. Majority of the goat farms owned are small because no well-constructed sheds were built for goat farming security. Mostly goat farming is done through grazing without any security. So the goat farmers are interested only in small farm in their backyard and they are not interested in investing more.

Income and Expenditure of Small farmers

The expenditure includes Water charges, Labour charges, Medical expenditure, and Land tax, Electricity cost, Telephone charges, Feeding cost, Rent for shed, and Transport cost. The income for the goat farm comes from sale of goats, claves, manures and gunny bags.

Table 5: Income and Expenditure Pattern per year

Farmers	Amount (in Rs.)	Income		Household Expenditure	
		No. of Respondents	Percentage	No. of Respondents	Percentage
Small	Below 20,000	11	34.37	7	21.87
	20,000 – 40,000	15	46.87	17	53.13
	Above 40,000	6	18.78	8	25
	Total	32	100	32	100
Medium	50,000-70,000	10	43.47	7	30.44
	71,000-90,000	12	52.19	12	52.17
	Above 90,000	1	4.34	4	17.39
	Total	23	100	23	100
Large	1,00,000 - 1,20,000	8	53.34	8	53.34
	1,21,000 - 1,40,000	6	40	6	40
	Above 1,40,000	1	6.66	1	6.66
	Total	15	100	15	100

Source: Primary

46.87 per cent of the small scale goat farmers are earning Rs. 20,000 income from their goat rearing business. 52.19 per cent of the medium scale goat farmers are earning Rs. 20,000 to 40,000 incomes from their goat rearing business. 40 percent of the large scale farmers are earning Rs. 1,21,000 - 1,40,000 income from their goat rearing business.

The expenditure pattern of goat farms differs from each other, depending upon their need, experience and financial position. Here medium farms are spending more next to large farms. The expenditure on labour charge and feeding cost are more when compared to others. It is very interesting to note that the income of the small farmers are comparatively high because they mostly spend less on feed and they rear only local varieties which have good disease resistance.

Suggestions

Goat farming is mostly dominated by males and females are engaged in small kitchen backyard farms. So steps have to be taken to get more females to get involved in it. Only the older people are getting more involved in goat farming. But steps have to be taken to create awareness and training to take part in their activities and it may fulfil the employment gap.

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An Economic Study on the Household Expenditure of Working Women in Nagercoil Town During Covid-19

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ABSTRACT

Household expenditure is the amount of final consumption expenditure made by resident households to meet their everyday needs, such as food, clothing, housing, energy, transport, durable goods, health costs, leisure, and miscellaneous services. Household expenditure is the prominent component of GDP in India. During COVID-19 household expenditure had a tremendous change. People suffered a lot to manage household income-expenditure. They find it difficult to bring back the economic condition which they had before COVID-19. Hence it is essential to understand the nature of household expenditure. In this context the study on "An Economic Study on the Household expenditure of working women in Nagercoil town during COVID-19" was taken.

Keywords: Household, Expenditure, COVID, Growth, Spending

Introduction

Household spending is the core driving force of economic growth; it represents more than half of GDP in most developed economies. As their wealth grows, households tend to rapidly alter their spending patterns through which a wide variety of new goods enters the consumption basket. The growth in the variety of available goods is seen as an important, welfare-enhancing feature of modern economic development, and has important implications for a range of economic issues. At low levels of income household spending is both highly concentrated on food spending, as well as highly homogenous. As household income rises, spending diversity rises and the observed differences in household spending patterns become larger.

Household Expenses

Studies of household expenses investigate how and why society and individuals consume goods and services, and how this affects society and human relationships. Contemporary studies focus on meanings of goods and the role of consumption in identity making. Traditionally, consumption was seen as rather unimportant compared to production, and the political and economic issues surrounding it. However, India continues to face stern challenges. Despite growing investment in education, 35% of its population is still illiterate, only 15% of Indian Students reach high school and just 7% graduate. As of 2008, India's

Postsecondary high schools offer only enough seats for 7% of India's college-age population, 25% of teaching positions nationwide are vacant, and 57% of college professors lack either a master's or Ph.D. Degree.

Types of Household Expenses

Home Expenses: In addition to the cost of the housing, whether it is rent, a mortgage payment, or real estate taxes, fees for utilities such as electricity and gas as well as insurance for the property are also part of household expenses. The needs of each person accounted for in the household also fall under these costs. These needs include the cost of prescription medicines and other healthcare fees.

Child-Related Expenses: Expenditures for education such as tutoring services, the purchase, and maintenance of school uniforms, textbooks, personal computers, stationery, and pens are all included as household expenses. Tuition, whether for private schools or universities, may be included as expenses carried by the household because the student typically relies on a parent or guardian to pay such fees. Childcare services, such as hiring babysitters or paying for daycare for young children while parents are at work, are included in household expenses as well.

Transportation Expenses: Transportation fees, such as the cost of leasing or buying a car through installment payments, commuting costs to work, and other services used by members of the household to get around, such as taxis or buses, can be counted as expenses to the household. Legal fees for members of a household, whether for consulting services or litigation, may also be included as well.

Entertainment Expenses: Costs for leisure and pastimes might be part of a household's regular expenditures. Nights out to the movies or subscription television services are part of entertainment purchases for the household. The money spent on vacations, costs to participate in hobbies such as procuring collectible items, and fees for club memberships also add to these expenses. However, the necessity of such expenditures may come into question when budgeting to maintain the necessities of a household, particularly if there is a decline in personal income. If household expenses surpass your capacity to pay them, increased debt and more extensive consequences may occur.

Factors Affecting Household Expenditure

Demographic and cultural factors: Demographic and cultural factors have an impact on household consumption as well as economic factors. The most 6 important demographic

factors affecting consumption expenditures are household size, number of children, age of consumer, marital status, place of residence, education level and profession, population growth rate, etc. in the country. These factors affect household consumption decisions at different levels.

Objectives

- ❖ To examine household income of the sample respondents during COVID-19
- ❖ To find out the household expenditure of the sample respondents during COVID-19

Statement of the Problem

Household expenditure is the amount of final consumption expenditure made by resident households to meet their everyday needs, such as food, clothing, housing, energy, transport, durable goods, health costs, leisure, and miscellaneous services. Household expenditure is the prominent component of GDP in India. During COVID-19 household expenditure had a tremendous change. All these happened because of change in household income. People suffered a lot to manage household income-expenditure. They find it difficult to bring back the economic condition which they had before COVID-19. Really it was a pandemic situation. Hence it is essential to understand the nature of household expenditure. In this context the study on "An Economic Study on the Household Expenditure of working women in Nagercoil town during COVID-19" was taken.

Sources of Data

For this study primary data and secondary were collected. A suitable questionnaire was constructed to collect the primary data. The secondary data was obtained from the materials published in journals, magazines, books, reports and websites.

Selection of Sample

For this study the primary data are collected from the respondents in Nagercoil town. The study is carried out on the basis of a convenient random sampling method. Data have been collected from fifty working women in Nagercoil town.

Results

1. Age Composition

Age is an important factor which influences the productive capacity of the owner. It gives a clear idea of the respondents. Age wise distribution of the sample respondents is given in table 1.

Table 1 shows that 52 percent of the sample respondents are in the age group of below 30 years, and 8 percent of the sample respondents belong to the age group above 50 years.

Table 1: Age Composition

Age (in year)	No of Respondents	Percentage
Below	26	52
30-40	11	22
40-50	9	18
Above 50	4	8
Total	50	100

Source: Primary Data

2. Occupation

Table 2 shows 38 per cent of the sample respondents working as a teacher and 12 per cent of them working as a nurse in hospitals

Table 2: Occupation

Occupation	Sample Respondents	Percentage
Teachers	19	38
Computer Operators	13	26
Nurse	6	12
Others	12	24
Total	50	100

Source: Primary data

3. Monthly Income

Table 3 shows that 46 percent of the respondents are having income between Rs.20,000-30,000 and 14 percent of them having income above Rs. 30,000.

Table 3: Monthly Income

Amount (In Rs.)	No of Respondents	Percentage
Below 10,000	8	16
10,000 – 20,000	12	24
20,000 – 30,000	23	46
Above 30,000	7	14
Total	50	100

Source: Primary data

4. Household Expenditure

Table 4 shows that 29 respondents gave first preference for food and 13 respondents gave least preference for others like rent, entertainment, celebrations and so on.

Table 4: Household Expenditure

Expenditure	Rank						
	1	2	3	4	5	6	7
Food	29	6	8	2	3	-	2
Education	13	16	4	4	4	4	5
Electricity	3	9	11	7	13	5	2
Clothes	4	10	6	12	6	4	8
Medical	3	4	7	7	15	8	6
Travel	2	2	10	9	4	15	8
Others	2	2	3	8	4	13	18

Source: Primary data

Findings

- ❖ Fifty two percent of the respondents are below the age group of 30 years.
- ❖ Thirty eight percent of the respondents are teachers.

- ❖ Forty six percent have an income between Rs.20000 to Rs.30000.
- ❖ Twenty nine respondents gave first preference for food.

Suggestions

- ❖ Government should provide proper training to women which may increase their productivity, thereby household income-expenditure of the sample respondents can be improved.
- ❖ Loans should be sanctioned to respondents without insisting on security in addition to starting the self employment work for getting more income by the respondents.

Conclusion

For countless women in economies of every size, along with losing income, unpaid care and domestic work burden has exploded. While everyone is facing unprecedented challenges, women are bearing the burst of the economic and social fallout of Covid-19. Regarding women's work and their contribution to the household income and expenditure brings out a lot of questions. As being a homemaker and working women, the government should decrease their burden by providing economic support to them and giving special training to improve their productivity which may increase the household income-expenditure of the working women.

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Impact of GST on Hotel Industry

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ABSTRACT

Goods and Services Tax is an indirect tax applicable throughout India. Now single tax would be levied on all Goods and Services. Around 160 countries have implemented GST. GST will ensure a comprehensive tax base with minimum exemptions, which will help the industry. GST will help the economy to grow in a more efficient manner by ameliorating accumulation as it will disrupt all the tax barriers between states and integrate countries via a single tax rate. It will benefit the Indian economy in many ways-help in reducing the price for consumers, rate of tax will be uniform, reduce multiple taxes. GST will affect many sectors in positive or negative manner. GST implementation reduces administrative steps and creates more opportunities to streamline the taxation of the economy. Reducing food bill taxes attracts more customers and creates revenue to the government. GST has replaced multiple taxes like sales tax, service tax, etc., which made India more of an integrated national market and brought more people into the taxation net is the need for GST. It is an indirect tax for the whole of the nation to make it one unified shared marketplace. It is designed to give India a world-class tax regime and improve the process and collection.

Introduction

GST was first introduced during the 2007-08 budget session. On 17th December 2014, the ahead of its time Union Cabinet ministry approved the proposal for inauguration of GST Constitutional Amendment Bill. On 19th of December 2014, the bill was presented on GST in Lok Sabha. The Bill was absorbed for discussion far and wide for the coming Budget session. The President of India canonical the Constitution Amendment Bill for Goods and Services Tax (GST) on 8 September 2016, consequently the bill's article in the Indian chamber and its ratification by greater than 50% of the size of its legislatures. GST has replaced the current indirect taxes. The implementation of GST will have a far-reaching strength at the point of all the aspects of the engagement in activity application operations in India. With greater than 140 countries soon adopting some compromise GST. India's day dream has been a stand-out exception.

There was a huge increase in the hotel industry after the introduction of the system of online booking. India ranks 18th on the list of business travel and it will be in the top 5 very soon according to The World Travel and Tourism Council. The hotel industry alone is

expected to have 2.3 million jobs while the jobs that will be generated under the segment of Travel Agents/Tour Operators will be around 0.66 million. No wonder GST in hotels with its reduced standardized rates and perks is being looked at with hope by many of the businesses in this sector, as this move currently seems to be the only way forward to incentivize and strengthen a growing component of the nation's economy after GST on hotels, but one that is saddled with far too many taxes to make noticeable progress.

Many hoteliers in Nagpur are supporting GST as GST helps in improving the financial management and minimizes the problem for hotel community leading to cost increase and free flow of negotiation [1]. The GST will impact primarily the promotional strategy of restaurants and food service trades and will give consumers a clear picture of taxes they pay in restaurants. Therefore restaurants and food service businesses must draw an outline of the future in view of evaluation of GST and its impact on their businesses and functions mandatorily [2]. GST removes the problems faced by the hotel sector leading to cost optimization and free flow of transactions [3, 4].

Objectives

- ❖ To study the need for GST in India.
- ❖ To Examine the Pros and cons of GST on the hotel industry.

Need for GST in India

GST is the most remarkable and ambitious tax reform in India's post-independence history. If asked about the need of GST in India then its aim and vision were to levy a single national uniform tax across the nation on all types of goods and services. GST has replaced multiple taxes like sales tax, service tax, etc., which made India more of an integrated national market and brought more people into the taxation net is the need for gst. By improving efficiency, it can add substantially to finances as well as the growth of the country. Implementing a new tax regime, inculcating both goods and services by the State and the centre in a large and complex system is perhaps unprecedented in the modern tax history of the globe.

The introduction of GST is one of the major steps of economic reform in the country. GST is basically summation of various state and central taxes into a one single tax. GST helps in reduction of double taxation, cascading effect, issue of classifying taxes, multiplicity

of taxes etc. GST created a wider tax base, rationalization of tax structure and harmonization of state and Centre administration. Before GST there were different VAT rates across the country which differs from state to state but with the introduction of GST, there is a uniform tax system across the country and the taxes are divided between the state and the central government. GST will help in reduction of tax theft and corruption in our economy, Goods and Services tax affects every person and business. There is some up and down in business sectors in the beginning, because it will not show effect instantly. Authors have studied the importance of VAT in the Indian Economy and its effect on the public, business, industry in India using the data which is made by the government. Author also mentioned that according to experts, the GST is likely to enhance the system of tax collection and will boost the economic development of India.

Pros and Cons of GST on Hotel Industry

Pros

- ❖ GST implementation leads to ease of administration and reduces the workload of the hotel management.
- ❖ GST reduces taxes on hotel bills which lead to attraction of more customers by which revenue increases.
- ❖ Due to transparency in the GST system, bill structure is easy to understand for customers as well as for hoteliers.
- ❖ The new structure makes tax avoidance and tax evasion difficult that leads to increase in government revenue

Cons

Though the bill has been introduced by the government there is a great deal of ambiguity on its implementation. The government should provide clear guidelines on how accounts have to be compelled for maintenance and filing of returns.

- The GST slab rate is very high for luxury hotels as their charges are more comparatively.
- Small hotels need skilled assistants to work on GST so they have to bear extra charges for hiring new assistants or to provide training to the old one.

Conclusion

Hotels are benefited in the food and beverages area and also this system is beneficial for budget hotels which are under slab rate of 12%. But hotels that come under 18-28% slab rate are facing adverse effects of GST. There is a significant relationship between the clarity customers have about GST rates in the hotel industry and issues faced by hoteliers in handling their customers. This enhances the revenues of the government as it will increase consumer consumption of hotels and which in turn increases the employment opportunities in the hotel industry. With this positive impact, hoteliers are facing some issues financially while dealing with the customers.

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The Role of Education in Human Development

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ABSTRACT

The article highlights the importance of human development, which is the main factor in developing society, economy and the state. Human development's main strategic directions are education, health care, the labour market, and other areas. Education is a crucial component of human development. In this regard, the purpose of this study is to identify the necessary conditions for the development and growth of educational potential, increase the level of efficiency of its use and ensure on this basis appropriate socio-economic growth. The study utilizes the capability approach to identify students' real opportunities to expand their learning and life capabilities.

INTRODUCTION

Education gives the ability to think with reason, pursue dreams and aspirations in life and live a respectable life in society. Education gives us a definite path to follow, to lead our lives by principles and gives us the freedom of expression. It frees our minds from the prejudices and motivates it to think with logic and reason. It is essential for the overall development of the human mind and brain. The literacy rate of a country determines its prosperity and economic health. Education is perhaps the essential aspect of human development as it provides an avenue to help people to grow economically and broaden their understanding of cultural and social practices in the community. Most educated persons within a society that does not value the importance of education, often leave. This leads to massive brain drain, that if left unchecked could adversely affect the social and economic viability of the entire community. Education is the key to development as it opens up a world of possibilities from advances in health care services, to innovative tools for use in the agricultural sector. For us to be able to reap these benefits fully, we need to unleash the potential off the human mind. The best way to achieve this is with education, which should not be taken lightly.

Objectives

- ❖ To identify the problems in the educational system
- ❖ To know the benefits of education enjoyed by the individuals

Benefits of Education

1. The Economic Benefit

Education and salary packages really don't always correlate. This is also true when it comes to human development and satisfaction. However, according to various studies, it has been found that individuals with better economic benefits are able to afford better quality essential services which mean that the potential for human development also tends to be higher in comparison to individuals who do not earn that much.

2. The Progress of the Entire Society

When everybody is educated then people tend to develop the necessary skills which will allow one to think beyond just his or her needs. This means that an individual will be able to work for the greater good of the entire mankind. This would further lead to the progress of the entire society and not just a specific section of the world.

3. Access to the Wider World

Even though all human beings might belong to the same species there are still many differences amongst all members. The most glaring differences are of the culture and the language. This also somewhat limits the possibilities which an individual could be exposed to. However, when an individual is educated then one gets to learn other languages beyond the native ones. This ensures that people are able to socialize with other individuals belonging to other countries and cultures. This would allow individual proper access to the wider world.

4. Figuring out the Talents and Abilities

It is a very common saying that all individuals have some sort of unique sets of qualities, abilities, and talents. And to explore all those abilities and talents one needs education. This concept of education would act as the necessary weapon for discovering and figuring out all the talents and abilities.

5. Finding the defects

There are many positive aspects and negative aspects of an individual's personality. And it is not just vital for an individual to discover his or her positive aspects. It is further required for an individual to be aware of his or her negative aspects and constantly work to improve those negative qualities. This can only be done with the help of education.

6. Decreasing Poverty and Lowering Crime Rates

Education is seen as the only way through which an individual can escape the vicious cycle of poverty. Further there are various surveys and reports which conclude that poverty is the main cause behind an individual committing some sort of crime. If the issue of poverty is solved with the help of education then that can also mean that the crime rates will also be greatly reduced.

Problems faced in progress of education

Lack of funds

The lack of sufficient funds is the main problem in the development of education. Outlay for education in Five Year Plans has been decreasing. Due to insufficient funds most educational institutions lack infrastructure, science equipment and libraries etc. Due to this reason, desired results cannot be achieved.

Negligence of Indian languages

The medium of instruction particularly in science subjects is English. So rural students who are not well versed in English, cannot study science properly in English. They suffer a lot; Indian languages are still underdeveloped. Standard publications are not available in the Indian language.

Problem of Brain drain

When intelligent, talented and deserving candidates do not get suitable jobs in the country, they prefer to go abroad to seek jobs. So our country is deprived of good talent. This phenomenon is called 'Brain drain'.

Mass illiteracy

Despite constitutional directives and economic planning we are not able to achieve percent literacy. Even now 35 percent of people remain illiterate. In India, the number of illiterates is almost one-third of the total illiterates in the world. Advanced countries are 100% literate and the position in India is quite dismal.

Wastage of resources

Our education system is based on General Education. The dropout rate is very high in primary and secondary levels. Most of the students in 6-14 age groups leave the school before completing their education. It leads to wastage of financial and human resources.

General education

Our educational system is of General Education in nature. Development of technical and vocational education is quite unsatisfactory. So our education is unproductive. Hence the number of educated unemployed persons is increasing day by day. This has become a great concern for Govt.

Problems of primary education

Our primary education is ridden with too many problems. Large number of primary schools have no buildings, what to talk of basic facilities like drinking water, urinals and electricity, furniture and study materials etc. Large numbers of primary schools are single teacher schools and many schools are even without teachers. So the drop rate is very high and a cause of concern. Concluding, we can say that there is quantitative expansion of education but in qualitative development we are still lagging behind.

Conclusion

To wrap it up, the function of education cannot be denied in human life and societal development. We believe that with progress, we will be able to eradicate illiteracy altogether in the nation and move forward in the truest form. Education can be defined as the procedure of acquiring knowledge, skills, habits, and values. It has also been widely agreed that education can aid an individual to develop in a more efficient manner. And some of those benefits of education include having better exposure to knowledge and wisdom, pursuing dreams, enhanced creativity and imagination, getting rid of social prejudice, contributing to the entire society, and many other benefits. It is important to remember the points which were discussed in this education essay so that an individual can get a better quality education.

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Challenges and Benefits of Rural Women Entrepreneurs

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ABSTRACT

Pandit Jawaharlal Lal Nehru has remarked "When women move forward, the family moves, the village moves and then ultimately the Nation moves forward." Women are one of the most relevant untapped resources if you talk about entrepreneurship. Female entrepreneurship is gaining attention and importance in light of the evidence of the importance of new business creation for economic growth and development. Entrepreneurship refers to the act of setting up a new business so as to take advantage of new opportunities. Entrepreneurs are responsible for shaping the economy and they help in creation of new wealth and new jobs by inventing new products, processes and services. We all understand that the economic development of today's women is crucial for the economic development of any country, especially a country like India. The dependency on the service sector has created many entrepreneurial opportunities for women that they can utilize to enhance their social standing and reputation. In this paper, an attempt has been made to study the opportunities and challenges related with entrepreneurship that the women of our country face in the present times. Much knowledge is not found about the economic relevance of women in entrepreneurship programs and the effect of these programs on society and economy.

Keywords: Women, Entrepreneurship, Rural, Challenges, Benefits.

Introduction

Entrepreneur means a person who takes initiative for the benefits, entrepreneur is people who recognize opportunities available in the market, invest money, take risk, monitor and control business activities. Entrepreneurship is the process of starting business through innovative goods and services. Entrepreneurship combined land, labour, capital, resources to make profit for the organization. Women entrepreneurs may be defined as women who initiate, organize and run an enterprise. The Government of India has defined women entrepreneurs who own and control an enterprise with a woman having a minimum financial interest of 51% of the capital.

In India, about seventy per cent of the population lives in the villages. Gone are the days, when rural people were totally dependent on agriculture and this was the only source of their income. Now they are entering into new professions. One of the emerging areas is rural entrepreneurship, especially women entrepreneurship. Entrepreneurship is the process of creating something new with value, allocate the necessary time and efforts assuming the

risk and reward. An individual who organizes and manages any business with substantial profit and risk is known as an entrepreneur.

A rural women entrepreneur is a woman or group of women who undertake to organize and run an enterprise in a rural area. The present study focuses on rural women entrepreneurs. The changing environment raises the question about the ability of the traditional, small scale business in the rural area. In man dominated society women comparatively entered late in the business scenario due to the many problems: for e.g. financial problem, women obligation and the lack of education. The mindset of the society in the case of the women is that they are mentally and physically weak as compared to the man; moreover they are not competent to take personal and professional decisions in the family and other matters of life. Most of the rural women face lots of problems like a balanced life between the business and family, lack of entrepreneurial skills, technological skills, sociobarriers, motivational factors, low confidence level and competition in the market etc. These all things pose a challenge for the rural women entrepreneurs. Rural women entrepreneurship has certain benefits like: economic empowerment, self-confidence, converting hobbies into profession, better living standard, role model for others and decision-making capacity in family and community.

The major challenges and problems faced by the women entrepreneurs are the lack of education and the technical skills in the competitive era [1, 2]. The big problem of the women entrepreneurs was the marketing and financial problems and the lack of a supportive network [3].

Methodology

This paper is descriptive in nature and applies secondary data for data collection from journals, newspapers, internet etc.

Objectives of the Study

1. To discuss the challenges faced by women entrepreneurs in India.
2. To find out the benefits received as a woman entrepreneur.

Challenges for Women Entrepreneur

1. Balance between Family and Work: A woman has to give time to the children, husband, in laws etc. This will take a lot of time and it's very difficult to give proper time to business.

2. **Lack of Education and Awareness:** Most of the rural women are illiterate because in rural India parents teach their male child only because they have less money and no education or very less education for the women. Lack of education becomes obstacles to cope up with new technology, government policies.
3. **Male Dominated Society:** In rural India there is no equality between male and female. For starting a business first they have to take permission from the head of the family.
4. **Lack of Finance and Raw Material:** Women entrepreneurs have to suffer a lot in raising finance for business because of less credit worthiness and there is the problem of poor connectivity of roads and transportation of raw material.
5. **Tough Competition:** Women entrepreneurs have to face tough competition from middle and large organizations.
6. **High Cost of Production:** There is a high cost of production because inefficient management and less production.
7. **Limited Managerial Ability and Low Risk Bearing Ability:** Planning, organizing, coordination, control etc all activities are not easy for women and lack proper education and emotional nature they are not able to take risk.
8. **Limited Mobility:** Due to security concerns women are not able to go outside and stay at night.
9. **Legal Formalities:** There is procedural delay of license, electricity, water and shed allotment.
10. **Lack of Motivation, Self- Confidence and Stronger Leadership:** Women in rural areas are not confident and have less leadership skills.
11. **Social-Culture Barrier:** In India there are a lot of social-culture barriers which are obstacles on the way of the women entrepreneurs.
12. **Distribution Channel and Sales Promotion:** There is less social network for women so distribution and sales is not easy for rural women.

Benefits

Economic empowerment: women entrepreneurship leads to women empowerment. The economic empowerment of women in India is due to increase in income, social

economic opportunity and personal rights. This leads to women development as well as community welfare and development.

Self-confidence: women become more confident while starting their own business. A strong determination to do something positive is an inherent quality of entrepreneurial women. They are capable of compensating values in both family and social life. Also, they know about their own rights, traits and the work situation. Motivational factors also raise the confidence level.

Converting hobby into profession: in the rural area women have several hobbies like cooking, sewing, knitting, painting, toy making and jewelry making. As an entrepreneur's women get a chance to develop their hobbies and they can use it as a source of income. Thus, rural women entrepreneurs can convert their hobbies into their profession. This will help in providing personal and professional satisfaction to them.

Role model for others: due to the economic empowerment and decision making capacity for their business they play a role model for the other women. Self-identity, education and qualification of a woman raise the confidence level. Now rural women entrepreneurs take part in other areas like increased social interaction, engaged in political activities and leadership qualities.

Better standard of living: due to economic empowerment, rural women entrepreneurs improve their living standards. Also, their lifestyle progresses as they have better living conditions and environment. The progress in living conditions leads to overall development of the community.

Decision making capacity in family and community: in the technological field women entrepreneurs play a significant role for the decision-making capacity in the family and the community. This will lead to the development of a family. Now they face new challenges, opportunities, innovative ideas and take the right decision based on them because of the self-confidence and social status. Also, they take the decision to be independent.

Conclusion

The role of rural women in Indian economic development is inevitable. In today's scenario, women did not enter only selected professions but captured all professions. But rural women face a lot of problems in starting and running a business, so there is an urgent need to promote women and introduce schemes for the benefit of the women and society. A rural women entrepreneur is a woman or group of women who undertake to organize and run

an enterprise in a rural area. The present study focuses on rural women entrepreneurs. The changing environment raises the question about the ability of the traditional, small scale business in the rural area.

In man dominated society women comparatively entered late in the business scenario due to the many problems, for e.g. financial problem, women obligation and the lack of education etc. The mindset of the society in the case of the women is that they are mentally and physically weak as compared to the man; moreover they are not competent to take personal and professional decisions in the family and other matters of life. Most of the rural women face lots of problems like a balanced life between the business and family, lack of the entrepreneurial skills, technological skills, socio barriers, motivational factors, low confidence level and competition in the market etc. These all things pose a challenge for the rural women entrepreneurs. Rural women entrepreneurship has certain benefits like: economic empowerment, self-confidence, converting hobbies into profession, better living standard, role model for others and decision-making capacity in family and community.

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A Study on Jobless Workers due to Covid-19 with special reference to Nagercoil town in Kanyakumari District

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ABSTRACT

The spread of COVID-19, a nationwide lockdown was imposed from late March till May. During the lockdown, severe restrictions were placed on the movement of individuals and economic activities were significantly halted barring the activities related to essential goods and services. Unemployment rate refers to the percentage of unemployed persons in the labour force. The lockdown restrictions were gradually relaxed during the subsequent months.

Introduction

Due to COVID-19 pandemic lockdown, there has been a devastating effect on the unemployment rate in India as most of the private companies have fired their employees. The main sufferers of the lockdown are the informal sector employees as the majority of them started losing jobs since construction works were closed. The COVID-19 pandemic has had a detrimental effect on the labour market worldwide, causing many individuals to lose their jobs and businesses to close. With no capital, thousands of people deserted cities, marching to their homelands for several hundreds of miles away in the absence of government transportation, which showed their intensity of anguish.

Factors determining the employment situation in the long term

Supply of Labour

The factors, which influence employment outcomes of an economy in the long term, operate both on the demand side of the labour as well as on the demand side. The supply side factors which need to be considered include the following: Age structure of population, the participation of population in labour force and characteristics of labour force.

Demand for Labour

The preparation of a longer term vision for employment must take into consideration the developments taking place on the supply side of labour while planning for a strategy to absorb the annual additions to the labour force. The longer term vision, however, needs to look beyond mere absorption of the labour force in any activity irrespective of the quality of

work that an activity can offer in terms of improving the living conditions of workers. The Report of the Special Group on Targeting 10 Million Employment Opportunities per year has established that with slightly altering the structure of growth in favour of labour intensive sectors, it is possible to achieve the overall balancing between the supply of labour and demand for labour, even in a shorter term perspective. Also, the demand for labour thus generated will be of gainful nature in terms of ensuring availability of work on a regular basis. However, the larger question of improving the income and productivity levels of existing workers and those who are likely to enter the labour force within the prospective period can be squarely addressed only in a longer term perspective. This would call for concerted efforts on many fronts, some of which are discussed below.

Methodology

A suitable methodology is necessary for any scientific analysis. The objectives and data interpretation of a problem cannot be done without research methodology. There are various methods to conduct research study. In this questionnaire methods is adopted, prepared different questions. The questionnaire is given to the respondents. Whenever respondents feel any doubt with regard to any question it may be easily clarified by the researcher. Also the researcher adopts sampling methods to conduct the study.

Objectives

- To understand the conditions of jobless workers due to covid-19.
- To find out the problems faced by jobless workers due to COVID-19.

Statement of the problem

The economic problems need special attention in the context of jobless workers due to corona. Available research studies point out the difficulties of jobless people due to corona. The most devastating impact of the virus and the lockdown had been on the economically backward classes, with limited access to proper healthcare and other resources. After the lockdown, a number of people and their families are barely able to survive. The rise in unemployment due to COVID-19 relates not only to the unemployed, but also to other family members.

Method of data collection

The study on the jobless workers due to corona with full reference to Nagercoil Town requires primary and secondary data. Both primary and secondary data have been used for the percent study.

Primary data

Primary data consist of first-hand information on the subject. The details regarding the data such as the level of income, expenditure and socioeconomic condition of jobless workers due to covid-19 and such other information have been collected with the help of well-structured questionnaire.

Secondary data

Secondary data were collected from the records of various journals, magazines, books and internet, articles, websites and theses.

Selection of data

For this study the primary data are collected from the respondent in Nagercoil. InNagercoil there are a number of jobless people due to corona to live. This study is carried out by selecting 50 sample respondents of jobless workers due to COVID-19 by using random sampling technique.

Data analysis

This Study is based upon both primary data and secondary data. This is collected from a sample respondent of jobless people due to corona. This present study has made use of the selection of sample respondents.

1. Age composition

Age plays a vital role in determining the efficiency of an individual. One's physical ability depends upon one's age. Table 1 shows the age wise composition of sample respondents.

Table 1: Age wise composition of the sample respondents

Age(in years)	No. of.Respondents	Percentage
25-30	5	10
31-40	19	38
41-50	16	32
Above 50	10	20
Total	50	100

Source: Primary data

Table 1 shows the age wise distribution of the sample respondents. 38 percent of sample respondents are between the age group of 31-40 and only 10 percent of sample respondents

are between the age group of 25-30. From this, it is understood that maximum respondents are middle age group.

2. Gender wise classification

Gender is the main determinant of any action. The gender wise distribution of the joblessworkers due to the corona of sample respondents is shown in table 2.

Table 2: Gender wise classification of the sample respondents

Gender	No. of. Respondents	Percentage
Male	36	72
Female	14	28
Total	50	100

Source: Primary data

Table 2 shows 72 per cent of the sample respondents are male and 28 percent of the sample respondents are female.

3. Occupation

Occupation is an important factor determining income. The occupation influences the standard of living. Table 3 shows the occupation of the sample respondents.

Table 3: Occupation of the sample respondents

Occupation	No. of. Respondents	Percentage
Teacher	6	12
Engineer	18	36
Executives	3	6
Beauticians	6	12
Supervisor	3	6
Driver	8	16
Event Management	6	12
Total	50	100

Source: Primary data

Table 3 includes that 36 percent of the sample respondents are Engineer, 6 percent of the sample respondents are Executives, 12 percent of the sample respondents are Beauticians, 6 percent of the sample respondents are Supervisor, 16 percent of the sample respondents are Driver and 12 percent of the sample respondents are Event manager.

4. Searching for another job in pandemic period

Due to COVID -19 many of them have lost their jobs. They are not able to live without income for their daily life. So in this pandemic many of them are trying to get another job for life survival. Table 4 shows how many of them are looking for another job in the pandemic period of the sample respondents.

Table 4: Searching for another job in pandemic of the sample respondents

Searching for another job inPandemic period	No. of .Respondents	Percentage
Yes	18	36
No	32	64
Total	50	100

Source: Primary data

Table 4 shows that only 36 percent of the sample respondents are trying to get another job in the pandemic period and 64 percent of the sample respondents are not trying to get a job.

5. Problems faced by jobless workers due to COVID-19

Problems faced by jobless workers due to COVID-19 related to finance, stress and health problems .Table 5 reveals the problems faced by jobless workers due to COVID-19.

Table 5: Problems faced by jobless workers due to COVID-19

Problem faced by jobless people due to COVID-19	No. of. respondents	Percentage
Finance	15	30
Stress	18	36
Health Problem	17	34
Total	50	100

Source: Primary data

Table 5 indicates that 36 per cent of the sample respondents are having the stress problem, 34 per cent of the sample respondents are having the health problem and 30 percent of the sample respondents are having the finance problem.

Findings

- ❖ Thirty eight per cent of the sample respondents are in the age group of 31-40.
- ❖ Seventy two per cent of the sample respondents are male.
- ❖ Thirty six per cent of the sample respondents are Engineer in Nagercoil.
- ❖ Sixty four per cent of the sample respondents are searching for another job.
- ❖ Thirty six per cent of the sample respondents are having the stress problem.

Suggestion

- ❖ Social protection through existing schemes and ad-hoc payments for workers, including informal, casual, seasonal and migrant workers, and self- employed.
- ❖ Employment retention schemes, including short-time work arrangements/partial unemployment benefits and other time-bound support for enterprises, such as wage subsidies, provision of paid leave and extension of existing entitlements to workers and training leave, grants and related schemes.
- ❖ Time- bound financial/ tax relief and income smoothing measures to support business continuity, especially MSEMs and the self- employed (e.g. subsidies, credit mediation/re-financing to overcome liquidity constraints).
- ❖ Provide universal health coverage, including all young people, and ensure that the health system effectively meets the needs of youth in COVID-19, including publichealth promotion, testing and treatment.
- ❖ Promote public health approaches and accurate information so that young people can be empowered to make evidence –based decisions on their health.

Conclusion

The most devastating impact of the virus and the lockdown had been on the economically backward classes, with limited access to proper healthcare and other resources. The COVID-19 economic crisis is hitting young people harder and faster than any other group. Young people have to face many hard situations including disruption to education and

training, employment and income losses, and greater difficulties in finding a job. Socio-economic impact assessment of COVID-19 to support policy response by estimating the overall economic impact. Providing disaggregated data about specific vulnerabilities and social groups, as well as evaluating the policy measures and identifying opportunities for better recovery at sectorial and municipal level.

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Comparative Study on New and Old Tax Regimes

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ABSTRACT

The Budget 2020 introduces a new tax regime under section 115 BAC giving individuals and HUF taxpayers an option to pay income tax at lower rates. From the Financial Year 2020-21, the assessee can choose to pay tax under an optional tax regime. The new tax regime gives an option to the assessee (Individual and Hindu Undivided Family) to go with the existing tax (old regime) or to opt for new lower tax rates and forgo many deductions or exemptions he can avail under the old regime. The assessee has confusion whether they can follow old or new tax regime and which scheme will provide benefits to them at the time of paying tax. This study is based on secondary sources and the researcher analysed the differences between old and new tax regime and the results are presented in this paper.

Keywords: Tax regime, Tax slab, Assessment year, Previous year

Introduction

Income tax is an annual tax levied on every person in respect of his income exceeding a specified limit. It is levied in every assessment year with respect to the income of the previous year at the rates prescribed for the assessment year. It is a direct tax. Its impact and incidence falls on the same person. It plays an important role in the national economy. It is one of the important sources of revenue to the Government. In addition, it is also looked upon as a tool for achieving the social and economic objectives as laid down in our constitution. It has been recognized as a good financial lever to narrow down the disparities in income. Regional economic imbalances are also being reduced by providing incentives and concessions in income-tax for starting new industries in backward areas. Thus, besides being a source of revenue, income tax has become an effective instrument to ensure balanced socio economic growth.

U/S 139(1) of the Income Tax Act, every person, being an Individual, a Hindu Undivided Family, an Association of Persons/ a Body of Individuals whether incorporated or not, or an Artificial Juridical Person, of which he is assessable for the previous year exceeds

the prescribed exemption limit (i.e. the maximum amount which is not chargeable to tax) is required to file, on or before the due date, the return in respect of its income or loss in every previous year [1].

Section 115 BAC has been introduced in the Finance Act 2020. This section is effective from the Assessment Year 2021-2022. It provides lower tax regime for individuals and HUF. Under the Alternative tax regime, income tax is to be computed at the option of the assessee as per the rates given in alternative tax regime [2].

Statement of the problem

In the budget 2020 the Government has announced the new tax regime. The new tax regime provides more tax slab and lower tax rates. However the assessee can avail the exemptions and deductions which are available only in the old tax regime. So the taxpayers are having confusion whether they can opt for the old tax scheme or new tax scheme and which will give them benefits. This study is to have a clear understanding of old and new tax regimes.

Objectives of the study

The objectives of this study are to understand the tax structure in India and to analyse the differences between old and new tax regime.

Methodology

This study depends on secondary sources of data which are collected from social sites, books, newspapers and Government reports. This study gives an analytical perspective of the old and new tax regimes and which is beneficial to the taxpayers.

Comparison between old and new tax regime

The new tax regime was announced in the budget 2020. In the new tax regime the number of tax slab increases and tax rates decrease comparatively. All exemptions and deductions that were availed by taxpayers in the old tax regime are not available in the new tax regime. The choice can be exercised every year and any regime which is beneficial can be adopted by the individual (except for those who have income from business or profession). Individuals who have income from business or profession cannot switch between the new and old tax regimes every year. An individual who has income from business or profession if opt for the new taxation regime, such individuals get only one chance in their lifetime to opt back

to the old regime. Further, if that individual switches back to the existing tax regime, he will not be able to opt again for the new tax regime, unless his business income ceases to exist [3].

Income Tax Slab Old Vs New

Income Slabs (Rs.)	Old Regime (in Percentage)	New Regime (in Percentage)
Up to 2,50,000	Nil	Nil
2,50,000 - 5,00,000	5	5
5,00,000 - 7,50,000	20	10
7,50,000 -10,00,000	20	15
10,00,000 -12,50,000	30	20
12,50,000 -15 ,00,000	30	25
Above 15 ,00,000	30	30

Source: www.incometaxindia.gov.in

The following are the features of the new and old tax regime.

Pros of new tax regime

The new regime provides for concessional tax rates with more tax slabs. The documentation required is lesser and tax filing is simpler since most of the exemptions and deductions are not available.

Under the new regime, benefit of deduction/allowances is not a criterion for availing the tax exemptions. This may be helpful for those categories of taxpayers who may not subscribe to the specified modes of investments, as most of the investments have a lock-in period, before which it cannot be withdrawn. They can invest in open-ended mutual funds/instruments/deposits, which provide them good returns as well as flexibility of withdrawal as well.

The reduced tax rate would provide more disposable income to the taxpayer, who could not invest in specified instruments due to certain financial or other personal reasons.

The existing tax regime provides for deductions to the taxpayer, provided he makes investments in certain instruments and manner as prescribed in the Act. This restricts the investment choices for the taxpayer as he has to make the investments only in the instruments specified. However, the new regime provides taxpayers with a flexibility of customising their investment choices.

Cons of new tax regime

Non-availability of certain specified tax deductions: The new tax regime does not allow the taxpayer to avail certain specified deductions.

- (a) Clauses referred in section 10 ie. Leave Travel Concession, House Rent Allowance, Special Allowance detailed in Rule 2BB (such as Children Allowance, transport Allowance, Per diem Allowance, Uniform Allowance, etc.), Allowances to MPs/MLAs, Allowance for clubbing of income of minor
- (b) Exemption for Special Economic Zone unit under section 10AA;
- (c) Standard deduction, deduction for entertainment allowance and employment / professional tax as contained in Section 16;
- (d) Interest under section 24 in respect of self-occupied or vacant property (loss under the head Interim Federal Health Programme for rented house shall not be allowed to be set off under any other head and would be allowed to be c/f as per Extant Law);
- (e) Additional depreciation under section 32(1) (iia);
- (f) Deductions under sections 32AD, 33AB and 33ABA;
- (g) Various deductions for donation or expenditure on scientific research contained in sub-clause (ii) or sub-clause (iia) or sub-clause (iii), of sub-section (1) or sub-section (2AA) of section 35;
- (h) Deduction under section 35AD or 35CCC;
- (i) Deduction from family pension under clause (iia) of section 57;
- (j) Any deduction under chapter VI-A (like section 80C, 80CCC, 80CCD, 80D, 80DD, 80DDB, 80E, 80EE, 80EEA, 80EEB, 80G, 80GG, 80GGA, 80GGC, 80IA, 80-IAB, 80-IAC, 80-IB, 80-IBA, etc.). However, deduction under sub-section (2) of section 80CCD (employer contribution on account of employee in notified pension scheme) and section 80JJAA (for new employment) can be claimed. If more individuals opt for the new regime, the savings rate would decrease [4].

The pros of old tax regime

The old income tax regime motivates the taxpayers to invest in specified tax-saving instruments.

India's Gross savings rate was approximately 30 percent in March 2019. Domestic savings and savings by individuals are the major contributors to the overall savings rate. This is because of the deductions and exemptions available in the old tax regime.

The cons of old tax regime

The tax benefits under the old regime are available on investments in specified instruments and also there is a specific lock-in period prescribed for most of the instruments from three-five years. This may not be a suitable tax-saving option for taxpayers who prefer to spend more than their savings.

The investor cannot opt for any other star-rated funds, which may be performing better than the specified instruments, which are mostly risk-averse in nature and may not provide significant returns over the period of investments.

Documentation and proof of investments is required to be retained and has to be submitted at the time of filing returns in the old regime, which may not be required in case of the new tax regime [5].

Comparison between Old and New tax regime with an example.

Mr. Pranab, a writer and professional furnishes the following particulars for the PY ended 31st March 2022.

Royalty on books Rs.1,26,000/-

Income from profession Rs.7,20,000/-

Expenses relating to royaltyincome Rs.24,000/-

Deposited in PPF Rs. 2,40,000/- Now let us see which tax regime will be preferable to Mr. Pranab.

Computation of Total Income of Mr.Pranab for the AY 2022-'23

	Rs.	Rs.
I. Income from Profession		7,20,000
II. Income from Other Sources:		
Royalty	1,26,000	
Less: Expenses	24,000	1,02,000
Gross Total Income		8,22,000
Less: Deductions under chapter VIA:		
U/s 80C-Deposit in PPF		1,50,000
U/s 80 QQB:Actual Royalty or Rs.3,00,000W.E.L		
Rs.1,02,000 or Rs.3,00,000W.E.L		1,02,000
Total Income		5,70,000

Computation of Tax Liability under Old Tax Regime

	Rs.
Upto Rs.2,50,000	Nil
Next Rs.2,50,001 @ 5%	12,500
Balance Rs.70,000 @ 20%	14,000
Tax	26,500
Add: Health and Education cess (26,500X4%)	1,060
Tax payable	27,560

Computation of Tax Liability under Alternative (New) Tax Regime

Deductions u/s VI A are not allowed to be deducted in the new tax regime. So income under new tax regime u/s 115 BAC is Rs.8,22,000.

	Rs.
Upto Rs.2,50,000	Nil
Next Rs.2,50,000 @5%	12,500
Next Rs. 2,50,000 @10%	25,000
Balance Rs.72,000 @ 15%	10,800
Tax	48,300
Add: Health and Education cessRs.48,300 X 4%	1,932
Tax payable	50,232

From the above calculation, it is clear that the tax payable under the old tax regime is lower than the new tax regime. Hence, Mr. Pranab is advised to opt for the old tax regime

Suggestions

1. In case a taxpayer has investments in tax saving instruments, pays premium on life or medical insurance policy, children's school fee, home loan principal repayment etc., and avails the benefit of the deduction for House Rent Allowance, Leave Travel Allowance etc. it may be more beneficial to opt for old tax regime since the benefit of deduction/exemption can be availed in the old tax regime.

2. The new tax regime can provide benefits to the middle class taxpayers who have a taxable income up to Rs. 15 lakhs. Old regime is a better option for high-income earners.
3. The new tax regime is beneficial for people who make low investments. As the new regime offers seven lower income tax slabs, anyone paying taxes without claiming tax deductions can benefit from paying a lower rate of tax under the new tax regime.
4. The Government can give a single tax regime and simplify the procedure for return filing in order to avoid confusion and difficulties of the taxpayers.

Conclusion

From the Financial Year 2020-21, the assessee can choose to pay tax under an optional tax regime. The new tax regime is available for Individual and Hindu Undivided Family with lower tax rates and fewer deductions/ exemptions. The assesses have confusion whether they can follow old or new tax regime and which will provide benefits to them at the time of paying tax. The assessee cannot easily choose any one tax regime because both have its own limitations and advantages. In case of tax rate slab the new tax regime is better and in case of availing all exemptions and deductions the old tax regime is good. The discussions and suggestions made in this study give a broad idea to the taxpayers. If taxpayers want to opt for the concessional tax rates, they may evaluate both regimes. Hence, it is advisable to do a comparative evaluation and analysis under both regimes and then choose the most beneficial one as it may vary from person to person. From this study it is clear that the tax payable under the new regime is less compared to the old regime, especially for middle income earners. So for those who are not interested in savings or nearing retirement the new regime will be more beneficial.

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Stolarsky-3 Mean Labeling of Arbitrary Super Subdivision of Few Disconnected Graphs

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ABSTRACT

Let $G = (V, E)$ be a graph with p vertices and q edges. G is said to be Stolarsky-3 mean graph if each vertex $x \in V$ is assigned distinct labels $f(x)$ from $1, 2, \dots, q+1$ and each edge $e = uv$ is assigned with labels $f(e = uv) = \left\lfloor \sqrt{\frac{[f(u)]^2 + f(u)f(v) + [f(v)]^2}{3}} \right\rfloor$ (or) $\left\lfloor \sqrt{\frac{[f(u)]^2 + f(u)f(v) + [f(v)]^2}{3}} \right\rfloor$ then the resulting edge labels are distinct. In this case f is called a Stolarsky-3 mean labeling of G and G is called a Stolarsky-3 mean graph. This paper contributes Stolarsky-3 mean labeling of arbitrary super subdivision of disconnected graphs $P_n \cup P_r, P_n \cup C_m, P_n \cup T_m, C_n \cup Q_m$ and $C_n \cup H_m$.

Keywords: Graph Labeling, Stolarsky-3 mean labeling, Super subdivision of graphs, Arbitrary super subdivision of graphs, Triangular snake graph, Quadrilateral snake graph and H graph.

Introduction

The graph $G = (V, E)$ is considered here to be finite, simple and undirected. We follow Gallian [1] for all detailed surveys of graph labeling and we refer to Harary [2] for all other standard terminologies and notations. The concept of “**Stolarsky-3 Mean Labeling**” was introduced by Kavitha, Sandhya and Ebin Raja Merely [3]. Sethuraman and Selvaraju [4] have introduced a new method of construction called super subdivision of a graph and they proved that every super subdivision of a path is graceful and every cycle has some super subdivision that is graceful. Sekar and Ramachandran [5] proved that an arbitrary super subdivision of disconnected graph is graceful [6]. This paper investigates Stolarsky-3 mean labeling of arbitrary super subdivision of few disconnected graphs.

The following definitions and theorems are useful for the present study.

Definition 1.1: A graph G with p vertices and q edges is said to be Stolarsky-3 mean graph if each vertex $x \in V$ is assigned distinct labels $f(x)$ from $1, 2, \dots, q+1$ and each edge $e = uv$ is

assigned with labels $f(e = uv) = \left\lfloor \sqrt{\frac{[f(u)]^2 + f(u)f(v) + [f(v)]^2}{3}} \right\rfloor$ (or) $\left\lfloor \sqrt{\frac{[f(u)]^2 + f(u)f(v) + [f(v)]^2}{3}} \right\rfloor$

then the resulting edge labels are distinct. In this case f is called a Stolarsky-3 mean labeling of G .

Definition 1.2: A walk in which all the vertices u_1, u_2, \dots, u_n are distinct and are called a path. It is denoted by P_n .

Definition 1.3: A closed path is called a cycle. A cycle on n vertices is denoted by C_n .

Definition 1.4. The **Union** $G_1 \cup G_2$ of two graphs G_1 and G_2 is the graph with $V(G_1 \cup G_2) = V(G_1) \cup V(G_2)$ and $E(G_1 \cup G_2) = E(G_1) \cup E(G_2)$. The union of m copies of G is denoted by mG .

Definition 1.5. A **Triangular Snake** T_n is obtained from a path u_1, u_2, \dots, u_n by joining u_i and u_{i+1} to a new vertex v_i for $1 \leq i \leq n-1$. That is, every edge of a path is replaced by a triangle C_3 .

Definition 1.6. A **Quadrilateral snake** Q_n is obtained from a path u_1, u_2, \dots, u_n by joining u_i and u_{i+1} to two new vertices v_i and w_i respectively and then joining v_i and w_i . That is, every edge of a path is replaced by a cycle C_4 .

Definition 1.7. The **H-graph** of a path P_n is the graph obtained from two copies of P_n with vertices v_1, v_2, \dots, v_n and u_1, u_2, \dots, u_n by joining the vertices $v_{\frac{n+1}{2}}$ and $u_{\frac{n+1}{2}}$ if n is odd and the vertices $v_{\frac{n}{2}+1}$ and $u_{\frac{n}{2}}$ if n is even.

Definition 1.8: Let G be a graph. A graph H is called a **Super subdivision** of G if H is obtained from G by replacing every edge e_i of G by a complete bipartite graph K_{2,m_i} for some $m_i, 1 \leq i \leq q$ in such a way that the ends of e_i are merged with the two vertices part of K_{2,m_i} after removing the edge e_i from graph G .

Definition 1.9: A Super subdivision H of G is said to be an **Arbitrary super subdivision** of G if every edge of G is replaced by an arbitrary K_{2,m_i} where m_i may vary for each edge arbitrarily. It is denoted by $ASS(G)$.

Main Results

Theorem 2.1. Arbitrary super subdivision of $P_n \cup P_r$ is Stolarsky-3 mean graph.

Proof. Let P_n be the path with successive vertices u_1, u_2, \dots, u_n and let $e_i (1 \leq i \leq n-1)$ denote the edge $u_i u_{i+1}$ of P_n . Let P_r be a path with successive vertices y_1, y_2, \dots, y_r .

Let H be an arbitrary super subdivision of disconnected graph $P_n \cup P_r$ where each edge e_i of $P_n \cup P_r$ is replaced by a complete bipartite graph K_{2,m_i} where m_i is any integer ($m_1 \leq 8$).

$$V(H) = \{u_1, u_2, \dots, u_n, y_1, y_2, \dots, y_r, v_1, v_2, \dots, v_{m_1}, v_{m_1+1}, v_{m_1+2}, \dots, v_{m_1+m_2}, v_{m_1+m_2+m_3+\dots+m_{n-1}}, x_1, x_2, \dots, x_{r_1}, x_{r_1+1}, x_{r_1+2}, \dots, x_{r_1+r_2}, x_{r_1+r_2+r_3+\dots+r_{(m-1)}}\}$$

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 4$ and $r_1 = r_2 = r_3 = \dots = r_{m-1} = 3$.

An Arbitrary super subdivision of $P_5 \cup P_4$ is given in **figure 1**

Define $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1$,

$$\varphi(u_i) = 8(i-1), 2 \leq i \leq n, \quad \varphi(y_i) = 6n+(6i-3), 1 \leq i \leq r,$$

$$\varphi(v_1) = 2, \quad \varphi(v_i) = 2i-1, 2 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1},$$

$$\varphi(x_1) = \varphi(v_{m_1+m_2+m_3+\dots+m_{n-1}}) + 3,$$

$$\varphi(x_i) = \varphi(x_{i-1}) + 2, 2 \leq i \leq r_1+r_2+r_3+\dots+r_{(r-1)}.$$

Then the edge labels are distinct. In this similar manner we can prove for all n 's, m_i 's ($m_1 \leq 8$) and r_i 's. Hence arbitrary super subdivision of $P_n \cup P_r$ is Stolarsky-3 mean graph.

Example 2.2. Labeling pattern of Stolarsky-3 mean labeling of arbitrary super subdivision of $P_5 \cup P_4$ is given below

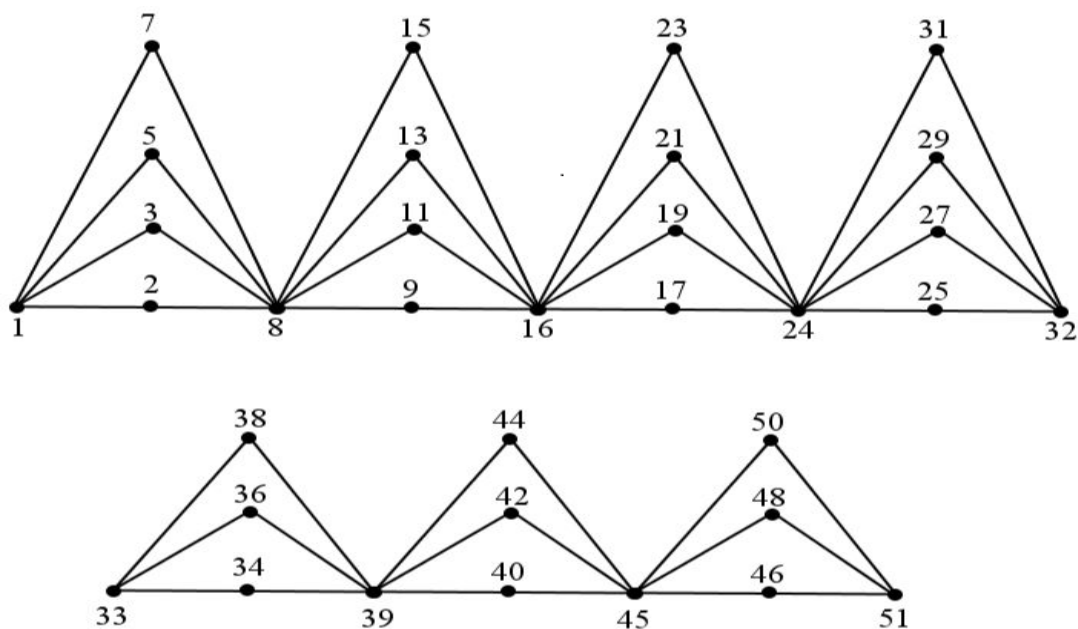


Figure 1

Theorem 2.3. Arbitrary super subdivision of $P_n \cup C_m$ is Stolarsky-3 mean graph.

Proof. Let P_n be the path with successive vertices u_1, u_2, \dots, u_n and let $e_i (1 \leq i \leq n-1)$ denote the edge $u_i u_{i+1}$ of P_n . Let C_m be a cycle $w_1, w_2, \dots, w_m, w_1$ and let $e_i (1 \leq i \leq m)$ denote the edge $w_{i-1} w_i$ of C_m .

Let H be an arbitrary super subdivision of disconnected graph $P_n \cup C_m$ where each edge e_i of $P_n \cup C_m$ is replaced by a complete bipartite graph K_{2,m_i} where m_i is any integer ($m_1 \leq 8$).

$$V(H) = \{u_1, u_2, \dots, u_n, w_1, w_2, \dots, w_m, v_1, v_2, \dots, v_{m_1}, v_{m_1+1}, v_{m_1+2}, \dots, v_{m_1+m_2}, v_{m_1+m_2+m_3+\dots+m_{n-1}}, x_1, x_2, \dots, x_{r_1}, x_{r_1+1}, x_{r_1+2}, \dots, x_{r_1+r_2}, x_{r_1+r_2+r_3+\dots+r_{(m-1)}}, x_{r_1+r_2+r_3+\dots+r_{(m-1)}} + 1\}$$

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 4$ and $r_1 = r_2 = r_3 = \dots = r_{m-1} = 3$.

An arbitrary super subdivision of $P_4 \cup C_3$ is given in **figure 2**

Define $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1$,

$$\varphi(u_i) = 8(i-1), 2 \leq i \leq n, \varphi(w_i) = 6n + (6i-5), 1 \leq i \leq m,$$

$$\varphi(v_1) = 2, \varphi(v_i) = 2i-1, 2 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1},$$

$$\varphi(x_1) = \varphi(v_{m_1+m_2+m_3+\dots+m_{n-1}}) + 3,$$

$$\varphi(x_i) = \varphi(x_{i-1}) + 2, 2 \leq i \leq r_1+r_2+r_3+\dots+r_{m-1}.$$

$$\varphi(x_{r_1+r_2+r_3+\dots+r_{(m-1)}} + 1) = \varphi(w_m) + 1.$$

Then the edge labels are distinct. In this similar manner we can prove for all n 's, m_i 's ($m_1 \leq 8$) and r_i 's. Hence arbitrary super subdivision of disconnected graph $P_n \cup C_m$ is Stolarsky-3 mean graph.

Example 2.4. Stolarsky-3 mean labeling of arbitrary super subdivision of $P_4 \cup C_3$ is given below.

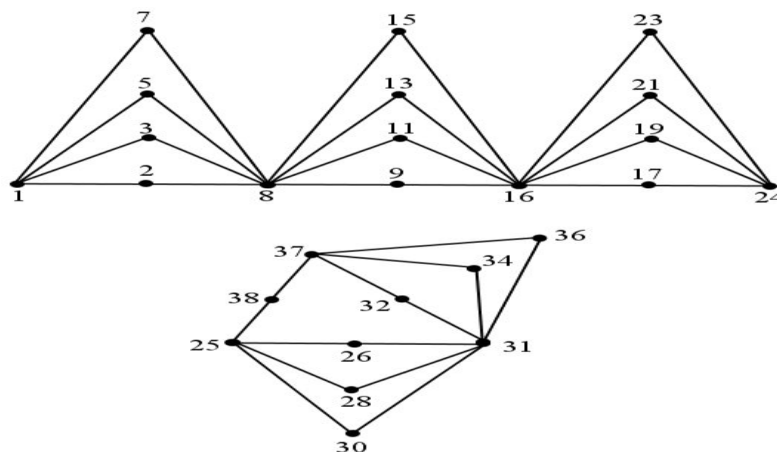


Figure 2

Theorem 2.5. Arbitrary super subdivision of $P_n \cup T_m$ is Stolarsky-3 mean graph.

Proof. Let P_n be the path with successive vertices u_1, u_2, \dots, u_n and let $e_i (1 \leq i \leq n-1)$ denote the edge $u_i u_{i+1}$ of P_n . Let T_m be the triangular snake with the vertices $w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_{m-1}$. Let $w_i w_{i+1}, w_i x_i, x_i w_{i+1} (1 \leq i \leq m-1)$ be the edges of a triangular snake graph T_m

Let H be an arbitrary super subdivision of disconnected graph $P_n \cup T_m$ where each edge e_i of $P_n \cup T_m$ is replaced by a complete bipartite graph K_{2,m_i} where m_i is any integer ($m_1 \leq 8$).

$$V(H) = \{u_1, u_2, \dots, u_n, v_1, v_2, \dots, v_{m_1}, v_{m_1+1}, v_{m_1+2}, \dots, v_{m_1+m_2}, v_{m_1+m_2+m_3+\dots+m_{n-1}}, w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_{m-1}, y_1, y_2, \dots, y_{r_1}, y_{r_1+1}, y_{r_1+2}, \dots, y_{r_1+r_2}, y_{r_1+r_2+r_3+\dots+r_{(m+2)}}, y_{r_1}^{(k)}, y_{r_2}^{(k)}, \dots, y_{r_{m-1}}^{(k)}\}.$$

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 4$ and $r_1 = r_2 = r_3 = \dots = r_{m+2} = 3$.

An arbitrary super subdivision of $P_4 \cup T_3$ is given in **figure 3**

Define $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1$,

$$\varphi(u_i) = 8(i-1), 2 \leq i \leq n,$$

$$\varphi(v_1) = 2, \varphi(v_i) = 2i-1, 2 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1},$$

$$\varphi(w_1) = 6n+1$$

$$\varphi(w_i) = 6n+(14i-14), 2 \leq i \leq m,$$

$$\varphi(y_1) = \varphi(w_1)+1,$$

$$\varphi(y_2) = \varphi(y_1)+1,$$

$$\varphi(y_i) = \varphi(y_{i-1}) + 2, 3 \leq i \leq r_1+r_2+r_3+\dots+r_{(m+2)}$$

$$\text{But } i \neq r_1+1, r_1+r_2+1, r_1+r_2+r_3+\dots+r_{(m+1)}+1,$$

$$\varphi(y_{\sum_{i=1}^k r_i+1}) = \varphi(y_{\sum_{i=1}^k r_i}) + 3, k = 1, 2, 3, \dots, m,$$

$$\varphi(y_{r_i,k}) = 13i+24, 1 \leq i \leq m-1,$$

$$\varphi(x_i) = 14i+16, 1 \leq i \leq m-1,$$

Then the edge labels are distinct. In this similar manner we can prove for all n 's, m_i 's ($m_i \leq 8$) and r_i 's. Hence arbitrary super subdivision of disconnected graph $P_n \cup T_m$ is Stolarsky-3 mean graph.

Example 2.6. Stolarsky-3 mean labeling of arbitrary super subdivision of $P_4 \cup T_3$ is given below.

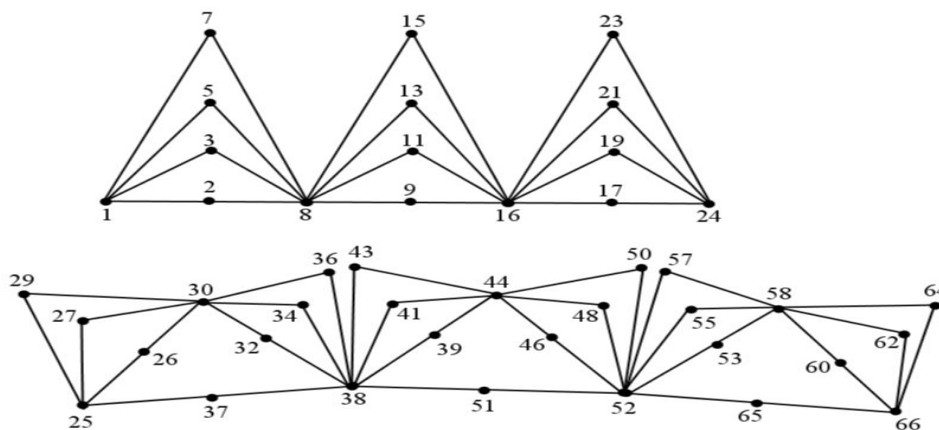


Figure 3

Theorem 2.7. Arbitrary super subdivision of disconnected graph $C_n \cup Q_m$ is Stolarsky-3 mean graph.

Proof. Let C_n be a cycle u_1, u_2, \dots, u_n and let e_i ($1 \leq i \leq n-1$) denote the edge

$u_{i-1}u_i$ of C_n . Let Q_m be the Quadrilateral snake graph with the vertices $w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_{m-1}$ and y_1, y_2, \dots, y_{m-1} and let $w_i x_i, x_i y_i, y_i w_{i+1}, 1 \leq i \leq m - 1$ be the edges of a Quadrilateral snake graph Q_m .

Let H be an arbitrary super subdivision of disconnected graph $C_n \cup Q_m$ where each edge e_i of $C_n \cup Q_m$ is replaced by a complete bipartite graph K_{2,m_i} where m_i is any integer ($m_1 \leq 4$).

$$V(H) = \{u_1, u_2, \dots, u_n, v_1, v_2, \dots, v_{m_1}, v_{m_1+1}, v_{m_1+2}, \dots, v_{m_1+m_2}, v_{m_1+m_2+m_3+\dots+m_{n-1}}, w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_{m-1}, y_1, y_2, \dots, y_{m-1}, z_1, z_2, \dots, z_{r_1}, z_{r_1+1}, z_{r_1+2}, \dots, z_{r_1+r_2}, z_{r_1+r_2+r_3+\dots+r_{(m+3)}}, z_{r_1}^{(k)}, z_{r_2}^{(k)}, \dots, z_{r_{m-1}}^{(k)}\}.$$

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 3$ and $r_1 = r_2 = r_3 = \dots = r_{m+2} = 3$.

An Arbitrary super subdivision of $C_3 \cup Q_3$ is given in **figure 4**

Define a function $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1$,

$$\varphi(u_i) = 6i-5, 2 \leq i \leq n,$$

$$\varphi(v_i) = 2i, 1 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1},$$

$$\varphi(v_{m_1+m_2+m_3+\dots+m_{n-1}+1}) = \varphi(u_n)+1,$$

$$\varphi(w_1) = 5n,$$

$$\varphi(w_i) = (5n-1) + 20(i-1), 2 \leq i \leq m,$$

$$\varphi(y_i) = 20i+7, 1 \leq i \leq m - 1,$$

$$\varphi(x_i) = 20i$$

$$\varphi(z_1) = \varphi(w_1) + 1, \varphi(z_2) = \varphi(z_1)+1,$$

$$\varphi(z_i) = \varphi(z_{i-1}) + 2, 3 \leq i \leq r_1 + r_2 + r_3 + \dots + r_{n+3},$$

$$\text{But } i \neq r_1+1, (r_1 + r_2) + 1, \dots, (r_1 + r_2 + r_3 + \dots + r_{n+2})+1,$$

$$\varphi(z_{r_i}^k) = 20i+13, 1 \leq i \leq m-1,$$

$$\varphi(z_{\sum_{i=1}^k r_{i+1}}) = \varphi(z_{\sum_{i=1}^k r_i}) + 3, k = 1, 3, 4, 6, \dots, m+2, \text{ but } k \neq 2, 5, 8, 11, 13, \dots$$

$$\varphi(z_{\sum_{i=1}^k r_{i+1}}) = \varphi(z_{\sum_{i=1}^k r_i}) + 2, k = 2, 5, 8, 11, 13, \dots,$$

Then the edge labels are distinct. In this similar manner we can prove for all n 's, m_i 's ($m_1 \leq 8$) and r_i 's. Hence arbitrary super subdivision of disconnected graph $C_n \cup Q_m$ is Stolarsky-3 mean graph.

Example 2.8. Labeling pattern of Stolarsky-3 mean labeling of arbitrary super subdivision of $C_3 \cup Q_3$ is given below

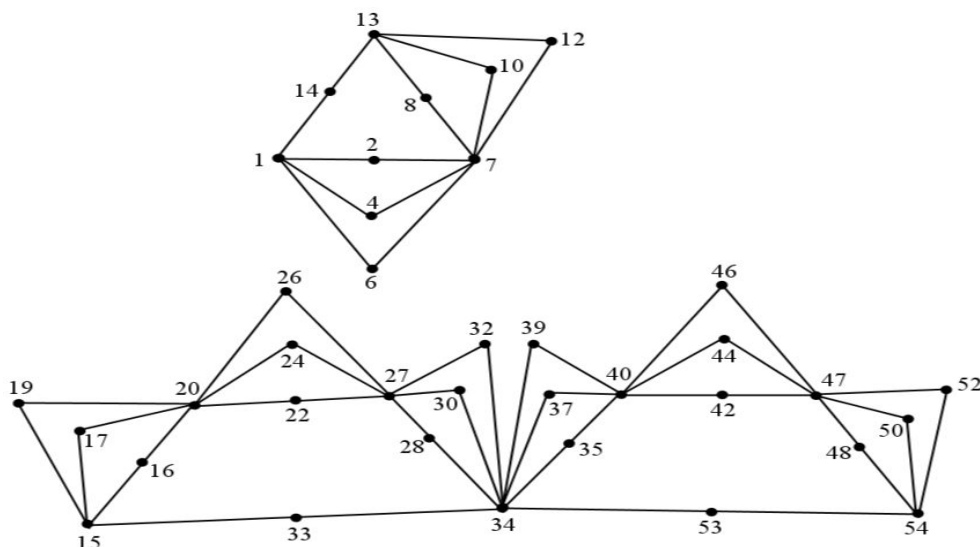


Figure 4

Theorem 2.9. Arbitrary super subdivision of disconnected graph $C_n \cup H_m$ is Stolarsky-3 mean graph if m is odd ($m \leq 11$) and m is even ($m \leq 10$).

Proof. Let C_n be a cycle u_1, u_2, \dots, u_n and let e_i ($1 \leq i \leq n-1$) denote the edge $u_{i-1}u_i$ of C_n . Let H_m be a H-graph with vertices $w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_m$ and let $w_iw_{i+1}, x_ix_{i+1}, 1 \leq i \leq m-1, \frac{w_{n+1}x_{n+1}}{2}, \frac{x_n w_n}{2}$ if n is odd and $\frac{x_{\frac{n}{2}+1}w_{\frac{n}{2}}}{2}$ if n is even be the edges of a H-graph H_m .

Let H be an arbitrary super subdivision of a H-graph H_m , where each edge of H_m is replaced by a complete bipartite graph K_{2,m_i} where m_i is any integer ($m_i \leq 4$).

$$\begin{aligned}
 &V(H) \\
 &= \{u_1, u_2, \dots, u_n, \\
 &v_1, v_2, \dots, v_{m_1}, \quad v_{m_1+1}, v_{m_1+2}, \dots, v_{m_1+m_2}, \dots, v_{m_1+m_2+m_3+\dots+m_{n-1}}, \\
 &w_1, w_2, \dots, w_m, x_1, x_2, \dots, x_m, y_1, y_2, \dots, y_{r_1}, y_{r_1+1}, y_{r_1+2}, \dots, y_{r_1+r_2}, \dots, y_{r_1+r_2+r_3+\dots+r_{(m-1)}}, \\
 &z_1, z_2, \dots, z_{r_1}, z_{r_1+1}, z_{r_1+2}, \dots, z_{r_1+r_2}, z_{r_1+r_2+r_3+\dots+r_{(m-1)}}, z_{r_k}\}.
 \end{aligned}$$

Case(i) When m is odd ($m \leq 11$)

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 3$ and $r_1 = r_2 = r_3 = \dots = r_{n-1} = 3$.

An Arbitrary super subdivision of $C_3 \cup H_3$ is given in **figure 5**

Define $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1,$

$$\begin{aligned}
 \varphi(u_i) &= 6i-5, 2 \leq i \leq n, \\
 \varphi(v_i) &= 2i, 1 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1}, \\
 \varphi(v_{m_1+m_2+m_3+\dots+m_{n-1}+1}) &= \varphi(u_n)+1, \\
 \varphi(w_1) &= 5n, \\
 \varphi(w_2) &= \varphi(w_1)+5,
 \end{aligned}$$

$$\begin{aligned} \varphi(w_i) &= \varphi(w_{i-1}) + 6, 3 \leq i \leq m, \\ \varphi(x_1) &= \varphi(x_m) + 1, \\ \varphi(x_i) &= \varphi(x_{i-1}) + 6, 1 \leq i \leq \frac{m+1}{2}, \left(\frac{m+1}{2}\right) + 1 \leq i \leq m, \\ \varphi(x_{\frac{m+1}{2}}) &= \varphi(x_{\left(\frac{m+1}{2}\right)-1}) + 7, \\ \varphi(y_1) &= \varphi(w_1) + 1, \\ \varphi(y_2) &= \varphi(y_1) + 1, \\ \varphi(y_i) &= \varphi(y_{i-1}) + 2, 3 \leq i \leq r_1 + r_2 + r_3 + \dots + r_{m-1}, \\ \varphi(z_1) &= (\varphi(y_{r_1+r_2+r_3+\dots+r_{m-1}})) + 3, \\ \varphi(z_i) &= \varphi(z_{i-1}) + 2, 2 \leq i \leq r_1, r_1 + 2 \leq i \leq r_1 + r_2 + r_3 + \dots + r_{m-1}, \\ \varphi(z_{r_1+1}) &= \varphi(x_{\frac{m+1}{2}}) + 1, \\ \varphi(z_{r_k}) &= \varphi(z_{r_1}) + 1. \end{aligned}$$

Then the edge labels are distinct. In this similar manner we can prove for all n's if m is odd ($m \leq 11$) and m_i 's ($m_i \leq 4$).

Example 2.10.

Stolarsky-3 Mean labeling of arbitrary super subdivision of $C_3 \cup H_3$ is given below

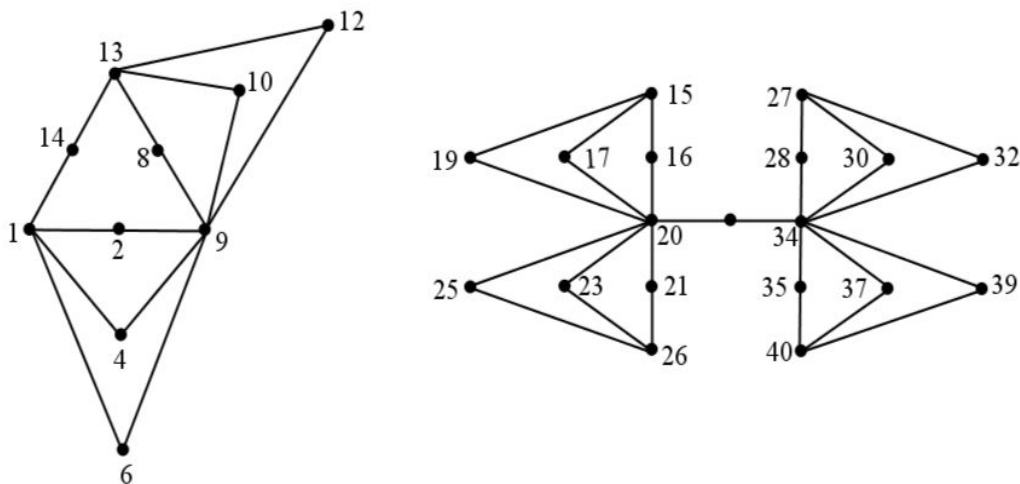


Figure 5

Case(ii) When m is even (m ≤ 10)

When $m_1 = m_2 = m_3 = \dots = m_{n-1} = 3$ and $r_1 = r_2 = r_3 = \dots = r_{n-1} = 3$.

An arbitrary super subdivision of $C_3 \cup H_4$ is given in figure 6

Define $\varphi: V(H) \rightarrow \{1, 2, \dots, q+1\}$ by $\varphi(u_1) = 1, \varphi(u_i) = 6i - 5, 2 \leq i \leq n,$

$$\varphi(v_i) = 2i, 1 \leq i \leq m_1 + m_2 + m_3 + \dots + m_{n-1},$$

$$\begin{aligned} \varphi(v_{m_1+m_2+m_3+\dots+m_{n-1}+1}) &= \varphi(u_n)+1, \\ \varphi(w_1) &= 5n, \varphi(w_2) = (w_1) +5, \varphi(w_i) = \varphi(w_{i-1}) + 6, 3 \leq i \leq m, \\ \varphi(x_1) &= \varphi(w_m) + 1, \varphi(x_{\frac{m}{2}}) = \varphi(x_{(\frac{m}{2})-1}) + 7, \\ \varphi(x_i) &= \varphi(x_{i-1})+6, \left(\frac{m}{2}\right)+1 \leq i \leq m, \varphi(y_1) = \varphi(w_1)+1, \\ \varphi(y_2) &= \varphi(y_1)+1, \\ \varphi(y_i) &= \varphi(y_{i-1})+2, 3 \leq i \leq r_1 + r_2 + r_3 + \dots + r_{m-1}, \\ \varphi(z_1) &= (\varphi_{r_1+r_2+r_3+\dots+r_{m-1}}) +3, \\ \varphi(z_i) &= \varphi(z_{i-1})+2, 2 \leq i \leq r_1, r_1+2 \leq i \leq r_1 + r_2 + r_3 + \dots + r_{m-1}, \\ \varphi(z_{r_1+1}) &= \varphi(x_{\frac{m}{2}})+1, \varphi(z_{r_k}) = \varphi(z_{r_1}) +1. \end{aligned}$$

Then the edge labels are distinct. In this similar manner we can prove for all m's if m is even (m ≤ 10) and m_i's (m₁ ≤ 4).

From case(i) and case(ii) we can conclude that arbitrary super subdivision of disconnected graph C_n ∪ H_m is Stolarsky-3 Mean graph.

Example 2.11. Labeling pattern of Stolarsky-3 mean labeling of arbitrary super subdivision of C₃ ∪ H₄ is given below

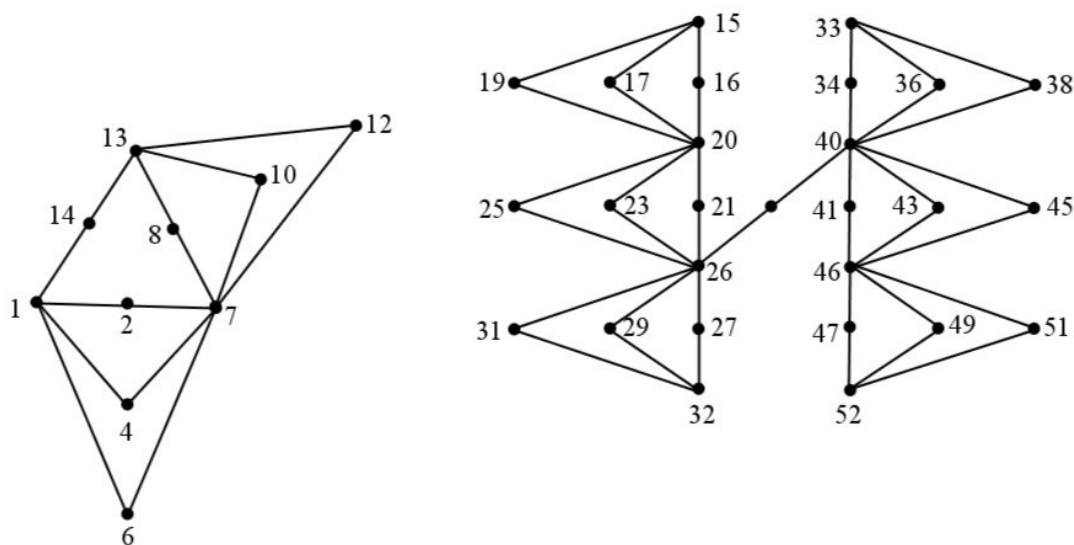


Figure 6

Conclusion

Sethuraman, Selvaraj [8] and Kathiresan, Amutha [3] have discussed graceful labeling in the context of arbitrary super subdivision of various graphs. This paper investigated Stolarsky-3 mean labeling of arbitrary super subdivision of disconnected graphs P_n ∪ P_r, P_n ∪ C_m, P_n ∪ T_m, C_n ∪ Q_m and C_n ∪ H_m.

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Product edge antimagic coloring of Graphs

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ABSTRACT

Let $G(V, E)$ be a graph of vertex set V and edge set E . A bijection $f: V(G) \rightarrow \{1, 2, \dots, |V(G)|\}$ is called a product edge antimagic labeling if for any two adjacent edges e_1 and e_2 , $w(e_1) \neq w(e_2)$, where for $e = uv \in G$, $w(e) = f(u) \cdot f(v)$. The product edge antimagic chromatic number γ_{pea} is the minimum number of colors taken over all colorings induced by product edge antimagic labelings of G . In this paper, we find the lower and upper bound of the product edge antimagic coloring of G and we find the product edge antimagic chromatic number of star graph and complete graph.

Keywords: Antimagic labeling, Local edge antimagic labeling, Product edge antimagic coloring, Product edge antimagic chromatic number.

AMS Subject Classification (2010): 05C78

Introduction

Graph labeling is currently an emerging area in the research of graph theory. All graphs in this paper are finite, simple and connected graph, for detail definition of graph see [1, 2]. A bijection mapping that assigns natural number to vertices or edges or both subject to certain conditions is called a graph *labeling*. In this type of labeling, we consider all weights associated with each edge. If all the edge weights have the different value then we call the labeling as *antimagic labeling*. There are a lot of results related to the antimagic labeling, some of them can be found in Baca et al. [3, 4], Dafik et al. [5, 6], Sugeng et al. [7], and also in Figueroa-Centeno et al. [8]. Arumugam et al. [9] define the local antimagic labeling as follows: A bijection $f: E(G) \rightarrow \{1, 2, \dots, |E(G)|\}$ is called a *local antimagic labeling* if for any two adjacent vertices u and v , $w(u) \neq w(v)$, where $w(u) = \sum_{e \in E(u)} f(e)$, and $E(u)$ is the set of edges incident to u . Dafik *et. al.* [5, 6] determined Super edge antimagic total labelings of $mK_{n,n}$ and Super edge antimagicness for a class of disconnected graphs, respectively. Hartsfield and Ringel [10] introduced the concept of antimagic labeling of a graph. A bijection $f: V(G) \rightarrow \{1, 2, \dots, |V(G)|\}$ is called a *local edge antimagic labeling* if for any two adjacent edges e_1 and e_2 , $w(e_1) \neq w(e_2)$, where for $e = uv \in G$, $w(e) = f(u) + f(v)$. Motivated by the above definition, we introduce the concept of product edge antimagic labeling of a graph. A bijection $f: V(G) \rightarrow \{1, 2, \dots, |V(G)|\}$ is called a *product edge antimagic labeling* if for any two adjacent edges e_1 and e_2 , $w(e_1) \neq w(e_2)$, where for $e = uv \in G$,

$w(e) = f(u) \cdot f(v)$. Thus, any product edge antimagic labeling induces a proper edge coloring of G if each edge e is assigned the color $w(e)$. The product edge antimagic chromatic number γ_{pea} is the minimum number of colors taken over all colorings induced by product edge antimagic labelings of G .

Definition 1.1. An assignment of colors to the vertices of a graph so that no two adjacent vertices get the same color is called a *coloring* of the graph. The chromatic number $\chi(G)$ of a graph G is the minimum number of colors needed to color G .

Definition 1.2. An assignment of colors to the edges of a graph G so that no two adjacent edges get the same color is called an *edge coloring*. The edge chromatic number $\chi'(G)$ is the minimum number of colors needed to edge color G .

Definition 1.3. Star graph is a special type of graph in which n vertices have degree 1 and a single vertex have degree n . A star graph with total of $n + 1$ vertex is termed as $K_{1,n}$.

Definition 1.4. A graph in which any two distinct points are adjacent is called a *complete graph*.

Main Results

In this paper, we find the lower and upper bound of the product edge antimagic coloring of a graph and determine the product edge antimagic chromatic number of star graph and the complete graph for $n \leq 7$.

Observation 2.1. For any graph G , $\gamma_{pea}(G) \geq \chi'(G)$, where $\chi'(G)$ is a chromatic number of edge coloring of G .

Observation 2.2. For any graph G , $\gamma_{pea}(G) \leq |E(G)|$, where $|E(G)|$ is a total number of edges in graph G .

Theorem 2.3. For $n \geq 2$, the product edge antimagic chromatic number of $K_{1,n}$ is $\gamma_{pea}(K_{1,n}) = n$.

Proof: The star $K_{1,n}$ is a graph with central vertex u and the leaves v_i , for $1 \leq i \leq n$. The vertex set $V(K_{1,n}) = \{v_i, 1 \leq i \leq n\} \cup \{u\}$ and the edge set $E(K_{1,n}) = \{uv_i, 1 \leq i \leq n\}$. Thus $|V(K_{1,n})| = n + 1$ and $|E(K_{1,n})| = n$.

Define a bijection $f: V(K_{1,n}) \rightarrow \{1, 2, \dots, |V(K_{1,n})|\}$ as follows:

$$f(u) = 1$$

$$f(v_i) = \{i + 1 / 1 \leq i \leq n\}$$

We formulate the edge weights as follows:

$$w(uv_i) = i + 1, \text{ if } 1 \leq i \leq n$$

The chromatic number of the edge coloring of $K_{1,n}$ is n , since all edges are adjacent to each other. So by the observation 1.1., we get $\gamma_{pea}(K_{1,n}) \geq n$. And by the observation 1.2., we get $\gamma_{pea}(K_{1,n}) \leq n$. It concludes that $\gamma_{pea}(K_{1,n}) = n$.

The example of product edge antimagic coloring of $K_{1,7}$ is shown in Figure 1.

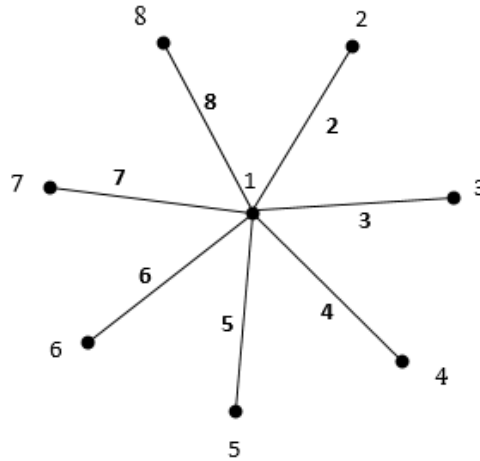


Figure 1

Theorem 2.4. For $n \leq 5$, the product edge antimagic chromatic number of K_n is $\gamma_{pea}(K_n) = \binom{n}{2} = \frac{n(n-1)}{2}$

Proof: The complete graph K_n is a connected graph with vertex set $V(K_n) = \{v_i, 1 \leq i \leq n\}$ and the edge set $E(K_n) = \{v_i v_{i+k}, 1 \leq i \leq n-1, 1 \leq k \leq n-i\}$ with the cardinality of vertices $|V(K_n)| = n$ and the cardinality of edges $|E(K_n)| = \frac{n(n-1)}{2}$.

Define a bijection $f: V(K_n) \rightarrow \{1, 2, \dots, |V(K_n)|\}$ by

$$f(v_i) = \{i / 1 \leq i \leq n\}$$

And the edge weights can be expressed as

$$w(v_i v_{i+k}) = i(i+k), \text{ if } 1 \leq i \leq n-1, 1 \leq k \leq n-i$$

The chromatic number of the edge coloring of $K_n = \begin{cases} n & \text{if } n \text{ is odd} \\ n-1 & \text{if } n \text{ is even} \end{cases}$

So by the observation 1.1., we get $\gamma_{pea}(K_n) \geq \frac{n(n-1)}{2} \geq n$, if n is odd, otherwise $\gamma_{pea}(K_n) \geq \frac{n(n-1)}{2} \geq n-1$, if n is even. And by the observation 1.2., we get $\gamma_{pea}(K_n) \leq \frac{n(n-1)}{2}$. It concludes that $\gamma_{pea}(K_n) = \frac{n(n-1)}{2}$.

The example of product edge antimagic coloring of K_5 is shown in Figure 2.

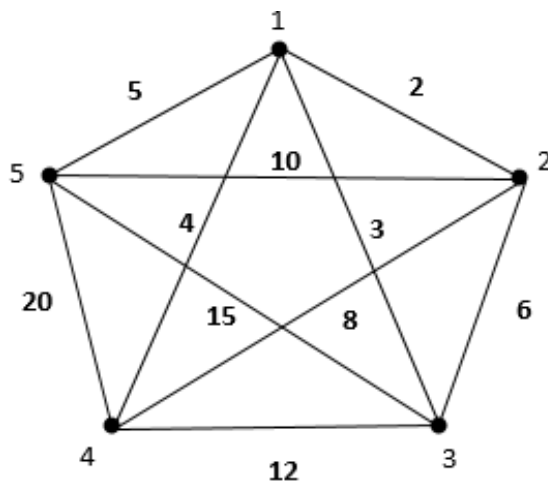


Figure 2

Theorem 2.5. For $n = 6, 7$, the product edge antimagic chromatic number of K_n is

$$\gamma_{pea}(K_n) = (n2) - 2 = \frac{n(n-1)}{2} - 2$$

Proof: The complete graph K_n is a connected graph with vertex set $V(K_n) = \{v_i, 1 \leq i \leq n\}$ and the edge set $E(K_n) = \{v_i v_{i+k}, 1 \leq i \leq n - 1, 1 \leq k \leq n - i\}$ with the cardinality of vertices $|V(K_n)| = n$ and the cardinality of edges $|E(K_n)| = \frac{n(n-1)}{2}$.

Define a bijection $f: V(K_n) \rightarrow \{1, 2, \dots, |V(K_n)|\}$ by

$$f(v_i) = \{i / 1 \leq i \leq n\}$$

And the edge weights can be expressed as follows:

$$w(v_i v_{i+k}) = i(i+k), \text{ if } 1 \leq i \leq n - 1, 1 \leq k \leq n - i$$

The chromatic number of the edge coloring of $K_n = \begin{cases} n & \text{if } n \text{ is odd} \\ n - 1 & \text{if } n \text{ is even} \end{cases}$

So by the observation 1.1., we get $\gamma_{pea}(K_n) \geq \frac{n(n-1)}{2} - 2 \geq n$, if n is odd, otherwise

$\gamma_{pea}(K_n) \geq \frac{n(n-1)}{2} - 2 \geq n - 1$, if n is even. In K_6 and K_7 , the edges labelled by 6 and 12

occurs twice, so we get $\gamma_{pea}(K_n) \leq \frac{n(n-1)}{2} - 2$. Therefore, we get

$$\gamma_{pea}(K_n) = (n2) - 2 = \frac{n(n-1)}{2} - 2 \text{ for } n = 6, 7.$$

The example of product edge antimagic coloring of K_6 is shown in Figure 3.

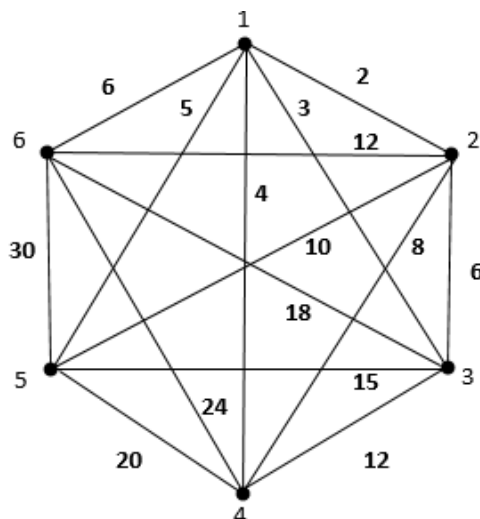


Figure 3

Observation 2.6. *If n is prime, the product edge antimagic chromatic number of K_n is $\gamma_{pea}(K_n) = \gamma_{pea}(K_{n-1}) + n - 1$.*

Conclusion

In this paper we have found the upper and lower bound of the product edge antimagic coloring of a graph and also determine the chromatic number of product edge antimagic coloring for the star graph and the complete graph.

Open Problem 3.1. Determine the product edge antimagic chromatic number of path and cycle.

Open Problem 3.2. Determine the product edge antimagic chromatic number of comb product $P_n \triangleright P_m$.

Acknowledgement

The authors thank the anonymous referees for their valuable suggestions which led to the improvement of the manuscripts.

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An Analysis on Determination of Edge Domination Number and Edge Cover Number in Graphs

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ABSTRACT

Domination in graphs is one of the emerging concepts in Graph Theory. In this paper some theorems and results regarding Edge domination, Total edge domination and Edge cover in graphs are discussed.

Keywords: *Dominating set, Edge domination, Edge domination number, Minimal and minimum edge domination, Edge cover, Minimum and minimal edge cover.*

Introduction

A graph is a pictorial representation of a set of objects where some pairs of objects are connected by edges. The term graph was introduced by Sylvester and he published in 1878. A graph is a pair of set of (V, E) where V is the set of vertices and E is the set of edges. Graph theory has countless applications in various fields including Computer Science, Electrical Engineering, Geometry and in certain parts of Topology. Oystein Ore introduced the term domination set and domination number [1].

The concept domination was studied from 1950's onwards, and the study rate of research in domination increased significantly in the middle of 1970. A dominating set of a graph $G = (V, E)$ is a subset D of V such that every vertex not in D is adjacent to atleast one member of D [2]. Dominating sets are used in several areas such as wireless networking, also used to find efficient rates in mobile network. A graph $G = (V, E)$ be a subset F of an edge set E is said to be an edge dominating set of the graph G if every edge e not in F is adjacent to some edges in F [3, 4, 5, 6]. The concept of edge domination is introduced by Mitchell and Hendetniemi [7]. Edge dominating set and edge domination number have been explored by several authors. The concept of edge domination requires the adjacency relation among the edges of a graph.

1.1 Edge Domination Number of some graphs

Theorem 1.1. For a bipartite graph, the edge domination number of G is $\gamma_E(G) = n$, if $m \geq n$ for all $m, n \in N$.

Proof. Let G be a bipartite graph. To prove that $\gamma_E(G) = n$, if $m \geq n$ for all $m, n \in N$.

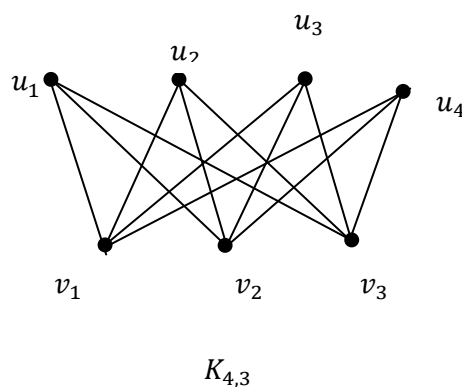
Case (i) When $m = n = 1$, the edge domination number cannot be determined as there is only one edge exists.

Case (ii) Suppose $m \geq 2$ and $n = 1$, let $\{u_1, u_2, \dots, u_m, v_1\}$ be the set of all vertices and $\{e_{11}, e_{12}, \dots, e_{1m}\}$ be their edges. The edge e_1 is dominated by all the other edges. Thus, the edge domination number of G is 1 for $m \geq 2$ and $n = 1$.

Case (iii) Suppose $m = 1$ and $n \geq 2$, let $\{u_1, v_1, v_2, \dots, v_n\}$ be the set of all vertices and $\{e_{11}, e_{12}, \dots, e_{1n}\}$ be their edges. The edge e_1 is dominated by all the other edges. Thus, the edge domination number of G is 1 for $m = 1$ and $n \geq 2$.

Case (iv) suppose $m \geq n$ for all $m, n \in N$. let $\{u_1, u_2, \dots, u_m\}$ be the set of all vertices of the first partition of $K_{m,n}$ and $\{v_1, v_2, \dots, v_n\}$ be the second partition of $K_{m,n}$ and e_{ij} where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ be the edges of $K_{m,n}$. Now choosing an edge e_{11} that connects the first vertex of the first partition to all the vertices in the second partition of G , the edge e_{11} dominates all the edges which are all adjacent to e_{11} . Choosing an edge e_{21} that connect the second vertex of the first partition to all the vertices in the second partition of G , the edge e_{21} dominates all the edges which are all adjacent to e_{21} . Proceeding like this the last edge e_{mn} which connects the last vertex of the first partition to all the vertices in the second partition of G , the edge e_{mn} dominates all the edges which are all adjacent to e_{mn} . Thus there are n edges which dominate all edges of G . Hence $\gamma_E(K_{m,n}) = n$, for all $m \geq n$.

Example 1.1.

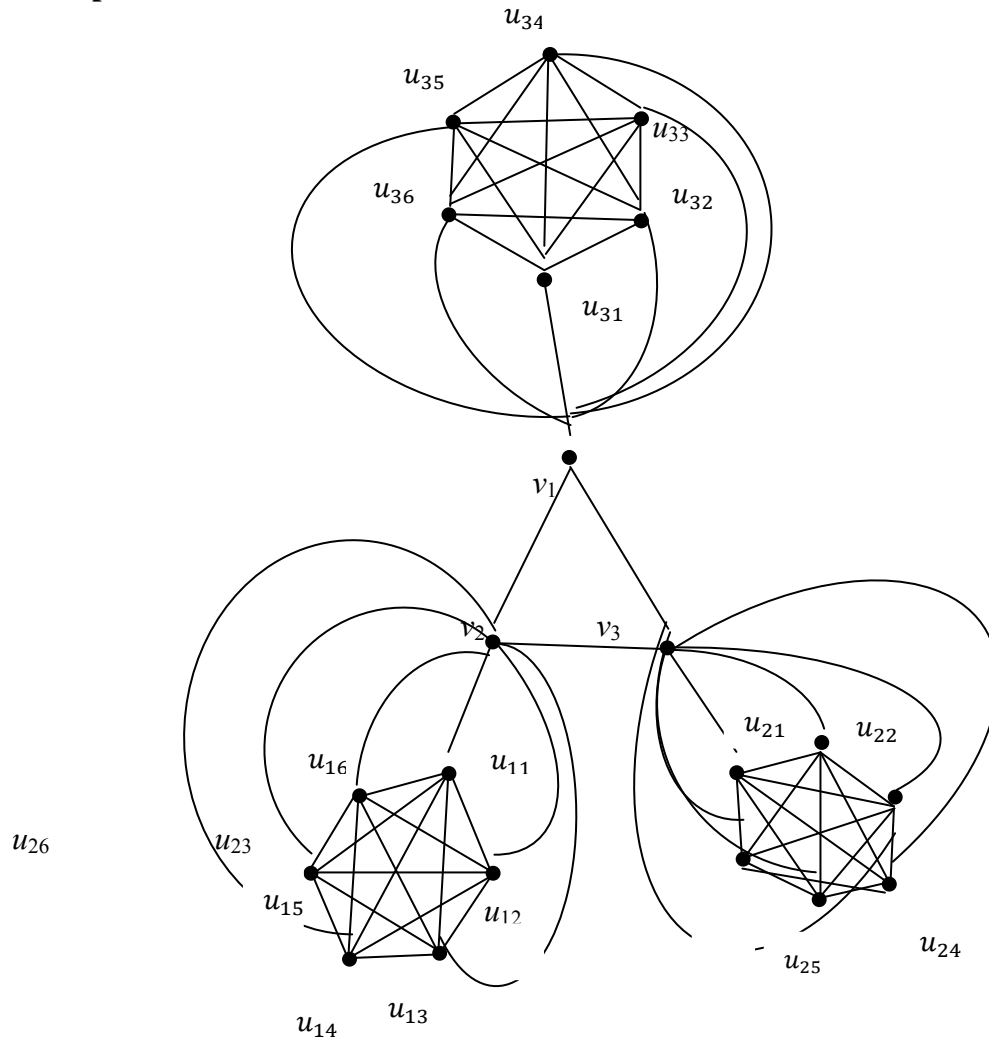


In this example 1.1, the edge domination number of $K_{m,n}$ is 3.

Result 1.2. For a Cycle and a connected graph the edge domination number of corona product of C_n and K_m is $\gamma_E(C_n \circ K_m) = n + m$, for all $n = 3$ and $m \geq 3$.

Proof. Let G be the corona product of the cycle C_n and the complete graph K_m . Let $\{v_1, v_2, v_3\}$ be the set of all vertices and $\{e_1, e_2, e_3\}$ be their edges of C_n where e_i is the edge joining the vertices v_i , where $i = 1, 2, 3$. Let u_{ij} where $i = 1, 2, 3$ and $j = 1, 2, \dots, m$ be the vertices which join the vertices v_i , h_{ij} be the edges of K_m which joins the vertices u_{ij} and l_{ij} be the edges which join vertices v_i of C_n to the vertices u_{ij} of K_m . From the definition of edge domination, the edge domination number of G is $n + m$, for all $n = 3$ and $m \geq 3$.

Example 1.2.



$$G = C_3 \circ K_6$$

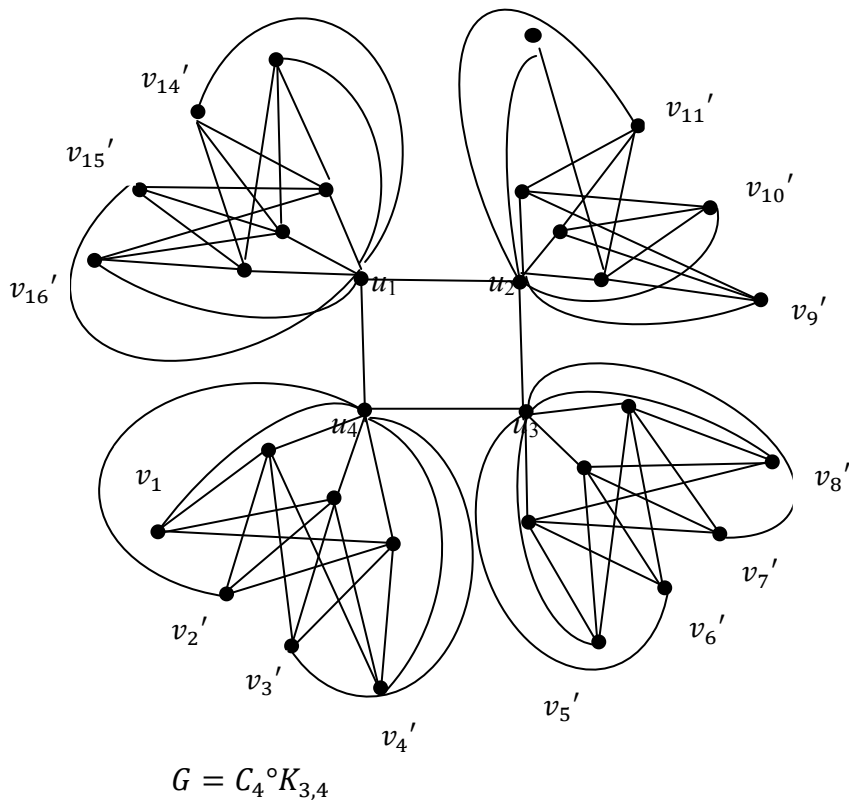
In this example 1.2, the edge domination number of $C_3 \circ K_6$ is $\gamma_E(C_3 \circ K_6) = 9$ when $n = 3$ and $m \geq 3$.

Theorem 1.3. For a cycle and a bipartite graph the edge domination number of $C_l \circ K_{m,n}$ is $\gamma_E(C_l \circ K_{m,n}) = lm$, for all $l, m, n \geq 2$ where $l, m, n \in N$.

Proof. Let G be the corona product of a cycle C_l and bipartite graph $K_{m,n}$. Let $\{u_1, u_2, \dots, u_l\}$ be the set of all vertices and $\{e_1, e_2, \dots, e_l\}$ be their edges of cycle C_l . Let $\{v_1, v_2 \dots, v_{mn}, v_1', v_2' \dots, v_{mn}'\}$ and $\{e_{11}', \dots, e_{mn}'\}$ be the set of all vertices and edges of a bipartite graph. Then E_{ij} be the edges which joins the cycle C_l to $K_{m,n}$, where $i = 1, 2, \dots, n$ and $j = 1, 2, 3 \dots, m$. Now, let $E_{11} = \{e_{11}, \dots, e_{1m}, e'_{11}, e_{12}', \dots, e_{1n}'\}$ be the set of edges which connects C_l to $K_{m,n}$ in the first set of $K_{m,n}$, and $E_{21} = \{e_{21}, \dots, e_{2m}, e'_{21}, e_{22}', \dots, e_{2n}'\}$ be the set of edges which connects C_l to $K_{m,n}$ in the second set of $K_{m,n}$, ..., $E_{mn} = \{e_{m1}, \dots, e_{mm}, e'_{m1}, e_{m2}', \dots, e_{mn}'\}$ be the set of edges which connects C_l to $K_{m,n}$ in the last set of $K_{m,n}$. From the first set of $K_{m,n}$, considering an edge $e_{11}' \in E_{11}$ which is adjacent to m edges, and $e_{21}' \in E_{21}$ is adjacent to another m edges and proceeding like this the $e_{mn}' \in E_{mn}$ is adjacent to m edges. Thus G has l copies of $K_{m,n}$. Therefore, there are lm edges which dominate all the edges of G . Hence the edge domination number of corona product of a cycle and bipartite graph is $\gamma_E(C_l \circ K_{m,n}) = lm$, for all $l, m, n \geq 2$ where $l, m, n \in N$.

Example 1.3.

$v_{11}' v_{12}'$



In this example 1.3, the edge domination number of $C_4 \circ K_{3,4}$ is $\gamma_E(C_4 \circ K_{3,4})$ is 12.

2.1 Total Edge Domination

In this section some theorems related to total edge domination number and corona product of some graphs are discussed.

Definition 2.1 [4]. Let G be a graph. An edge dominating set X of G is called a *Total Edge Dominating Set* of G if the induced subgraph $\langle X \rangle$ has no isolated vertices. The minimum number of edges in a total edge dominating set of G is called a *Total Edge Domination Number* of G and is denoted by $\gamma_t(G)$.

Theorem 2.2. For a cycle and a connected graph, the total edge domination number of $C_n \circ K_m$ is $\gamma_t(C_n \circ K_m) = n(m - 1)$, for all $n \geq 2$ and $m \geq 3$.

Proof. Let G be the corona product of a cycle C_n and a connected graph K_m . Let $\{v_1, v_2, \dots, v_{mn}\}$ be the set of all vertices and $\{e_{11}, \dots, e_{n[\frac{m-1}{2}]}\}$ be their edges of K_m . Let M_{ij} be the edges that connects a cycle C_n to K_m where $i = 1, 2, 3, \dots, m$ and $j = 1, 2, 3, \dots, n$. Let e_{11} be the edge which is adjacent to M_{11} , e_{21} be the edge which is adjacent to M_{21} , ..., and $e_{n[\frac{m-1}{2}]}$ be the edge which is adjacent to M_{mn} . Now, the edge M_{11} is adjacent to t_1 edges where t_1 is the union of edges which are all dominated by M_1 , M_2 is adjacent to t_2 edges where t_2 is the union of edges which are all dominated by M_2 , ..., M_{mn} is adjacent to t_{mn} edges where t_{mn} is the union of edges which are all dominated by M_{mn} . Hence the total edge domination number of corona product of cycle and a connected graph, $C_n \circ K_m$ is $\gamma_t(G) = n(m - 1)$, for all $n \geq 2$ and $m \geq 3$.

Theorem 2.3. For a cycle and a bipartite graph the total edge domination number of corona product of C_t and $K_{m,n}$ is $\gamma_t(C_t \circ K_{m,n}) = tm$, for all $t, m, n \geq 2$ where $t, m, n \in N$.

Proof. Let G be the corona product of a cycle C_t and a bipartite graph $K_{m,n}$. Let $\{u_1, u_2, \dots, u_t\}$ be the set of all vertices and $\{e_1, e_2, \dots, e_t\}$ be the set of all edges of cycle C_t , let $\{v_1, v_2, \dots, v_m\}$ be the set of all vertices of the first partition of $K_{m,n}$. Let l_j ($j = 1, 2, \dots, n$) be the vertices of the second partition of $K_{m,n}$. Let h_{ij} be the edges that connects v_j to l_j where $i = 1, 2, \dots, m$ and $j = 1, 2, 3, \dots, n$. Let w_{ij} be the edges which connects $\{u_1, u_2, \dots, u_t\}$ of a cycle C_t to v_j of the second partition of $K_{m,n}$. Let m_{ij} be the edges that connects

$\{u_1, u_2, \dots, u_t\}$ of a cycle C_t to v_j of the first partition of $K_{m,n}$. Now consider an edge h_{11} which is adjacent to m edges, so that h_{11} is adjacent to m edges, Proceeding like this the edge h_{mn} is adjacent to m edges.. Also G has l copies of $K_{m,n}$. So that h_j is adjacent to lm edges. Hence the total edge domination of corona product of a cycle and a bipartite graph is $\gamma_t(C_t \circ K_{m,n}) = tm$, for all $t, m, n \geq 2$ where $t, m, n \in N$.

3. Edge Cover

In this section a theorem related to edge cover of a cycle is discussed.

Definition 3.1 [3]. Let G be a graph. An *Edge Cover* of G is the set of all edges which covers all the vertices of G . An edge cover with minimum cardinality is called a *Edge Covering Number* of G and is denoted by $\alpha_c(G)$. Let G be a graph and F be an edge cover of G then F is said to be a *Minimal Edge Covering* of G if no proper subset F is an edge cover of G , i.e., $F - e$ is not an edge cover.

Theorem 3.2. Let G be a cycle. Then the edge covering number of G is

$$\alpha_c(G) = \begin{cases} \frac{m+1}{2} & \text{if } m \text{ is odd} \\ \frac{m}{2} & \text{if } m \text{ is even} \end{cases}$$

Proof. Let G be a cycle. Let $\{v_1, v_2, \dots, v_m\}$ be the set of all vertices and $\{e_1, e_2, \dots, e_m\}$ be the set of all edges of $G = C_m$.

Case(i): When m is odd, let $M = \{e_1, e_2, \dots, e_m\}$ be the set of all edges of G . An edge e_1 covers the vertices v_1 and v_3 , e_5 covers the vertices v_5 and v_7 , e_9 covers the vertices v_9 and v_{11} , and the last edge e_m covers the vertex v_m . Thus M covers $\frac{m+1}{2}$ vertices. This set M is minimal, if one edge e_1 is deleted from M the edge e_1 does not cover the vertices v_1 and v_3 , if the edges e_5 and e_7 are deleted then these edges does not cover the vertices v_5 and v_7 , and proceeding like this if the last edge e_m is deleted this edge does not cover the vertex v_m . Thus M is minimal. Then $|M| = \frac{m+1}{2}$ if m is odd, for all $m \geq 2$ and $m \in N$.

Case(ii): When m is even, let $M = e_1, e_2, \dots, e_m$. Repeating the above case, the edge M covers all the vertices. Thus the edge covering number can be determined. Thus $|M| = \frac{m}{2}$ if m is even for all $m \geq 2$ and $m \in N$. Hence the edge covering number of a cycle is

$$\alpha_c(G) = \begin{cases} \frac{m+1}{2} & \text{if } m \text{ is odd} \\ \frac{m}{2} & \text{if } m \text{ is even} \end{cases}.$$

Example 3.3: The edge covering number of $G = C_8$ is 4, if m is even and the edge covering number of $G = C_9$ is 5, if m is odd.

Conclusion

The Edge domination number and Edge covering number of different graphs and the corona product of some graphs are studied and determined in this paper.

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Total Certified Domination Number of Graphs

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ABSTRACT

A dominating set D of graph $G=(V,E)$ is an total certified dominating set, if every vertices in D has zero or at least two neighbor in $V(G)-D$. The minimum cardinality taken over all the total certified dominating set is called the total certified domination number and is denoted by $\gamma_{tcer}(G)$. In this paper, we investigate the total certified domination number for some standard graphs.

Keywords: Dominating set, domination number, total domination set, total domination number, certified dominating set, certified domination number.

Introduction

In graph theory, the study of dominating set began around 1960. The term dominating set and domination number of a were first defined by Ore in 1962. The concept of total dominating set were introduced by Cockayne, Dawes and Hedetniemi. A total dominating set D of a graph $G = (V(G), E(G))$ is said to be total certified dominating set if every vertices in D has either zero or at least two neighbors in $V(G) - D$. The minimum cardinality taken over all total certified dominating set in G is called total certified number of a graph is denoted by $\gamma_{tcer}(G)$.

Definition:1.1

Let $G=(V,E)$ be a finite, simple, connected and graph has p vertices and q edges. The subset D of V is a dominating set if every vertex in $V - D$ is adjacent to at least one vertex in D . The minimum cardinality of dominating set is called the **Domination Number** and it is denoted by $\gamma(G)$.

Definition:1.2

A dominating set D is said to be total dominating if $\langle D \rangle$ has no isolate vertices. The minimum cardinality taken over all total dominating set is called the **Total Domination Number** and is denoted by $\gamma_t(G)$.

Definition:1.3

A dominating set D of a graph G is said to be certified dominating set if every vertex in D has either zero or at least two neighbors in $V - D$. The minimum cardinality taken over all

certified dominating set is called **Certified Domination Number** and is denoted by $\gamma_{cer}(G)$.

Definition: 1.4

A **Corona Product** $G \circ H$ of two graphs G and H is obtained by taking one copy of G and $|V(G)|$ copies of H and by joining each vertex of the i^{th} copy of H to the i^{th} vertex of G where

$$1 \leq i \leq |V(G)|.$$

Total Certified Domination Number of a Graph

Definition:2.1

A total dominating set D of a graph $G = (V(G), E(G))$ is said to be total certified dominating set if every vertex in D has either zero or atleast two neighbors in $V(G) - D$. The minimum cardinality of total certified dominating set in G is called **Total Certified Domination Number** of a graph and is denoted by $\gamma_{tcer}(G)$.

Theorem:1

For a web graph $w_p, p \geq 3$ then $\gamma(w_p) = \gamma_{cer}(w_p) = \gamma_{tcer}(w_p) = p$

Proof:

Let G be a web graph denoted by w_p with $3p$ vertices

Then $V(G) = \{v_1, v_2 \dots v_n\}, U(G) = \{u_1, u_2 \dots u_n\}, T(G) = \{t_1, t_2 \dots t_n\}$ be the vertices of web graph G

Let $V(w_p) = \{v_1, v_2 \dots v_n\}$ be a dominating set D of G

Then the support vertex of $\{v_1, v_2 \dots v_n\}$ are a minimum dominating set such that $\gamma(w_p) = p$ _____ (1)

Also each vertex of D has at least two neighbours in $V - D$

Thus D is a certified dominating set of w_p

Therefore $\gamma_{cer}(w_p) = p$ _____ (2)

Then the subgraph induced by D has no isolate vertex

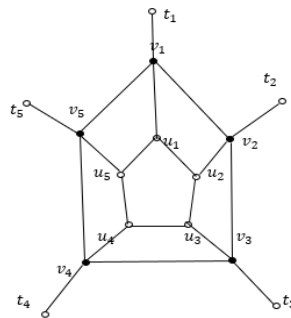
Hence D is a minimum total certified dominating set of w_p

Therefore $\gamma_{tcer}(w_p) = p$ _____ (3)

From (1),(2) and (3) we get,

$$\gamma(w_p) = \gamma_{cer}(w_p) = \gamma_{tcer}(w_p) = p$$

Example



Theorem:2

For any book graph B_n , then $\gamma(B_n) = \gamma_{tcd}(B_n)$ where $n \geq 3$

Proof:

Let B_n graph two vertices V_k and V_l are connected to all the vertices with the neighborhood

$$N(V_k) = \{v_1', v_2', \dots v_n'\}$$

$$N(V_l) = \{v_1'', v_2'', \dots v_n''\}$$

Therefore $D = \{V_k, V_l\}$ be the dominating set of B_n

$$\gamma(B_n) = 2 \quad \text{————— (1)}$$

Then clearly the vertices V_k and V_l are adjacent to atleast two neighborhood of $V - D$

The subgraph induced by D has no isolate vertex

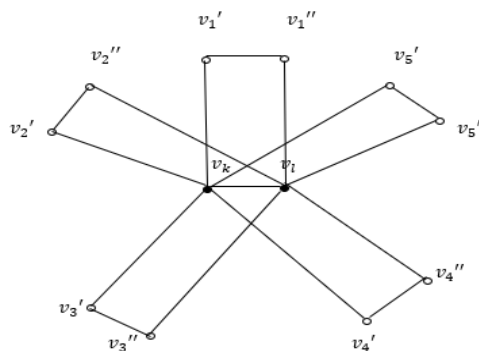
Thus D is a minimum total certified dominating set

$$\text{Since } \gamma_{tcer}(B_n) = \{V_k, V_l\} = 2 \quad \text{————— (2)}$$

From (1) and (2) we get;

$$\gamma(B_n) = \gamma_{tcer}(B_n)$$

Example



Theorem:3

For a closed helm graph, then $\gamma_{tcd}(CH_n) = n, n \geq 3$

Proof:

Let G be a closed helm graph CH_n , where $n \geq 3$

Let u be the apex vertex of w_n

The vertices of G are labeled by $\{u_1, u_2 \dots u_n, v_1, v_2 \dots v_n, u\}$ and G contains $2n+1$ vertices and $4n$ edges

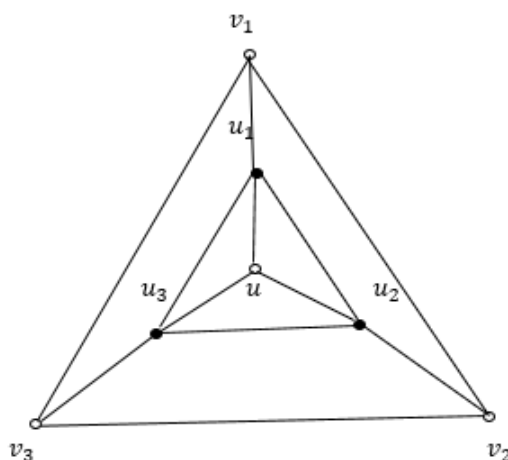
Consider the set $D = \{u_1, u_2 \dots u_n\}$ is a dominating set and it is clear that $u_i (1 \leq i \leq n)$ has adjacent to v_i and also adjacent to u

Thus each element in D has two neighbors in $V - D$

Also subgraph induced by D has no isolate vertices

$$\gamma_{tcd}(G) = |D| = n$$

Example



Theorem:4

For any corona graph $p_n \circ k_m, n \geq 2, m \geq 2$ then $\gamma_{tcer}(p_n \circ k_m) = \begin{cases} n & \text{if } n = m \\ \text{otherwise } n \neq m \end{cases}$

Proof:

Let G be a connected graph with vertices $V(p_n) = \{a_1, a_2 \dots a_n\}$ and

k_{n1} be the complete graph having vertex set $\{a_{11}, a_{12} \dots a_{1m}\}$

k_{n2} be the complete graph having vertex set $\{a_{21}, a_{22} \dots a_{2m}\}$

k_{nm} be the complete graph having vertex set $\{a_{n1}, a_{n2} \dots a_{nm}\}$

Since a_1 is adjacent to a_{1i} , a_2 is adjacent to a_{2i} and a_n is adjacent to a_{ni} where $i = 1$ to n

Let $D = \{a_1, a_2 \dots a_n\}$ be the dominating set of $p_n \circ k_m$

Then clearly each vertex of D has atleast two neighbors in $V - D$

Thus D is a certified dominating set of $p_n \circ k_m$

Therefore $\gamma_{cer}(p_n \circ k_m) = |D| = n$

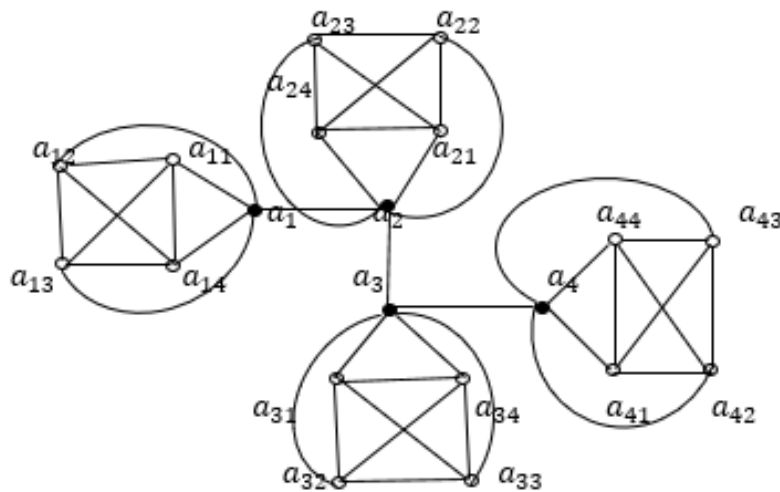
Then the subgraph induced by D has no isolate vertex

Hence D is a minimum total certified dominating set of $p_n \circ k_m$

Therefore $\gamma_{tcer}(p_n \circ k_m) = |D| = n$

Similarly we can prove $n \neq m$

Example



Theorem: 5

The total certified domination number of a stacked book graph $B_{m,n}$ for $m \geq 3, n \geq 2$ is $\gamma_{tcer}(B_{m,n}) = n$

Proof:

Let $B_{m,n}$ be a stacked book graph with $m + 1$ vertices

If $m = 3,4,5 \dots$ then $n = 2,3,4, \dots$

$$S(G) = \{s_1^1, s_1^2, \dots, s_1^n, s_2^1, s_2^2, \dots, s_2^n, s_3^1, s_3^2, \dots, s_3^n, \dots, s_{m+1}^1, s_{m+1}^2, \dots, s_{m+1}^n, B_1, B_2, \dots, B_n\}$$

be a vertices of G

Let $D = \{B_1, B_2, \dots, B_n\}$ be a dominating set of G

Then B_1 is adjacent to $\{s_1^1, s_2^1, \dots, s_{m+1}^1\}$

B_2 is adjacent to $\{s_1^2, s_2^2, \dots, s_{m+1}^2\}$

B_n is adjacent to $\{s_1^n, s_2^n, \dots, s_{m+1}^n\}$

Then clearly the vertices $B_1, B_2 \dots B_n$ are adjacent to atleast two neighborhood of $V - D$

Thus D is a certified dominating set of $B_{m,n}$

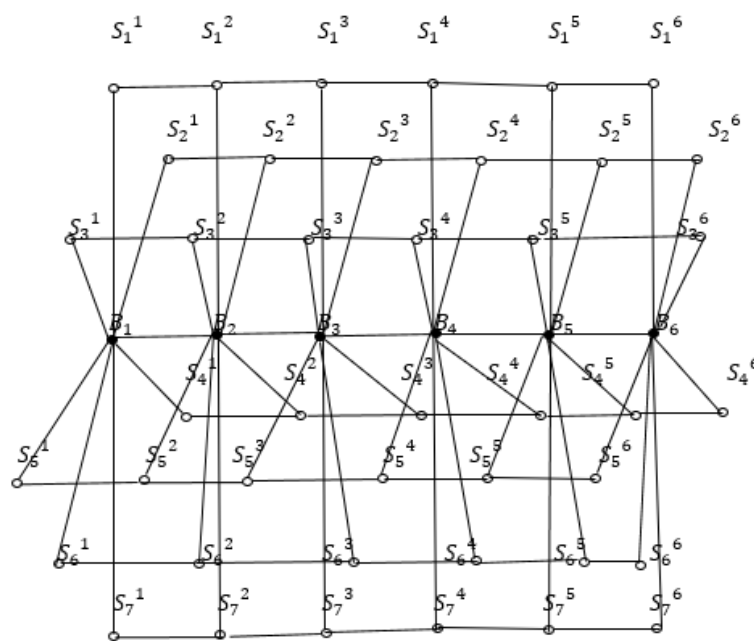
Therefore $\gamma_{cer}(B_{m,n}) = |D| = n$

Also it clear that the subgraph $\langle D \rangle$ has no isolate vertex

Hence D is a minimum total certified dominating set of $B_{m,n}$

Therefore $\gamma_{tcer}(B_{m,n}) = |D| = n$

Example



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Computational Study of Ruthenium(II)-Benzimidazole Complex

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ABSTRACT

The computational study of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ ($\text{H}_2\text{pbbzim} = 2,6\text{bis}(\text{benzimidazole-2-yl})\text{pyridine}$) complex having tridentate ligands has been investigated using Gaussian 09 software. The DFT calculation of the complex is carried out by the B3LYP method in the LANL2DZ basis set. The bond lengths and the bond angles of the complex can be determined from the optimized structure. Quantum chemical parameters like E_{HOMO} , E_{LUMO} , HOMO-LUMO energy gap, chemical potential, electronegativity, chemical hardness, ionization energy, electron affinity, Softness and electrophilicity index of the $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is calculated. The energy gap of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex obtained from the theoretical calculation is 0.7319 eV. The theoretical values predict that $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is appropriate for optical sensing studies. Thus, the computation study may shed some light on the future applications of the complex.

Keywords: Computational study, $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex, DFT calculation, Quantum chemical parameters

Introduction

Transition metal-based materials are much more advantageous over pure organic frameworks, as they can offer better tunability of the structural, optical, electrochemical and electronic properties [1]. Among the various transition metals, coordination complexes based on Ru(II) metal are considered as potential building blocks for the design of suitable functional materials, as they possess outstanding photophysical and optoelectronic properties which primarily evolve from their metal to ligand charge transfer (MLCT) excited states [2,3].

Ruthenium complexes are widely used and studied in different chemical fields. They attract the attention of researchers due to their high stability and the easy modification of their

properties by employing carefully controlled synthetic methods. Complexes bearing π -conjugated ligands or systems that enable electronic delocalization have shown specific

properties in non-linear optics, magnetism, molecular sensing and liquid crystals. However, the most employed are ruthenium complexes with heterocyclic N-donor ligands due to their interesting spectroscopic, photophysical and electrochemical properties. These may be taken into advantage for their application as photosensitizers for photoactive conversion of solar energy, molecular electronic devices and photoactive DNA cleavage agents for therapeutic purposes [4].

Benzimidazole derivatives have attracted strong research interest due to their potential applications in coordination chemistry, asymmetric catalysis, chemo-therapeutics and supramolecular chemistry. The Ru(II) complexes of benzimidazole derivatives are practically non-luminescent at room temperature and their excited state lifetime are also very short. Therefore, much effort has been devoted to design and synthesise tridentate polypyridine ligands that can produce Ru(II) complexes with enhanced emission quantum yields and excited-state lifetimes. Most of the approaches aim to increase the energy gap between the radiative $^3\text{MLCT}$ and quenching ^3MC (metal centred) states.

Design of molecular systems capable of responding to a specific set of ionic inputs is important for the constructions of effective sensors and molecular logic devices. Density Functional Theory (DFT) and Time-Dependent Density Functional Theory (TD-DFT) have become a popular tool for computing the optical and spectral properties of the complexes. In order to understand the physical and quantum chemical parameters of Ru(II) complexes, the present investigation focuses on the computational study of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex in LANL2DZ basis set by B3LYP method using Gaussian 09 software.

Methodology

The $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex has been drawn in AVOGADRO software and MOPAC software was used for the pre-optimisation of the complex using semi empirical method. The program Gaussian 09 was employed to perform DFT and TD- DFT calculations on $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex. HOMO-LUMO energy level calculation and geometry optimization have been carried out using LANL2DZ Basis set and optimized molecular structure was visualized by Gauss view (6.0.16) program.

The physical and quantum chemical parameters of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex were analysed by DFT studies. The quantum chemical descriptors were defined as the partial derivatives of the total electronic energy (E) with respect to the number of electrons (N) at a

fixed external potential. Quantum chemical parameters like E_{HOMO} , E_{LUMO} , HOMO-LUMO energy gap, chemical potential (μ), electronegativity (χ), chemical hardness (η) ionization energy (I), electron affinity (A), Softness (σ) and electrophilicity index (ω) of the $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex was calculated from the following equations[5].

$$\mu = -\chi = \left(\frac{\partial E}{\partial N}\right)_{v(r)} \quad \text{----- (1)}$$

$$\eta = \frac{1}{2} \left(\frac{\partial^2 E}{\partial N^2}\right)_{v(r)} = \frac{1}{2} \left(\frac{\partial \mu}{\partial N}\right)_{v(r)} \quad \text{----- (2)}$$

$$\chi = -\mu = \left(\frac{I + A}{2}\right) \quad \text{----- (3)}$$

$$\chi = -\mu = \frac{-E_{HOMO} - E_{LUMO}}{2} \quad \text{----- (4)}$$

$$\eta = \frac{E_{HOMO} - E_{LUMO}}{2} \quad \text{----- (5)}$$

$$\omega = \frac{\mu^2}{2\eta} = \frac{\chi^2}{2\eta} \quad \text{----- (6)}$$

$$\varepsilon = 1/\omega \quad \text{----- (7)}$$

$$\sigma = 1/\eta \quad \text{----- (8)}$$

Results and Discussion

Ground-state electronic structure calculations of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex under investigation have been done using the DFT method. The optimized structure gives the basic information such as empirical formula, molecular weight, point group and planar/ non-planar nature of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex. The calculated empirical formula, molecular weight and point group of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is $\text{C}_{38}\text{H}_{26}\text{N}_{10}\text{Ru}$, 723.7604 and C_1 point group respectively. The geometry optimization of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex yields non-planar structure (**Fig. 1**).

The geometrical parameters of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex can be determined from the optimized structure. The bond length of C=C in $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is in between 1.4017 - 1.4187 Å (**Table 1**). The bond lengths of C₃-C₁₇, C₅-C₇, C₉-C₁₄, C₁₉-C₂₄, C₃₉-C₅₃, C₄₁-C₄₃, C₄₅-C₅₀ and C₅₅-C₆₀ are slightly higher (~1.43 Å), this is due to the presence of electronegative N atom. Ru-N bond lengths are observed in this complex within the range 2.020 - 2.102 Å. In $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex the bivalent metal is coordinated by the

tridentate ligand and has a distorted octahedral geometry having a meridional N3N3 chromophore. The chelate bite angles span the range between 77.87° and 77.94° . The inter ligand trans angle of N_4-Ru-N_{40} is 179.95° and is very close to linearity, the intra ligand trans angle N_8-Ru-N_{25} and $N_{44}-Ru-N_{61}$ are 157.82° and deviates significantly from linearity.

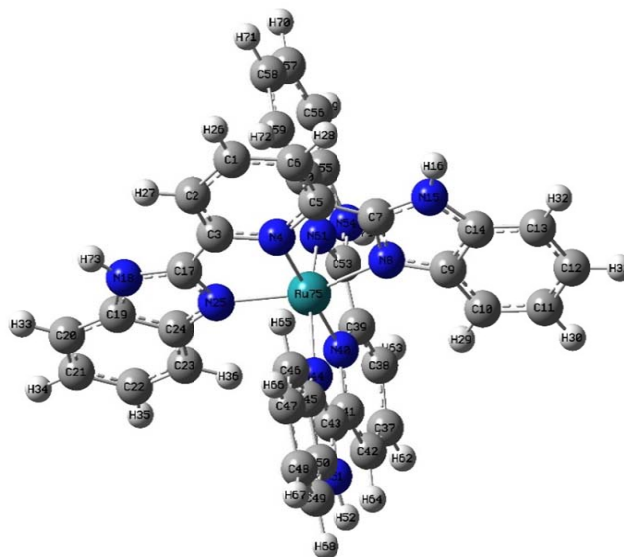


Fig. 1 Optimized geometry of $[Ru(H_2pbbzim)_2]^{2+}$ complex obtained at B3LYP/LANL2DZ

Quantum chemical parameters E_{HOMO} , E_{LUMO} , HOMO-LUMO energy gap, chemical potential (μ), electronegativity (χ) and chemical hardness (η) ionization energy (I), electron affinity (A), Softness (σ) and electrophilicity index (ω) of $[Ru(H_2pbbzim)_2]^{2+}$ complex in the gas phase has been calculated and presented in **Table 2**

Table 1 Bond length of $[Ru(H_2pbbzim)_2]^{2+}$ complex obtained by DFT calculation

Atoms	Bond Length (Å)	Atoms	Bond Length (Å)
C ₁ -C ₂	1.4175	C ₃₇ -C ₃₈	1.4175
C ₁ -C ₆	1.4187	C ₃₇ -C ₄₂	1.4187
C ₁ -H ₂₆	1.0858	C ₃₇ -H ₆₂	1.0858
C ₂ -C ₃	1.4024	C ₃₈ -C ₃₉	1.4024
C ₂ -H ₂₇	1.0878	C ₃₈ -H ₆₃	1.0878
C ₃ -N ₄	1.3999	C ₃₉ -N ₄₀	1.3999

C ₃ -C ₁₇	1.4344	C ₃₉ -C ₅₃	1.4344
N ₄ -C ₅	1.3980	N ₄₀ -C ₄₁	1.3980
N ₄ -Ru ₇₅	2.0200	N ₄₀ -Ru ₇₅	2.0200
C ₅ -C ₆	1.4017	C ₄₁ -C ₄₂	1.4017
C ₅ -C ₇	1.4359	C ₄₁ -C ₄₃	1.4359
C ₆ -H ₂₈	1.0877	C ₄₂ -H ₆₄	1.0877
C ₇ -N ₈	1.3732	C ₄₃ -N ₄₄	1.3731
C ₇ -N ₁₅	1.3971	C ₄₃ -N ₅₁	1.3971
N ₈ -C ₉	1.3990	N ₄₄ -C ₄₅	1.3990
N ₈ -Ru ₇₅	2.1015	N ₄₄ -Ru ₇₅	2.1016
C ₉ -C ₁₀	1.4070	C ₄₅ -C ₄₆	1.4070
C ₉ -C ₁₄	1.4309	C ₄₅ -C ₅₀	1.4308
C ₁₀ -C ₁₁	1.4060	C ₄₆ -C ₄₇	1.4060
C ₁₀ -H ₂₉	1.0851	C ₄₆ -H ₆₅	1.0851
C ₁₁ -C ₁₂	1.4181	C ₄₇ -C ₄₈	1.4181
C ₁₁ -H ₃₀	1.0873	C ₄₇ -H ₆₆	1.0873
C ₁₂ -C ₁₃	1.4098	C ₄₈ -C ₄₉	1.4098
C ₁₂ -H ₃₁	1.0874	C ₄₈ -H ₆₇	1.0874
C ₁₃ -C ₁₄	1.4027	C ₄₉ -C ₅₀	1.4027
C ₁₃ -H ₃₂	1.0869	C ₄₉ -H ₆₈	1.0869
C ₁₄ -N ₁₅	1.4014	C ₅₀ -N ₅₁	1.4014
N ₁₅ -H ₁₆	1.0089	N ₅₁ -H ₅₂	1.0089
C ₁₇ -N ₁₈	1.3977	C ₅₃ -N ₅₄	1.3977
C ₁₇ -N ₂₅	1.3742	C ₅₃ -N ₆₁	1.3742
N ₁₈ -C ₁₉	1.4015	N ₅₄ -C ₅₅	1.4015
N ₁₈ -H ₇₃	1.0089	N ₅₄ -H ₇₄	1.0089

C ₁₉ -C ₂₀	1.4025	C ₅₅ -C ₅₆	1.4025
C ₁₉ -C ₂₄	1.4310	C ₅₅ -C ₆₀	1.4310
C ₂₀ -C ₂₁	1.4101	C ₅₆ -C ₅₇	1.4101
C ₂₀ -H ₃₃	1.0870	C ₅₆ -H ₆₉	1.0870
C ₂₁ -C ₂₂	1.4179	C ₅₇ -C ₅₈	1.4179
C ₂₁ -H ₃₄	1.0874	C ₅₇ -H ₇₀	1.0874
C ₂₂ -C ₂₃	1.4063	C ₅₈ -C ₅₉	1.4063
C ₂₂ -H ₃₅	1.0873	C ₅₈ -H ₇₁	1.0873
C ₂₃ -C ₂₄	1.4071	C ₅₉ -C ₆₀	1.4071
C ₂₃ -H ₃₆	1.0851	C ₅₉ -H ₇₂	1.0851
C ₂₄ -N ₂₅	1.3986	C ₆₀ -N ₆₁	1.3986
N ₂₅ -Ru ₇₅	2.1003	N ₆₁ -Ru ₇₅	2.1002

Table 2 Quantum chemical parameters of [Ru(H₂pbbzim)₂]²⁺ complex

Parameters	[Ru(H ₂ pbbzim) ₂] ²⁺ (eV)
E _{HOMO}	-2.272
E _{LUMO}	-1.5401
Energy gap	0.7319
Ionization energy	2.272
Electron affinity	1.5401
Electronegativity	1.90605
Chemical potential	-1.90605
Chemical hardness	0.36595
Softness	1.366307
Electrophilicity index	4.963829

The energy level diagram of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is shown in **Fig. 2**. The electronic absorption is mainly described by one electron excitation from HOMO to LUMO. Both HOMO and LUMO are the main orbitals that take part in chemical stability. These orbitals play an important role in the electronic properties and determine the way the molecule interacts with other species [6,7]. The energy of HOMO and LUMO in $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is directly related to ionization potential and electron affinity.

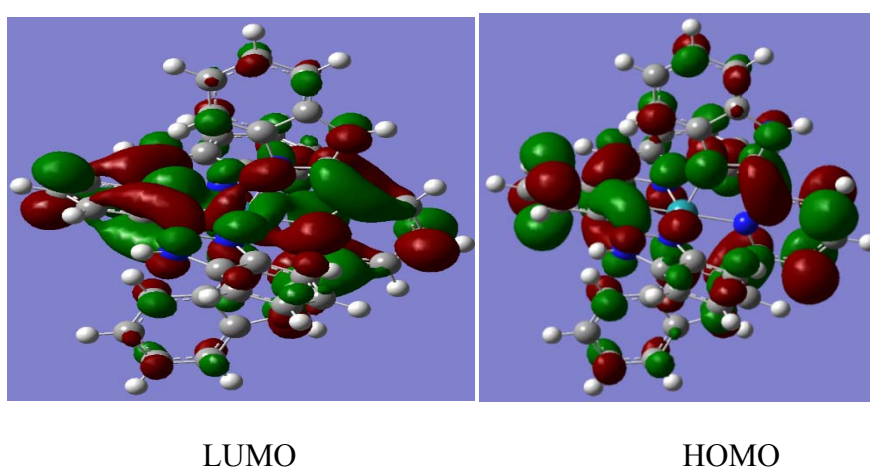


Fig. 2 Energy level diagram for $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex

The frontier orbital gap between HOMO and LUMO, represents the stability of structure and helps to determine the kinetic stability and the chemical reactivity of the molecule. Chemical hardness is also associated with the stability and reactivity of a chemical system. The energy gap value of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is 0.7319 eV which reflects the chemical activity of the molecule. The Frontier Molecular orbitals of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex are shown in **Fig. 3**. This small energy gap confirms that the $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is highly reactive and polarizable. Thus, the theoretical values predict that $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex is appropriate for optical sensing studies.

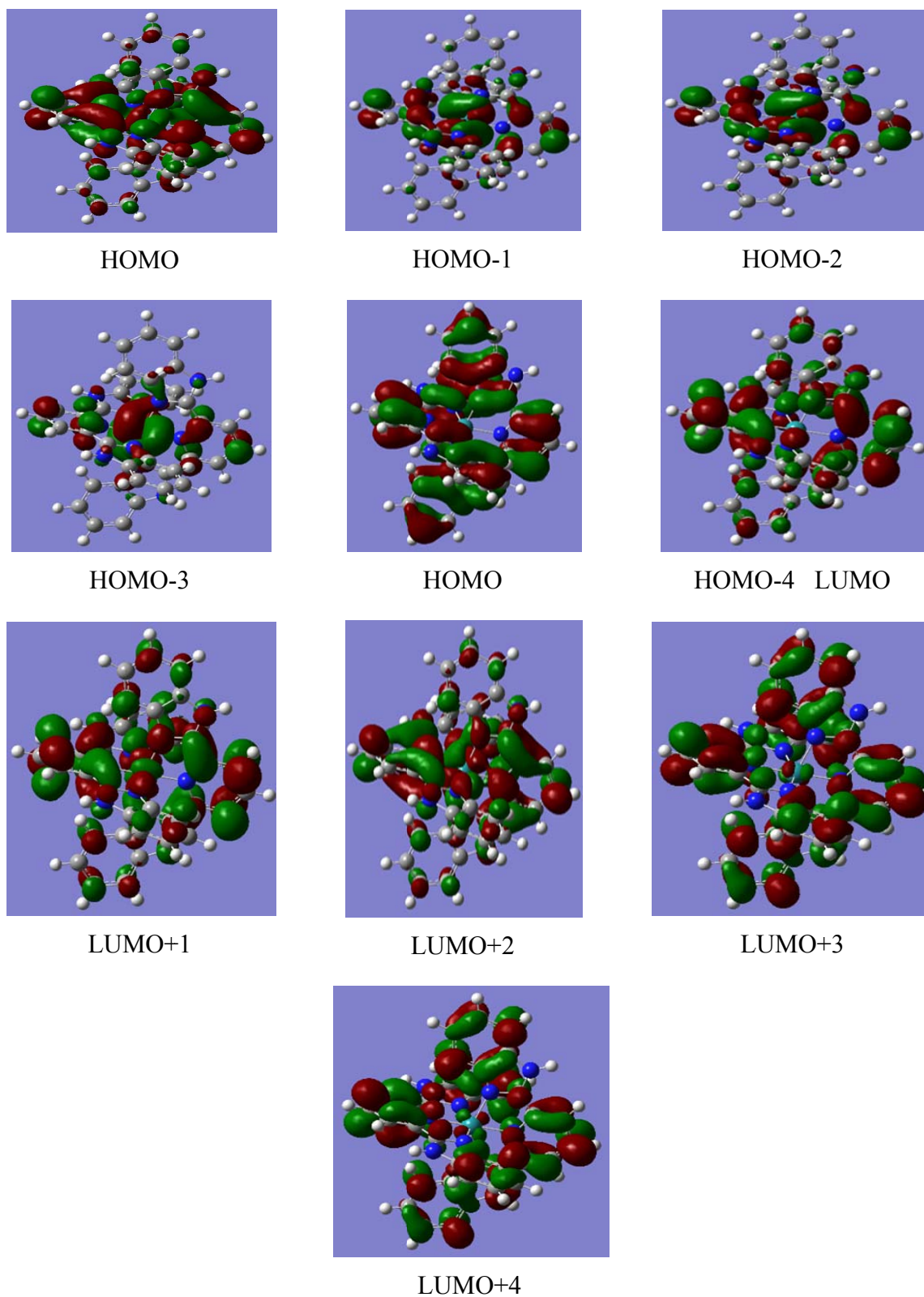


Fig. 3 Frontier molecular orbitals of $[\text{Ru}(\text{H}_2\text{pbbzim})_2]^{2+}$ complex

Conclusion

The Ru(II) complex having tridentate H₂pbbzim ligands has been designed and the theoretical calculations have been carried out using the LANL2DZ basis set. The physico-chemical parameters of the complex have been calculated using the DFT method. The energy gap of [Ru(H₂pbbzim)₂]²⁺ complex is found to be 0.7319 eV. This small HOMO-LUMO energy gap of [Ru(H₂pbbzim)₂]²⁺ complex confirms the chemical reactivity and the polarizability of the complex. The theoretical energy gap value indicates that the metal complex is suitable for further studies. Quantum chemical parameters also predict that this complex is appropriate for optical sensing studies. Thus, the computation study may shed some light on future applications of [Ru(H₂pbbzim)₂]²⁺ complex.

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Comparison of Pesticide Contamination in Domestic and Market samples

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ABSTRACT

Pesticides, ripening agents and other toxic chemicals have their effects on plants, animals and humans and cause bioaccumulation. The current article makes a comparative study on the pesticide contamination of domestic and market vegetable and fruit samples. The concentration of phosphate, sulphate and nitrate were determined using photo colourimetric method while chloride was estimated using argentometric titration. It was found that the market samples possess high phosphate, sulphate, nitrate and chloride contents when compared to that of domestic samples. Market sample Spinacia oleracea has the maximum amount of phosphate (9 mg/l) and sulphate (33.6 mg/L), whereas Solanum melongena has the maximum amount of nitrate (480 mg/L) and Vitis vinifera has the maximum amount of chloride (177.25 mg/L) among all the analysed samples which may be due to the over usage of pesticides and other chemicals.

Keywords: Phosphate, domestic, pesticides, photo-colourimetry, argentometric

Introduction

Pesticides are substances that are meant to control pests, including weeds. These are substances which improve the growth of the plants and to increase the yield. Organophosphates, thiocarbamates and sulphur containing compounds are commonly used pesticides. These chemicals have their effects on plants, animals and humans and cause bioaccumulation. Phosphate forms the structural component of nucleic acids and phospholipids and it is also involved in the energy transformation of cells. Phosphorus is taken up by the plants as inorganic phosphate and as organophosphate [1]. Unlike sulphate and nitrate, phosphate is not reduced during assimilation in plants but it exists in oxidized state to form as esters [2]. It is also essential for photosynthesis and for oxidative metabolism which takes place in plants. But when its intake far exceeds the plants due to the application of organophosphorus pesticides, it results in phosphate residues on plants, soil and plant products like fruits and vegetables.

Sulphate forms the structural component of amino acids cysteine and methionine. It also forms the component of some metabolites which are derived from these amino acids. Sulphur nutrient is mostly essential for vegetables like cabbage, cauliflower, broccoli and

some others, for the production of anticarcinogenic glucosinolate compounds [3]. When the intake of sulphate far exceeds the limit in the plants due to the over usage of organosulphur pesticides, the accumulation of sulphate occurs in plant tissues. Excess of sulphate is highly anthropogenic and its high concentration creates a non-toxic stain to the leaves and fruits of plants. It causes dehydration to humans on inhaling or on ingestion of sulphate contaminated water or plant products containing sulphate and it is sensitive to infants also.

Human exposure to nitrate is derived from consumption of raw vegetables and fruits at about 80%, from drinking water at about 15%, then from other sources 5% [4,5]. In most of the plants high concentration of nitrate accumulates in the leaves whereas lower levels accumulate in the seeds, roots, tubers, bulbs and fruits, hence leafy vegetables like spinach, celery and others have high concentration of nitrate [6,7]. Humans on exposure to nitrate in large amounts suffer from gastric upset, diarrhoeal infection, heavy metal toxicity and then it leads to Blue baby syndrome and Methemoglobinemia.

Chlorine is commonly taken up by the plants in the form of Cl⁻. It is required in minor amounts by the plants for the purpose of osmosis process, ionic balance and for photosynthesis. High concentration of chlorine affects the crop growth, hence crop cultivation in saline areas is restricted [8]. So when its amount in the plant body exceeds due to the application of most commonly used organochlorine pesticides and from saline soils where the plant lives results in the accumulation of chloride ion in the soil, plant and in plant products like fruits and vegetables.

As these residues listed and described above have already entered other animals and in human food chain by consuming these plant products, it is necessary to analyze phosphate, sulphate, nitrate and chloride contents present in the plant products like fruits and vegetables as we are consuming it and a comparative study has been made.

Materials and Methods

Domestic and market samples of *Vitis vinifera*, *Manilkara zapota*, *Psidium guajava*, *Carica papaya*, *Lycopersicon esculentum*, *Solanum melongena* and *Spinacia oleracea* were taken and the concentration of phosphate, sulphate, nitrate and chloride were determined. The raw extracts obtained from all the samples were used for determining the above parameters.

Concentration of phosphate, sulphate and nitrate were determined by using photo-colourimetric method and chloride was estimated using argentometric titration.

Results and Discussion

Phosphorus exists as phospholipids in all plant and animal bodies and it is available in soil as phosphate form. Market sample *Spinacia oleracea* has the maximum amount of phosphate (9 mg/L) and domestic sample *Manilkara zapota* has the lowest concentration (0.16 mg/L). The results are shown in Table-1 & 2 and in Figure-1. Due to the application of organo-phosphorous pesticides to plants, high levels of phosphate is observed in the samples. Excess of phosphate causes immune toxicity to humans and other animals. High phosphate concentration in water sources causes severe algal bloom and death to the aquatic organisms.

Market sample *Spinacia oleracea* has the maximum amount of sulphate (33.6 mg/L) and domestic sample *Lycopersicon esculentum* has the lowest concentration (0.24 mg/L) among all the samples. The results are given in Figure-2. A high concentration of sulphate (25 mg/kg) in spinach from the market was also reported earlier [9].

Nitrogen is taken up by the plants in a fixed state as nitrate or as ammonium. When this nitrate intake far exceeds the plants it starts accumulating in the plant tissues [10]. Majority of the nitrate content accumulated in the human body comes from plant sources such as vegetables and fruits. Market sample *Solanum melongena* has the maximum amount of nitrate (480 mg/L) and domestic sample *Lycopersicon esculentum* has the lowest concentration (8 mg/L). The results are given in Figure-3. Similar results were observed in eggplant which is grown through conventional methods [11, 12].

Chlorine forms the essential micronutrient in all the plants and which is commonly taken up by the higher plants in the form of Cl. *Vitis vinifera* from the market has the maximum amount of chloride (177.25 mg/L) and domestic sample *Psidium guajava* has the lowest level of chloride (15 mg/L). The variation in concentrations is given in Figure-4. High concentration of chloride may be due to the exposure from the fields or by consuming chlorine contaminated products. High concentration of chloride causes disruption of the endocrine system, respiratory system and eyes of humans and irritates the skin. It also affects the immune system, blood, heart and respiratory system of both aquatic and land animals.

Market samples have high contents of phosphate, sulphate, nitrate and chloride than domestic samples which is mainly due to the application of organophosphorus, organosulphur, nitrogen containing pesticides and commonly used harmful organochlorine pesticides to the soil, plant and plant products such as fruits and vegetables.

Table 1: Concentration in domestic Samples

S.No	Domestic Samples	Concentration in mg/L			
		Phosphate	Sulphate	Nitrate	Chloride
1.	<i>Vitis vinifera</i>	0.48	1.4	14	25
2.	<i>Manilkara zapota</i>	0.16	0.7	30	30
3.	<i>Psidium guajava</i>	0.49	1.15	18	15
4.	<i>Carica papaya</i>	0.48	1.35	14	32
5.	<i>Lycopersicon esculentum</i>	0.4	0.24	8	35
6.	<i>Solanum melongena</i>	0.2	2.7	66	32
7.	<i>Spinacia oleracea</i>	2.83	28	13.5	28

Table 2: Concentration in market Samples

S.No	Market Samples	Concentration in mg/L			
		Phosphate	Sulphate	Nitrate	Chloride
1.	<i>Vitis vinifera</i>	0.6	2.4	200	177.25
2.	<i>Manilkara zapota</i>	0.45	2.7	66	45
3.	<i>Psidium guajava</i>	0.49	1.27	66	25
4.	<i>Carica papaya</i>	0.5	1.45	180	45
5.	<i>Lycopersicon esculentum</i>	0.5	0.77	12	52
6.	<i>Solanum melongena</i>	2	22.5	480	48
7.	<i>Spinacia oleracea</i>	9	33.6	27	99.26

Figure 1: Concentration of phosphate in various samples

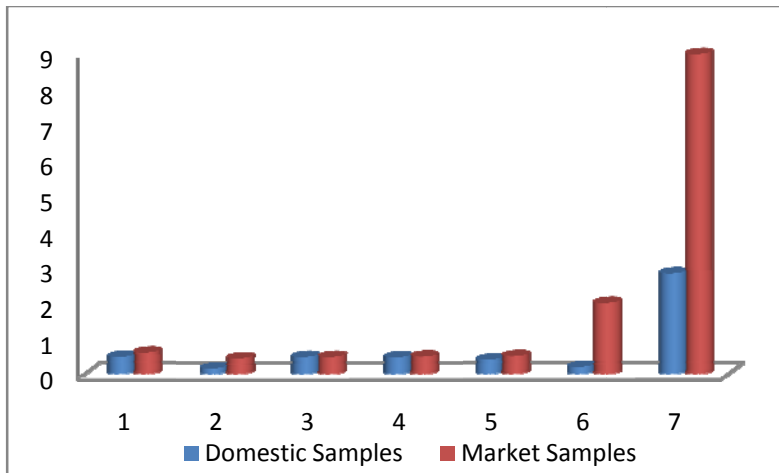


Figure 2: Concentration of sulphate in various samples

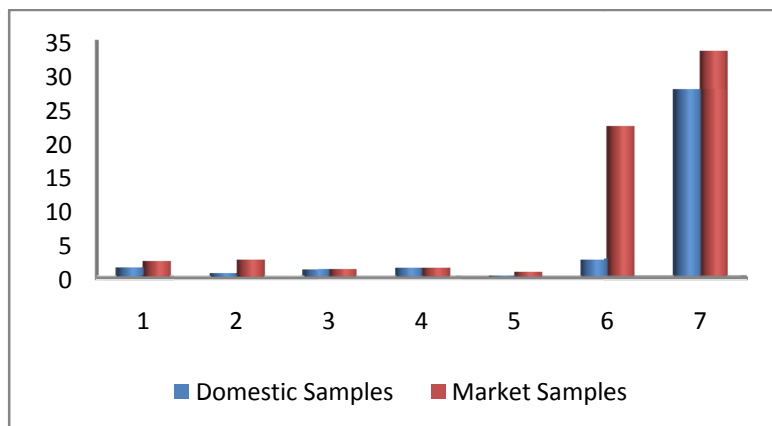


Figure 3: Concentration of nitrate in various samples

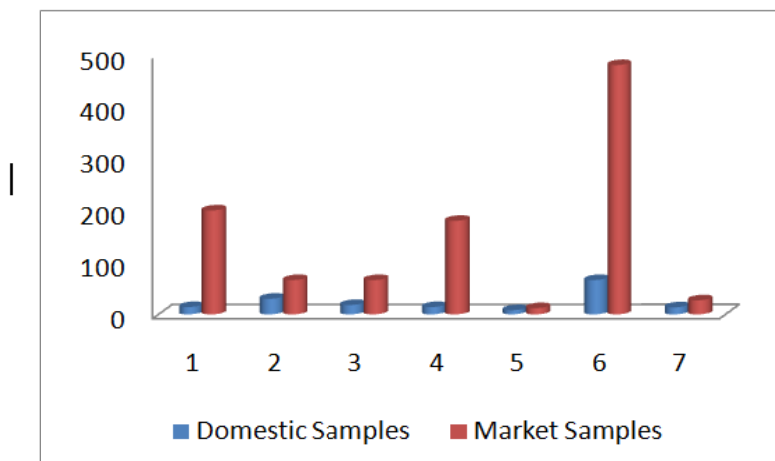
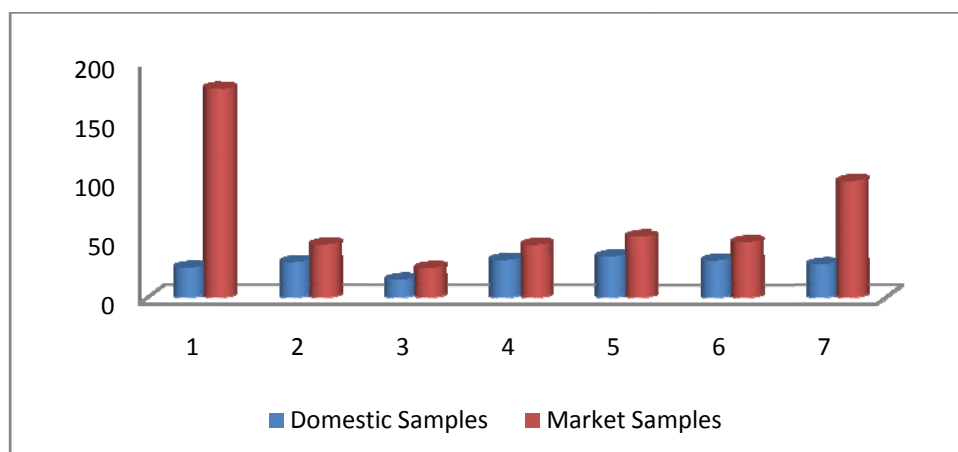


Figure 4: Concentration of chloride in various samples

Conclusion

The present work confirmed that the market samples possess high amount of phosphate, sulphate, nitrate and chloride which comes from organophosphorous, organosulphur, nitrogen containing pesticides and organochlorine pesticides along with the fertilizers. These are required by the plants in certain amounts. But when it far exceeds the limit, it gets accumulated in plant tissues which on consumption by humans causes bioaccumulation. To avoid this bioaccumulation, house grown vegetables and plants should be used.

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Novel Synthesis of Phyto-Mediated Silver Nanoparticles and Their Antioxidant Activity

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ABSTRACT

In recent science, nanotechnology is a burning field for researchers. Nanotechnology deals with nanoparticles having a size of 1-100 nm in one dimension used significantly in medical chemistry, atomic physics, and all other known fields. Nanoparticles are used immensely due to their small size, orientation, and physical properties, which are reportedly shown to change the performance of any other material which is in contact with these tiny particles. These particles can be prepared easily by different chemical, physical and biological approaches. But the biological approach is the most emerging approach to preparation because this method is easier than the other methods, eco-friendly, and less time-consuming. The green synthesis was done by using the aqueous solution of Wedelia Chinensis leaf extract and AgNO₃. Silver was of particular interest for this process due to its evocative physical and chemical properties. A fixed ratio of plant extract to metal ion was prepared and the color change was observed which proved the formation of nanoparticles. The nanoparticles were characterized by UV-vis Spectrophotometer, FTIR, XRD, and TEM. The nanoparticles were found to have sizes ranging from 160-180 nm.

Keywords: Nanotechnology, Nanoparticles, Green Synthesis, *Wedelia chinensis*, Antioxidant activity.

Introduction

The field of nanotechnology is one of the upcoming areas of research in the modern field of material science. Nanoparticles show completely new or improved properties, such as size, distribution, the morphology of the particles, etc. Novel applications of nanoparticles and nanomaterials are emerging rapidly in various fields [1]. Metal nanoparticles have a high specific surface area and a high fraction of surface atoms. Because of the unique physicochemical characteristics of nanoparticles, including catalytic activity, optical properties, electronic properties, antibacterial properties, and magnetic properties [2-5] they are gaining the interest of scientists for their novel methods of synthesis.

Silver is well known for possessing an inhibitory effect on many bacterial strains and microorganisms commonly present in medical and industrial processes. In medicines, silver and silver nanoparticles have ample application including skin ointments and creams containing silver to prevent infection of burns and open wounds, medical devices, and

implants prepared with silver-impregnated polymers. In the textile industry, silver-embedded fabrics are now used in sporting equipment [6].

In recent days several attempts have been made to fabricate AgNPs with controlled sizes and shapes [14]. However, most of the wet chemical methods reported rely heavily on organic solvents and use hazardous reducing agents [7]. Hence, there is an increased interest to design a green chemistry route to minimize or eliminate the use and generation of toxic substances in synthetic processes [8]. Even though a number of plants have already attempted to synthesize AgNPs, synthesizing nanoparticles with controlled size and various morphologies is still a great challenge.

To date, no reports have been documented on a biogenic synthesis of AgNPs using the abundantly and commercially available *Wedelia chinensis* as a biomaterial. The plant has been claimed to have significant therapeutic effects in the management of cancer, inflammation, wound healing, CNS disorder, ulcer, etc. *Wedelia* is also known for its antioxidant and antimicrobial activities due to the presence of active constituents such as triterpenoids, flavonoids, and wedelolactones, and research is still in progress to find uses for them [9]. Hence, the present research aimed to investigate the synthesis and characterization of the AgNPs from the aqueous extract of *Wedelia chinensis* and evaluated its antioxidant activity.

Methodology

Sample Collection

Fresh green and mature leaves of *Wedelia Chinensis* were collected from Veliavillai, Kanniyakumari District (Tamilnadu, India), and used for the preparation of extract. Silver nitrate and AgNO_3 were procured from Merck Specialties Private Limited, Mumbai. Double distilled deionized water was used as a solvent for the synthesis.

Preparation of Leaf Extract

In a general manner, 10g of healthy and matured leaves of plant portion were selected and then washed thoroughly with deionized water. These leaves were ground well and collected using glass vessels. Afterward, it was boiled in 100ml of deionized water in a water bath at 600°C for 20 minutes. The mixture was cooled and this extract is filtered using Whatman's no.1 filter paper. The filtrate was collected in a clean and dried conical flask by standard sterilized filtration method and was stored in a refrigerator for further use.

Synthesis of Silver Nanoparticles

1 mM aqueous solution of AgNO_3 was prepared and used for the synthesis of silver nanoparticles. 10 ml of leaf extract was added to 90 ml of 1 mM aqueous AgNO_3 solution in a 250 ml Erlenmeyer flask and incubated at room temperature. The sample colour changes from colourless to light grey within 10 minutes indicating the formation of AgNPs. Ninety-

five percent of the bioreduction of Ag^+ ions occurred within 1 hour. The AgNPs obtained by leaf extract was centrifuged at 15,000 rpm for 5 min and subsequently dispersed in sterile distilled water to get rid of any uncoordinated biological materials. The pellet of AgNPs collected at the bottom of the centrifuge tube was collected, dried, and stored at -40°C .

Results and Discussion

The characterization of the silver nanoparticles and the detailed analysis on antioxidant activities are reported in this session.

UV – Visible Analysis of Silver Nanoparticle

Bioreduction of plant extracts to reduce silver ions into silver nanoparticles during exposure to the leaf extract could be followed by colour change (**Fig. 1**). Silver nanoparticles exhibit light grey colour in an aqueous solution due to the surface plasmon resonance phenomenon, which results from collective oscillations of their conduction band electrons in response to electromagnetic waves. The strong absorption peak located at 400 nm confirms the reduction of silver ions to form metallic silver nanoparticles (AgNPs).

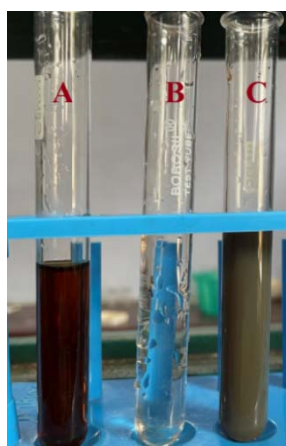


Fig. 1. Visual Observation of silver nanoparticles synthesis

(A- Plant extracts, B- Salt solution, C- Reaction mixture)

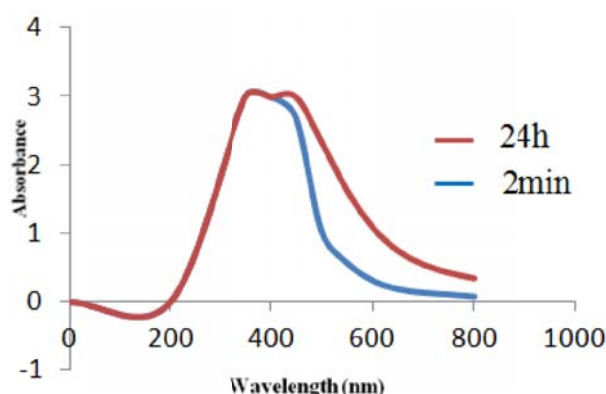


Fig. 2. UV-Visible spectra of AgNPs at different incubation times

FT-IR Analysis of Silver Nanoparticles

The FTIR measurements were carried out to identify the possible biomolecules present in aqueous Wedelia leaf extract responsible for the bioreduction and stabilization of silver nanocrystals. The spectra of leaf extract were recorded and compared before and after the addition of silver nitrate (**Fig. 3**). The interferogram of dried leaf extract before the reaction shows a prominent peak at 1022, 1326, 1696, 2929, 3409 cm^{-1} represent the complex nature of the biomolecules (**Fig. 3a**). The very strong absorption bands centered around 1022, 1326, 1696 cm^{-1} may arise from -C-O, C-O-C and C=O stretching modes of vibration. A moderate intense peak located at around 2929 cm^{-1} is due to the presence of C-H deformation vibration. Additionally, a broad band centered at 3409 cm^{-1} was observed confirming the O-H stretching vibrations, present in the leaf extract. The FT-IR spectrum of biosynthesized AgNPs exhibited few distinct peaks in the range of 1080, 1421, 1626, 2940, and 3463 cm^{-1} (**Fig. 3b**). Further, a comparison study between the FTIR spectrum of leaf extract and biosynthesized AgNPs showed only minor changes in the position of absorption bands. On the basis of IR data, it may be inferred that the biomolecules present in WLE significantly have a bioreduction property to synthesize AgNPs.

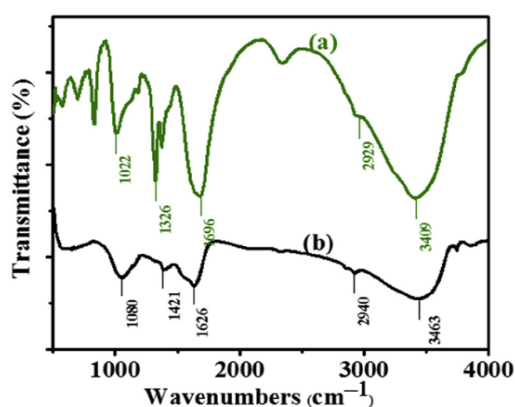


Fig. 3. FT-IR spectrum of: (a) WLE (alone) and (b) synthesized AgNPs from WLE

X-ray diffraction (XRD) Analysis

X-ray diffraction (XRD) analysis is carried out for synthesized AgNPs. The lattice constant $a = 4.086 \text{ \AA}$ calculated from the XRD spectrum was in good agreement with standard diffraction data JCPDF Card No. 03-0921. The average diameter of particle (D) was estimated to be 31.68 nm using Scherrer's equation $D = K\lambda/\beta\cos\theta$. A wide base corresponding to the peak indirectly indicates the presence of small particles where little

changes in the peak positions confirm the presence of biomolecules on the crystal. XRD pattern of AgNPs shows clear peaks at 38.080, 44.260, 64.670, and 77.540 (**Fig. 4**) correspond to miller indices of (1 1 1), (2 0 0), (2 2 0), and (3 1 1) of zero-valent silver, respectively. The crystalline size of AgNPs is 25 nm. The XRD study thus confirmed face-centered cubic geometry for the silver nanoparticles.

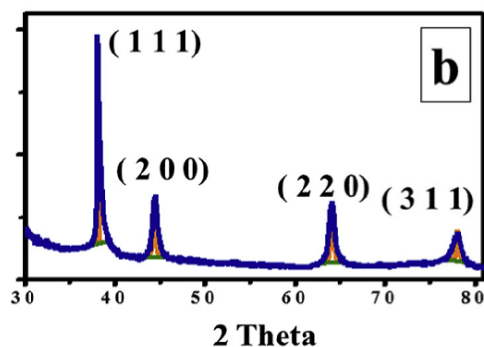


Fig. 4. XRD spectra of AgNPs synthesized using WLE

Transmission electron spectroscopy (TEM)

The TEM analysis was performed to visualize the size and shape of AgNPs formed. TEM micrograph shows the particles were predominantly spherical within 18-68.76 nm and distributed with little aggregation in solution (**Fig. 5a and b**). The distribution of AgNPs observed in the images could be due to the surface capping hence stabilizing effect of leaf extract over the AgNPs.

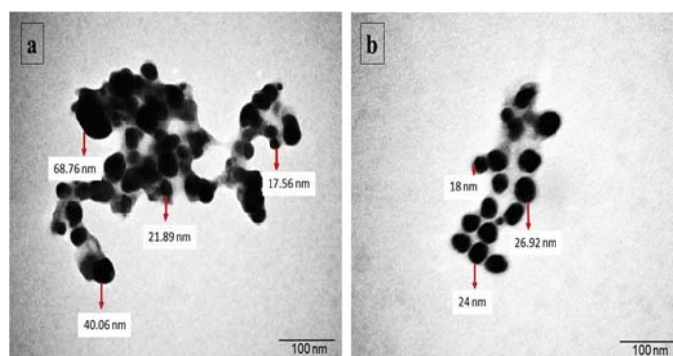


Fig. 5. (a and b) TEM micrographs of biosynthesized spherical-shaped AgNPs

Antioxidant Assay

Antioxidant activity of the biosynthesized AgNPs was evaluated using two different methods as follows, where Wedelia leaf extract and L-ascorbic acid (AA) were considered as control and reference, respectively. The mechanism of the reduction of Ag^+ ions to Ag^0 is due

to the presence of water-soluble antioxidative substances like ascorbic acid which is present in the gooseberry extract. Ascorbic acid is the reducing agent and can reduce and thereby neutralize, reactive oxygen species leading to the formation of ascorbate radical and an electron. This free-electron reduces the Ag^+ ions to Ag^0 .

DPPH free radical scavenging assay

The efficiency of antioxidants to scavenge the free radical from DPPH was carried out by DPPH assay. The reduction of DPPH was assessed spectrophotometrically by observing the decrease in absorbance due to the formation of a stable DPPH-H molecule (reduced form). The free radical scavenging activity of AgNPs increased gradually with an increasing concentration of AgNPs (12.25-200mg/mL) (**Fig.6**). The maximum scavenging activity of AgNPs (200 mg/mL) was found to be $80.2 \pm 0.15\%$ as compared to control leaf extract ($67.53 \pm 0.34\%$), and reference L-ascorbic acid ($96.32 \pm 0.33\%$).

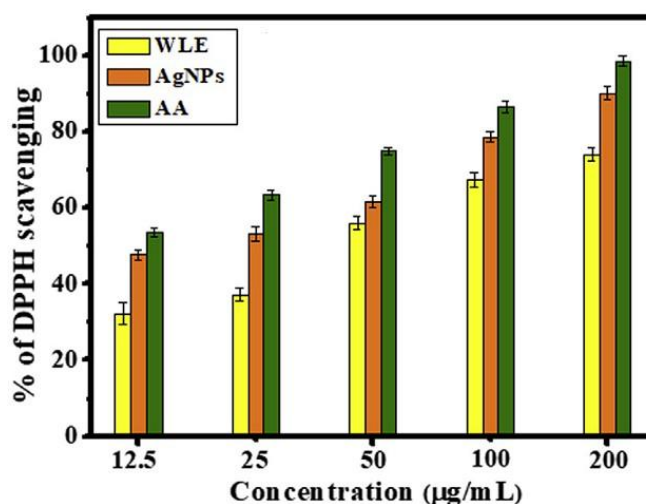


Fig. 6. DPPH free radical scavenging activity of WLE, biosynthesized AgNPs, and AA (L-ascorbic acid) at different concentrations (12.5-200 mg/mL).

Reducing power assay

The reducing power of Wedelia leaf extract, AgNPs, and AA was determined based on the reduction of Fe^{3+} ions to Fe^{2+} ions. The reducing capacity of the biogenic AgNPs (200 mg/mL) was observed higher (absorbance 0.81 ± 0.146) compared to control leaf extract (absorbance 0.18 ± 0.006) and lower than the reference L-ascorbic acid (0.86 ± 0.048) (**Fig.**

7). Because of their free radical scavenging properties, AgNPs can be considered as a potential candidate in the management of cancer, diabetes, AIDS, neurodegenerative disease, etc.

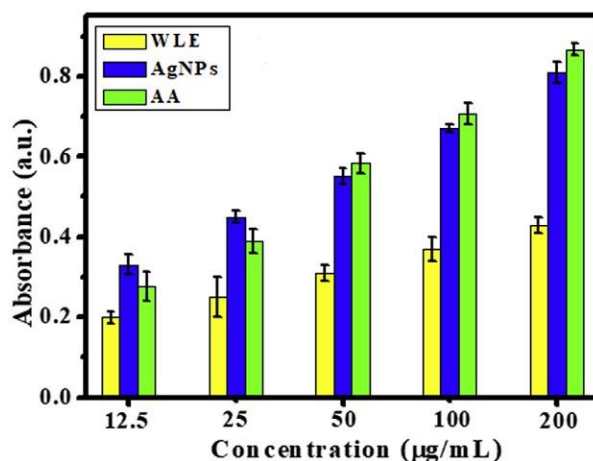


Fig. 7.Reducing power of WLE biosynthesized AgNPs and AA (L-ascorbic acid) at different concentrations (12.5-200mg/mL).

Conclusion

The present investigation deals with the leaf extract mediated green synthesis of fabricated silver nanoparticles using *Wedelia Chinensis*. Photosynthesis of spherical nanosilver particles was effectively established without using any templates, additives, or accelerants. Flavonoid/wedelolactone comprises functional groups as evident from the FT-IR analysis might have been associated with the reduction and stabilization.

The leaf extract of *Wedelia Chinensis* was used as a reducing agent for the synthesis of silver nanoparticles from aqueous silver nitrate. A greater conversion of silver ions to nanoparticles was achieved by employing leaf broth. The successful formation of silver nanoparticles has been confirmed by UV-Vis spectrophotometer, Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), and Transmission Electron Microscopy (TEM).

FTIR studies confirmed the presence of silver nanoparticles which may responsible for the reduction of silver ions to silver nanoparticles. Most of the characteristic vibrational bands originated from water-soluble compounds like polyphenols, flavonoids, triterpenoids, wedelolactones, etc. present in the *Wedelia* leaf extract. The XRD pattern revealed the complex crystalline nature of silver nanoparticles. While the TEM image confirms the formation of a spherical shape. Synthesized AgNPs possess significant antioxidant activity.

These nanoparticles may have a great application in the field of pharmacology and other industries. Silver nanoparticles are a promising material for future cancer therapy.

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Isolation and Biochemical Characterization of Bacteria Isolated from Human Urine Samples

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ABSTRACT

This study focused on isolation and biochemical characterization of bacteria from the urine samples. Bacteria were isolated using HiCrome Urinary Tract Infection Agar which contains chromogenic substrates that can be utilized by bacterial isolates and produce different colors. Obtained colonies were categorized as Gram negative, Gram positive bacteria and their morphology were identified by Gram's staining method. Biochemical characterization was done using various tests like Catalase, Oxidase, Indole, Methyl red, Voges- Proskauer, Citrate and Triple Sugar Iron test for further identification. Enterococcus faecalis, Pseudomonas sp., Klebsiella pneumonia and Staphylococcus aureus were identified from the collected urine samples.

Key words: Bacteria, Biochemical Characterization, HiCrome UTI agar, Urine samples.

Introduction

When compared to other biofluids, urine may be collected easily and non-invasively in significant quantities, making it one of the most appealing biofluids for clinical diagnostics. The urine's color, smell, and volume reveal whether a problem exists. Urine is separated or filtered by the kidneys and it allows the body to get rid of waste products from the blood. The glomerulus filters the plasma to produce the "primitive" urine. The renal tubule reabsorbs the majority of the primitive urine. About 900 litres of plasma flow through the kidneys in 24 hours and 150–180 liters of that is filtered. The majority of this primitive urine, nevertheless, is reabsorbed. The remaining final urine leaves the kidney through the ureter and enters the bladder. Therefore, urine may contain information from more remote organs via plasma collected through glomerular filtration, in addition to the kidney and urinary tract [1]. As a result, urine culture is the “gold standard” for clinical diagnostics.

Urinary Tract Infections (UTIs) are among the most prevalent infections in both inpatients and outpatients, and they have a significant financial impact on health. About 50% of women report having had one infection in their lifetime, and between 27% - 48% of them suffer recurrent infections [2]. Although the infection itself causes only a minor illness

in the majority of patients, it can have serious consequences in select populations, including children, pregnant women, the elderly, and people with immune system disorders [3]. Clinical signs and symptoms of the patient as well as the findings of urinalysis are used to make the diagnosis of UTI. Consequently, clinical microbiology laboratories receive the most urine samples as specimens.

Many prompt diagnostic methods are available including wet mount microscopy, Gram's stain, and automated assays, but the gold standard method for diagnosis of UTI is quantitative urine culture. The rate of presumptive identification of organisms in the primary culture plate is high in HiCrome UTI agar media [4]. *Escherichia coli* has been frequently linked to UTI (in 80% of cases), although commensal members of the gut microbiota like *Enterococcus* and *Staphylococcus* are also involved [5].

There is no universally applicable standardized bacterial count that denotes substantial bacteriuria in UTIs. It is crucial to keep in mind that many circumstances can affect the number of bacteria and it is considered significant for the diagnosis of UTI. It is important to take into account the type of specimen (mid-stream urine, catheter urine, bag urine, suprapubic aspiration urine, and urostomy urine), the patient's clinical condition (genitourinary tract abnormalities, the presence of clinical manifestations, gender, pregnancy, age, and previous antibiotic use), or the variety of bacteria (category and isolated species) [6].

Kass in 1960 [7] introduced the concept of significant bacteriuria, defining it as more than 10^5 Colony Forming Units (CFU)/mL when pyelonephritis occurs during pregnancy. This analysis introduced quantitative microbiology into the infectious disease diagnosis and still is of great significance. For a diagnosis of a UTI, the European urinalysis guidelines prescribe a threshold of $>10^5$ CFU per ml in MSU (midstream urine) for women or $>10^4$ CFU/ml in MSU for males. The Infectious Diseases Society of America (IDSA) guidelines state that counts of more than 10^4 CFU/ml can be used as the threshold for a positive culture in cases of uncomplicated UTI. But this raises some concerns, particularly for specific patients, children, pregnant women, and elderly persons, for whom low counts are significant [6].

All microbiota in a certain microbial population are referred to as the "microbiome." Bacteria constitute ninety percent of all cells in our body, and this symbiotic relationship is essential to the host's development and wellbeing. Historically healthy individuals' urine has been thought to be sterile until it reaches the urethra because it lacks an accompanying

microbiota. However, large numbers of bacteria are also present in the urine of healthy people (due to bladder microbiota). The composition of the microbiota throughout the human body will be altered by physiological changes brought on by aging, age-related events (such as morbidity, medication, and lifestyle choices), and the immune system's decline in function, or immunosenescence [8]. Thus, research into the healthy urine microbiome as well as its connection to disease through the proliferation of opportunistic pathogens has the potential to shed light on new approaches for the prevention, diagnosis, and treatment of urinary diseases [9].

Materials and Methods

Healthy Urine specimen collection: A urine culture needs a clean catch urine sample, to make the urine sample as free of outside contaminants as possible, such as normal flora that live on the skin or other microbes from the environment. The volunteer is informed before collection and to adhere to standard urine collection norms such as not to urinate within one hour of sample collection and to drink at least 250ml of water 20 minutes before collecting the urine sample. The midstream urine is collected and the sample is sent for microbiological examination.

Isolation of bacteria from urine specimen: HiChrome UTI agar plates were prepared and 20 µl of urine sample was spread and streaked on agar plates by spread plate techniques and simple streaking techniques. Plates were incubated at 37°C for 24 hours.

Gram Staining: Thin smear of colonies was prepared on a clean glass slide and fixed by gentle heat. It was further flooded with Gram's crystal violet for 1 minute and drained. This step was repeated by using Gram's iodine, Gram's decolourizer and safranin. Allowed to air dry the slides and observed under oil immersion objective.

Biochemical Tests

Catalase test: A colony was picked using a sterile loop and spotted on the clean glass slide and a drop of 3% hydrogen peroxide. Immediate production of air bubbles were observed to find whether a test organism was capable of producing catalase enzymes.

Oxidase test: A colony was picked using a sterile stick and patched on an oxidase disc impregnated with N, N-dimethyl-p-phenylenediamine oxalate, ascorbic acid and a-naphthol. Purple color change in the oxidase disc was observed indicating a test organism capable of producing cytochrome oxidase.

Indole test: A loop of colonies was inoculated into the autoclaved peptone broth and incubated for 24 hours. After the incubation, 10 drops of Kovac's reagent were added to the culture. The color changes were observed whether a test organism was capable of hydrolysing the peptone.

Methyl red test: A loop of colonies was inoculated into MR-VP broth and incubated for 24 hours. After the incubation, five drops of the methyl red indicator were added to the culture. The color changes were observed, whether a test organism was capable of fermenting glucose into acid.

Voges-Proskauer test: A loop of colonies was inoculated into the autoclaved MR-VP broth and incubated for 24 hours. After the incubation, 10 drops of Barritt's reagent A were added, and the cultures were shaken. Immediately, 10 drops of Barritt's reagent B were added and shaken. Again, the cultures were shaken every 3 to 4 minutes. After 15 minutes the color change of the cultures was observed and whether a test organism was capable of fermenting glucose with ultimate production of acetylmethylcarbinol was analysed.

Citrate: A loop of colonies was streaked on the Simmon citrate agar slant and incubated for 24 hours. After incubation, the color changes were observed to find whether a test organism was capable of using citrate as its sole source of carbon.

Triple Sugar Iron (TSI) test: A loop of colonies was stabbed on the TSI agar butt and further continuously streaked on the TSI agar slant and incubated for 24 hours. After incubation, the color changes were observed on the butt and slant as well as gas production.

Results and Discussion

A total of six samples were collected from healthy males and females (shown in Table 1 & Fig. 1), among these three Gram positive cocci and two Gram negative rod shaped bacteria (shown in Fig. 2) were isolated using HiCrome UTI agar plates. MacConkey agar, Nutrient agar and Luria Bertani Agar are commonly used to isolate the bacteria from urine samples. The identification of the bacterial isolates by using these media is difficult so all biochemical tests must need further biochemical identification. In chromogenic agar, each bacteria produces a different color by the enzymatic reaction with chromogenic substrates. This may help to comfortably identify isolates with only a few crucial biochemical tests.



Figure 1: Isolation of bacteria from urine samples in UTI agar plates

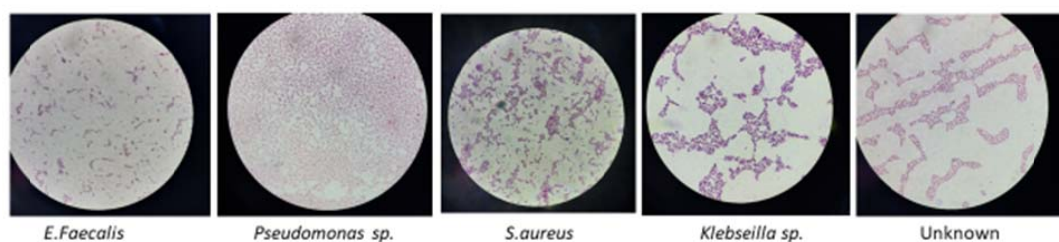


Figure 2: Gram staining of isolated bacteria

Table 1: Sample details and isolation of bacteria from urine samples

S. No.	Sample ID	Sex	Age	No. of colonies
1	SID 1	Female	45	No growth
2	SID 2	Female	24	3
3	SID 3	Female	24	Too numerous to count
4	SID 4	Female	23	Too numerous to count
5	SID 5	Male	21	No growth
6	SID 6	Male	23	Too numerous to count

Morphological characterization of isolates in UTI agar

It has been identified that the isolates such as *E. faecalis*, *Pseudomonas* sp., *S. aureus*, *K. Pneumoniae* and unknown organisms were observed based on the colour and morphological characters as shown in Table 2.

Table 2: Morphological observation of bacterial isolates in UTI agar

Isolates	Size	Colour	Form	Elevation
<i>E. faecalis</i>	Small	Turquoise	Circular	Dry, flat
<i>Pseudomonas</i> sp.	Large	Blue-green	Irregular	Flat
<i>S. aureus</i>	Large	White	Irregular	Flat
<i>K. pneumoniae</i>	Large	Blue-purple	Circular	Raised
Unknown	Large	Dark blue	Irregular	Raised

Biochemical tests

Even though isolation was done in chromogenic agar, few biochemical tests were needed for further confirmation. The 24 hours cultured broth has been used for biochemical tests such as oxidase, catalase, indole, methyl red, Voges-Proskauer, citrate, and Triple Sugar Iron (TSI) agar tests as shown in Table 3.

Oxidase discs are sterile filter paper discs impregnated with N, N-dimethyl-p-phenylenediamine oxalate, ascorbic acid and a-naphthol. *Pseudomonas* sp. produces the cytochrome oxidase enzyme that combines with N,N-dimethyl-p-phenylenediamine oxalate and a-naphthol to form indophenol blue dye indicated as oxidase positive and the other isolates haven't formed indophenol blue due to lack of cytochrome oxidase enzyme indicated as oxidase negative. *Pseudomonas* sp., *S. aureus*, *K. pneumoniae* and unknown organisms produce catalase enzymes when the organism inoculated in a drop of hydrogen peroxide, catalase enzyme breakdown into oxygen and gas indicated as catalase positive. Unknown organism ability to hydrolase tryptophan by tryptophanase enzyme to produce indole. Indole production is demonstrated by the addition of Kovac's reagent which acts with the indole giving a red color.

Except *Pseudomonas* sp. other isolates were able to utilise glucose and produce acid that changed the pH 4.4 or below, the colour of the methyl red changes from yellow to red. *Pseudomonas* sp. may produce nonacidic or neutral end products from organic acids via glucose metabolism detected by the Voges-Proskauer test. *K. pneumoniae* is capable of

utilizing citrate as a carbon source by the presence of citrate permease enzyme was detected by citrate utilizing test.

Triple Sugar Iron (TSI) agar test is used to differentiate the *Enterobacteriaceae* group or genera, all gram-negative bacilli capable of fermenting glucose with the production of acid, and to distinguish *Enterobacteriaceae* from other gram-negative bacilli, based on the carbohydrate fermentation and hydrogen sulfide production. The TSI agar contains 1% of sucrose and lactose and 0.1% of glucose which permits detection of the utilization of this substrate only. Phenol red as an acid-base indicator was incorporated into the medium to detect carbohydrate fermentation.

Color changes from orange-red to yellow in the presence of acids and orange-red to pink in the presence of alkaline. *E. faecalis* and *K. pneumoniae* ferment lactose or sucrose by acidic yellow color changes in both slant and butt. Carbohydrates can't be fermented by *Pseudomonas* sp. and so pink colour was observed. The unknown organism has only glucose fermentation as shown in Fig. 3. One of the organisms that appeared blue in the UTI agar plate is difficult to identify based on these biochemical characterizations.

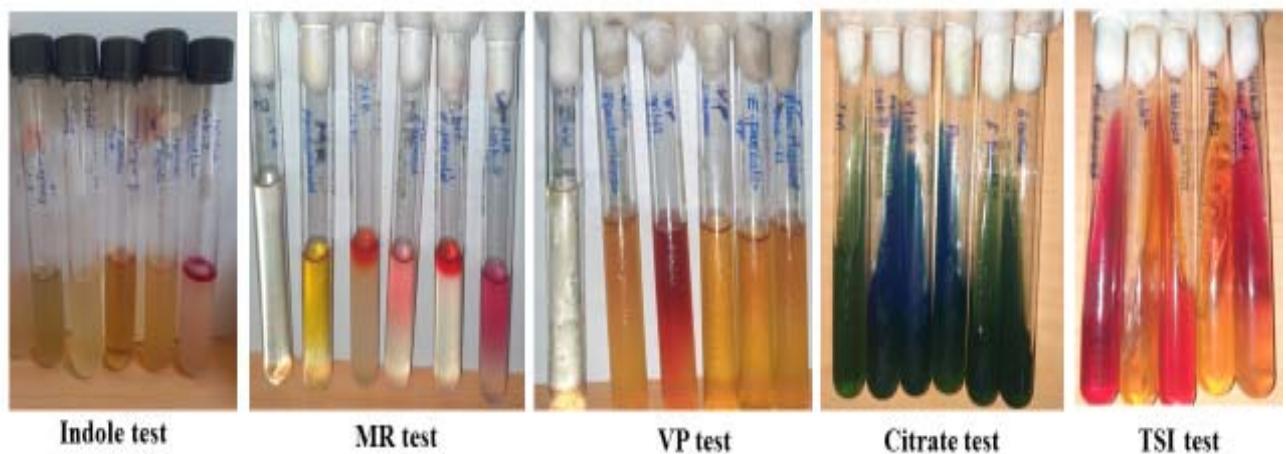


Figure 3: Biochemical tests

Table 3: Biochemical characteristics of the isolated bacteria

Isolates	Oxidase	Catalase	Indole	Methyl red	Voges-proskauer	Citrate	TSI test			
							Slant	Butt	Gas	H ₂ S
<i>E. faecalis</i>	Negative	Negative	Negative	Positive	Negative	Negative	Acid	Acid	Negative	Negative
<i>Pseudomonas</i> sp.	Positive	Positive	Negative	Negative	Negative	Positive	Alkaline	Alkaline	Negative	Negative
<i>S. aureus</i>	Negative	Positive	Negative	Positive	Negative	Negative	Acid	Alkaline	Negative	Negative
<i>K. pneumoniae</i>	Negative	Positive	Negative	Weakly Positive	Positive	Positive	Acid	Acid	Positive	Negative
Unknown	Negative	Positive	Positive	Positive	Negative	Positive	Alkaline	Acid	Negative	Negative

The study and characterization of microbial communities in different healthy human body environments is essential. The composition of the microbial community present in human body niches such as the oral cavity, skin, gastrointestinal tract or vagina, and its role in health and disease analysed by the Human Microbiome Project. The urine was sterile before reaching the urinary bladder, however the identification of the commensal microbial community in the urinary tract by high-throughput DNA sequencing techniques [10].

Urine is hostile for the microorganisms to survive because of its low pH, high concentration of urea, and other substances such as antimicrobial properties. But the flushing and voiding of microorganisms may persist in the bladder. Those microbes may survive and colonize causing infections by utilizing urine as a substrate [11]. Among six urine samples examined in this study, three samples has no growth, one sample only three colonies were

observed which is statistically considered to be insignificant, other two samples were too numerous to count.

In the urine microbiome of healthy men and women, the majority of genera are shared. *Prevotella*, *Escherichia*, *Enterococcus*, *Streptococcus*, and *Citrobacter* are among the species that are frequently found, while the genus *Pseudomonas* has only been reported in males [9]. In this study, bacteria such as *Enterococcus faecalis*, *Pseudomonas* sp., *Klebsiella pneumoniae* and *Staphylococcus aureus* were isolated and identified from both male and female urine samples. There is a lot of variation in the bacterial composition of human female urine samples, which is polymicrobial. The most common genera were *Gardnerella*, *Prevotella*, and *Lactobacillus* [12]. Some genera such as *Corynebacterium* and *Streptococcus* are more abundant in men [8].

Conclusion

Healthy urine samples also exhibited growth of pathogenic microorganisms. Hence any biofluids should be considered potentially hazardous and handled with caution. Adequate drinking of water and urination at regular intervals may avoid the accumulation of microorganisms in the urinary bladder.

Acknowledgement

We acknowledge the Molecular Diagnostic Research Facility, RUSA Department of Immunology, School of Biological Sciences, Madurai Kamaraj University, Madurai, Tamilnadu for the facility and thank Dr.G.Gnanakumar, Assistant Professor and Head, Department of Physical Chemistry, Madurai Kamaraj University for raising this biological question.

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Antibacterial activity of the tissue extracts of Marine crab, *Ocypode macrocera* (H. Milne-Edwards 1852)

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ABSTRACT

*The search for antimicrobial agents has taken a definite direction and marine crabs have been found to possess antimicrobial activity against pathogens like bacteria, fungi and viruses. The present investigation was taken up to study the antibacterial potential of different solvent extracts of haemolymph, gills, muscle, testes and hepatopancreas of *Ocypode macrocera*. Five human pathogenic bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus cereus* and *Klebsiella pneumoniae* were used for antibacterial studies. Maximum zone of inhibition was observed with the chloroform extracts of hemolymph and muscle. Acetone and aqueous extracts of the tissues also recorded moderate antibacterial activity. Thus the results revealed that *Ocypode macrocera* has potential antibacterial compounds.*

Key words: antibacterial activity, *Ocypode macrocera*, pathogens, solvent extracts.

Introduction

Marine inhabitants have been investigated as a valuable source of functional and chemo therapeutic compounds during the last decade [1]. As crustaceans living in an aquatic environment, they have confronted a broad variety of challenges and have developed effective strategies for detecting and eliminating invasive pathogens. Marine invertebrates lack a highly specific adaptive immune system and they use their innate and non-adaptive immune system to resist pathogen invasions. Cellular immunity predominantly involves the phagocytic activity of haemocytes, whereas humoral immunity requires the release of antimicrobial factors. Humoral defenses are related to the haemolymph and include receptor proteins, clotting proteins and antimicrobial peptides. Among the humoral components, antibacterial peptides/ proteins are predominant and constitute the first line of defence.

The marine crabs are potential sources of new antibiotics as antimicrobial peptides/ proteins are a major component of the innate immune defense system in marine invertebrates. These antibacterial peptides/ proteins are the first line of host defense and have been extensively studied [2] as they interact directly with foreign materials, particularly the potential microbial pathogens. The potential of marine crabs as a source of biologically active

products is largely unexplored. Hence the present study aimed at analyzing the antimicrobial activity of the different tissue of the marine crab *Ocypode macrocera*.

Materials and Methods

Experimental animal and sample collection: *Ocypode macrocera* were collected from Periya Kaadu coastal area, Kanyakumari District, Tamil Nadu, India in the month of April 2022. Haemolymph was collected by cutting the walking legs of the crab with a fine sterile scissor. The haemolymph collected was centrifuged at 2000 rpm for 15 minutes at 4°C to remove haemocytes from the haemolymph. Supernatant was collected and stored at 4°C until use. Gills, muscle, testes and hepatopancreas were carefully dissected and stored at 20°C prior to extraction for antibacterial work.

Preparation of extracts for antimicrobial activity: Tissue extracts of the crab were prepared following the method of Karthikeyan *et al.* [3] with slight modification. 1 g each of gills, muscle, testes and hepatopancreas were homogenized and extracted with 10 volumes (v/w) of acetone, chloroform and aqueous and kept for three days at room temperature. The extracts were filtered through Whatman No 1 filter paper, concentrated by evaporating in room temperature to give a dark gummy mass and used for the antibacterial assay. Haemolymph was treated with all the above mentioned solvents (1:1) and used for antimicrobial studies.

Bacterial strains: Antibacterial activity of crab was determined against five bacterial strains viz., *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus cereus* and *Klebsiella pneumoniae*. These pathogens strains were obtained from the Scudder Laboratory, Nagercoil.

Assay of antibacterial activity: Antibacterial activity was analysed by following the standard disc diffusion method [4]. 20 ml of sterilized Muller Hinton Agar was poured into sterile petri-plates. After solidification 100 µl of fresh culture of pathogenic bacteria (*E. coli*, *P. aeruginosa*, *S. aureus*, *B. cereus*, *K. pneumoniae*) were swabbed on the respective Muller Hinton Agar plates. The discs impregnated with 50 µl of samples were kept over the agar plates using sterile forceps. Streptomycin was used as positive control. The plates were incubated for 24 hours at 37°C. After incubation the diameter of inhibitory zones formed around each discs were measured (mm) and recorded.

Results

Antibacterial activity of haemolymph

The acetone haemolymph extract of *O. macrocera* showed high antibacterial activity on *P. aeruginosa* (16 ± 0.25 mm) followed by *B. cereus* (10 ± 0.5 mm). The acetone haemolymph extract did not inhibit the growth of *E. coli*, *S. aureus* and *K. pneumoniae*. The chloroform extract of haemolymph showed high antibacterial activity on *E. coli* (17 ± 0 mm) followed by *P. aeruginosa* (15 ± 0.5 mm). However the chloroform extract did not inhibit the growth of *S. aureus*, *K. pneumoniae* and *B. cereus*. The aqueous extract of haemolymph inhibited the growth of *E. coli* ($10\text{ mm}\pm 0.5$) only (Table 1).

Antibacterial activity of gills

The acetone extract of gills found to be active only against *B. cereus* (7 ± 0.25 mm). The chloroform and aqueous extracts of gills showed activity against *E. coli* with an inhibition zone of 9 ± 0 and 10 ± 0.5 mm respectively. They did not show inhibitory activity against *P. aeruginosa*, *S. aureus*, *B. cereus* and *K. pneumoniae* (Table 2).

Antibacterial activity of muscle

The acetone extract of muscle inhibited the growth of *Bacillus* (9 ± 0.25 mm), followed by *E. coli* (8 ± 0.5 mm) and *K. pneumoniae* (8 ± 0 mm). However it did not show inhibitory activity against *S. aureus* and *P. aeruginosa*. The chloroform extract showed maximum activity against *B. cereus* (18 ± 0 mm) followed by *K. pneumoniae* (17 ± 0.25 mm), *P. aeruginosa* (16 ± 0.25 mm) and *E. coli* (15 ± 1 mm). Aqueous extract of muscle inhibited the growth of *B. cereus* (13 ± 1 mm) only (Table 3).

Antibacterial activity of testes

Acetone extract of testes showed inhibitory activity against *B. cereus* (8 ± 0 mm), *K. pneumoniae* (8 ± 0 mm) and *S. aureus* (7 ± 0.25 mm). Chloroform extract of testes exhibited maximum activity against *S. aureus* (10 ± 0.25 mm) followed by *E. coli* (9 ± 0 mm), *P. aeruginosa* (8 ± 0.5 mm), *B. cereus* (7 ± 0.5 mm) and did not inhibit the growth of *K. pneumoniae*. The aqueous extract inhibited the growth of *B. cereus* (10 ± 0.5 mm) only (Table 4).

Antibacterial activity of hepatopancreas

Acetone extract of hepatopancreas showed antibacterial activity against *K. pneumoniae* (8 ± 1 mm) and *S. aureus* (7 ± 0.25 mm). However the acetone extract of hepatopancreas did not inhibit the growth of *E. coli*, *P. aeruginosa* and *B. cereus*. The aqueous extract inhibited the growth of *E. coli* only (Table 5).

Table 1

Antibacterial activity of haemolymph of *Ocypode macrocera* against tested pathogens

Pathogen	Strain of pathogen	Zone of inhibition (mm)			
		Acetone	Chloroform	Aqueous	Positive control
Bacteria	<i>Escherichia coli</i>	-	17 ± 0	10 ± 0.5	19 ± 0
	<i>Pseudomonas aeruginosa</i>	16 ± 0.25	15 ± 0.25	-	15 ± 0.5
	<i>Staphylococcus aureus</i>	-	-	-	19 ± 0.25
	<i>B. cereus</i>	10 ± 0.5	-	-	13 ± 1
	<i>Klebsiella pneumoniae</i>	-	-	-	15 ± 0.25

Table 2: Antibacterial activity of gills of *Ocypode macrocera* against tested pathogens

Pathogen	Strain of pathogen	Zone of inhibition (mm)			
		Acetone	Chloroform	Aqueous	Positive control
Bacteria	<i>Escherichia coli</i>	-	9 ± 0	10 ± 0.5	25 ± 0.25
	<i>Pseudomonas aeruginosa</i>	-	-	-	20 ± 1
	<i>Staphylococcus aureus</i>	-	-	-	10 ± 0.25
	<i>B. cereus</i>	7 ± 0.25	-	-	16 ± 0
	<i>Klebsiella pneumoniae</i>	-	-	-	14 ± 0.5

Table 3: Antibacterial activity of muscle of *Ocypode macrocera* against tested pathogens

Pathogen	Strain of pathogen	Zone of inhibition (mm)			
		Acetone	Chloroform	Aqueous	Positive control
Bacteria	<i>Escherichia coli</i>	8±0.5	15±1	-	17±0.5
	<i>Pseudomonas aeruginosa</i>	-	16±0.25	-	15±0
	<i>Staphylococcus aureus</i>	-	-	-	22±0.25
	<i>B. cereus</i>	9±0.25	18±0	13±1	19±0.5
	<i>Klebsiella pneumoniae</i>	8±0	17±0.25	-	18±0.25

Table 4: Antibacterial activity of testes of *Ocypode macrocera* against tested pathogens

Pathogen	Strain of pathogen	Zone of inhibition (mm)			
		Acetone	Chloroform	Aqueous	Positive control
Bacteria	<i>Escherichia coli</i>	-	9±0	-	12±1
	<i>Pseudomonas aeruginosa</i>	-	8±0.5	-	18±0.5
	<i>Staphylococcus aureus</i>	7±0.25	10±0.25	-	20±0.25
	<i>B. cereus</i>	8±0	7±0.5	10±0.5	13±0
	<i>Klebsiella pneumoniae</i>	8±0	-	-	14±0

Table 5: Antibacterial activity of hepatopancreas of *Ocypode macrocera* against tested pathogens

Pathogen	Strain of pathogen	Zone of inhibition (mm)			
		Acetone	Chloroform	Aqueous	Positive control
Bacteria	<i>Escherichia coli</i>	-	-	8±0.5	15±0.5
	<i>Pseudomonas aeruginosa</i>	-	-	-	14±0.25
	<i>Staphylococcus aureus</i>	7±0.25	-	-	13±0
	<i>B. cereus</i>	-	-	-	13±0.25
	<i>Klebsiella pneumoniae</i>	8±1	-	-	16±0.5

Discussion

In recent years, great attention has been paid to study the bioactivity of natural products due to their potential pharmacological utilization. The present research investigation is made on the basis of in search of antimicrobial peptides from the haemolymph and other tissues of *Ocypode macrocera*, a marine crab collected from the Periya Kaadu coastal area, Kanyakumari district. The results revealed that the haemolymph, hepatopancreas, carapace, gills and testes of the crab had antibacterial activity against different ranges of bacterial strains. Previous work showed that decapod crustaceans contain factors with antibacterial activity in the haemolymph and different body parts[5]. The influence of crab hemolymph against a wide range of clinical pathogens proves that crustaceans are a very good source of antimicrobial potency[6]. Antibacterial peptides can also be induced in response to wounding or infection in the cuticles[7] and these are secreted into the haemolymph of which some are lysozyme[8] and andropin [9]. These proteins show strong resistance to microbial growth.

From the present study it was observed that *Ocypode macrocera* has potential antibacterial components which are evident from the high zone of inhibition recorded with the solvent extracts of haemolymph, gills, muscle, testes and hepatopancreas against human pathogens. The chloroform extracts showed better results when compared to acetone and aqueous suggesting chloroform solvent as efficient in eluting the bioactive compounds. Our results are in confirmation with the results of Zodape [10], who studied the antibacterial and antifungal activity of bioactive compounds of *A. integerrimus*.

Conclusion

The present study indicates that haemolymph and tissue extracts of *Ocypode macrocera* may contain potential antibiotics. The antimicrobial assay done so far will serve as a baseline data for further studies that may confirm the hypothesis that brachyuran crabs are indeed potential sources of novel compounds with biological potential. Further purification of the active compounds is necessary in order to identify their chemical nature and to evaluate their potency as a novel drug.

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Antibacterial activity of the hemolymph of the freshwater crab *Spiralothelphusa wuellerstorfi*

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ABSTRACT

*The circulating hemolymph of aquatic crustaceans contains bioactive compounds like complements, lectins, clotting factors and antimicrobial peptides. Most of these substances are isolated for treating infectious diseases and cancer. With this understanding, the hemolymph of the freshwater crab *S. wuellerstorfi* was analyzed for its antibacterial potential by disc diffusion method against Gram negative and Gram positive bacterial strains such as *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, and *Bacillus cereus*. It was found that the hemolymph of the crab was more sensitive to *Bacillus cereus* and *Proteus mirabilis*. *Bacillus cereus* was examined with different concentrations of the hemolymph (25, 50, 75 and 100 μ l) and maximum zone of inhibition was observed at 75 μ l (14 mm). These results revealed that the hemolymph has antibacterial peptides and the purification of these biomolecules would be of great help in antibacterial drug discovery.*

Key words: *Antibacterial, Hemolymph, *Spiralothelphusa wuellerstorfi*, Zone of inhibition*

Introduction

The side effects of currently available drugs, microbial resistance and emergence of new strains of pathogens made the researchers discover new drugs from natural products. Due to the development of antibiotic-resistant bacteria, antibacterial peptides have attracted attention in recent years, in order to find new therapeutic agents. The peptides with antibacterial activity have been found in plants and the whole animal kingdom, from bacteria and different insect orders to amphibians, mammals and humans [1, 2]. It is interesting that the diversity, complexity and variety of the natural compounds that exhibited antimicrobial activity seem to be much wider than suspected. The immune system of invertebrates possesses many defensive molecules, which protect themselves against pathogens. Invertebrates of aquatic environments take over rich sources of chemical structures with enormous health effects, which include antioxidant, anti-cancerous, antimicrobial, anti-HIV, neuronal death inhibition, anti-inflammatory, especially proteins and with others. Several antimicrobial peptides were isolated from the hemolymph of arthropods [3]. These humoral factors/ molecules can be tapped as an alternative source of natural drugs. In this

investigation, an attempt was made to assess the antibacterial activity of the hemolymph of the freshwater crab *S. wuellerstorfi*.

Materials and Methods

Hemolymph Collection: The freshwater crab *S. wuellerstorfi* were collected from Ramayanpatti, Tirunelveli by hand picking from the rice field. Hemolymph was collected from uninjured, non autotomised crabs by inserting a sterile 1.0 ml syringe and 22 gauge needles into the arthroal membrane at the base of third walking leg in eppendorf tubes placed on ice [4].

Bacterial Strains: Gram positive bacterial strain *Bacillus cereus* (MTCC no. 430), and Gram negative bacterial strains *Escherichia coli* (MTCC no. 443), *Proteus mirabilis* (MTCC no. 1429), *Klebsiella pneumoniae* (MTCC no. 530) and *Enterobacter aerogenes* (MTCC no. 111) were purchased from Inbiotics Research Institute, Nagercoil and maintained at 4°C.

Antibacterial Assay: Antibacterial study was carried out by following the standard Agar disc diffusion method [5]. 15.2 g of Muller Hinton Agar was dissolved in 400 ml of distilled water, shaken well and sterilized by autoclaving at 15 Lbs pressure at 121°C for 15 minutes and poured in petri plates. After solidifying the agar, the plates were swabbed with pathogenic bacteria. Streptomycin disc (positive control), plane disc dipped in distilled water (negative control) and the plane disc dipped in hemolymph of 20 µl (test/ sample) were placed in the agar plate and incubated for 24 hours. The inhibition zone was observed and measured in millimeters.

The bacterial strain which showed maximum inhibition was chosen and the antibacterial activity with different concentrations of hemolymph (25, 50, 75 and 100 µl) was tested. Streptomycin was used as a positive control.

Results

Antibacterial activity of hemolymph of the freshwater crab *S. wuellerstorfi* was observed (Table and Figure 1 & 2). *P. mirabilis* and *Bacillus cereus* showed high sensitivity to the hemolymph of the crab *S. wuellerstorfi* followed by *E. aerogenes*, *K. pneumoniae* and *E. coli*. Since a clear zone of 8 mm was noted in Gram positive bacteria, *Bacillus cereus*, different concentrations of the hemolymph (25, 50, 75 and 100 µl) were tested for antibacterial activity. Maximum zone of inhibition was observed at 75 µl (14 mm). This indicates that the hemolymph of the crab produces/ possesses certain antibacterial substances to combat infections, which could be utilized in the pharmaceutical industry.



Enterobacter aerogenes



Escherichia coli

N = Negative Control; P = Positive Control; H = Hemolymph

Table 2: Antibacterial effect of different concentrations of hemolymph against *B. Cereus*

Hemolymph (µl)	25	50	75	100
Zone of Inhibition (mm)	7.5	13	14	11

Fig 2: Antibacterial effect of different concentrations of hemolymph against *B. cereus*



Discussion

Multidrug resistant bacteria are a global threat to human health and the abuse of antibiotics is the main cause of this problem. Antimicrobial peptides are the living functional by-products which have been noted as one of the vital ways out to such an upcoming crisis [6]. Studies of antimicrobial peptides provide new insights into dynamic interactions between microorganisms and their host, and generate new paradigms for the pathogenesis [7].

The present study discusses the antibacterial effect of the hemolymph of the freshwater crab, *S. wuellerstorfi*. Antibacterial activity was observed against *B. cereus* and *P. mirabilis* but inhibitory zone was not observed in *E. coli*, *K. pneumoniae* and *E. aerogenes*.

The possible reason for the zone of inhibition could be the factors like antimicrobial peptides, clotting factors or complements in the hemolymph which would have been responsible for the antimicrobial activity due to constituents of the innate immune system [8]. It is believed that circulating haemocytes are playing an important role in the innate immune response of invertebrates, including being the storage reservoir of several immune components, such as lectins, coagulation factors and protease inhibitors [9]. In the current study the *B. cereus* showed maximum inhibition (14 mm) at 75 μ l concentration. Thus the hemolymph of the crab *S. wuellerstorfi* is found to be sensitive to bacterial strains tested and hence could be considered as a natural resource for the preparation of antibiotics.

Similar antimicrobial activity of the hemolymph of the crabs against pathogenic Gram positive and Gram negative strains was studied [8, 10, 11], and Antimicrobial protein of molecular weight 33 KDa was purified by sequential step of ammonium sulfate precipitation, dialysis, ion exchange chromatography, and fast protein liquid chromatography from the hemolymph of the freshwater crab *Oziotelphusa senex senex* [12]. The hemolymph having antibacterial proteins were also isolated from the crab *Mesocyclops leuckarti* and efficacy is evaluated against pathogenic microbes viz., *E. coli*, *S. aureus*, *K. pneumonia* and *S. flexneri* [13] and the results conveyed that the hemolymph is more effective at certain concentrations. Accordingly in the present investigation, when the antibacterial activity was tested with 25, 50, 75 and 100 μ l of hemolymph, maximum zone of inhibition was observed at 75 μ l, confirming the report of [13].

The outcome of the present work revealed the presence of antibacterial compounds in the hemolymph of the freshwater crab, *S. wuellerstorfi*. that will provide an opportunity for the production of new compounds with natural activities as an alternative to antibiotics.

Conclusion

The hemolymph of the crab *S. wuellerstorfi* is found to be sensitive to bacterial strains tested and hence could be considered as a natural resource for the preparation of antibiotics. Further investigations will be continued for the purification of the antibacterial compound present in the hemolymph.

Acknowledgement

We acknowledge the Zoological Survey of India, Western Regional Centre for their assistance in identification of crabs.

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