RNI No. APTEL/2003/12253

భావవీణ

కళలు, సాహిత్య సాంస్కృతిక భాషాధ్యయన పత్రిక

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శ్రీమతి భానుమతి రామకృష్ణ

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వెన్నెల రాత్రి వానలో హైకూలాట

– డా॥ జి.వి. రమణ, తెలుగుశాఖాధిపతి, ఎ.ఎస్.ఆర్. కళాశాల, గుడివాడ, కృష్ణా జిల్లా.

ఆధునిక తెలుగు సాహిత్యంలో పచ్చిన అత్యంత శక్తివంతమైన సాహిత్య ప్రకియ హైకూ. రూపంలో మూడే మూడు లైన్లు. భావంలో ముల్లోకాల్ని ఒడిసి పట్టుకో గలిగేంత విశాలమైంది హైకూ. అత్యంత ఆధునిక భావాల్ని సంతరించుకుని హైకూ విస్తరిస్తోంది. హైకూ జపాన్ నుండి దిగుమతి చేయబడిన

సాహిత్య ప్రక్రియ. హైకూలో 17 అక్షరాలు ఉన్నా అది మన తెలుగు లిపికి సరిపోకపోవడంతో ఇంచుమించు అవే లక్షణాలతో ఇస్మాయిల్, గాలి నాసర రెడ్డికి, బి.వి.వి. ప్రసాద్ (పూలు రాలాయి), పెన్నా శివరామకృష్ణ వంటి కపులు హైకూల్ని రాస్తున్నారు. రూప పరంగా కొత్తగా పచ్చిన సాహిత్య ప్రక్రియ హైకూ.

పస్తు, స్థల, కాలాలు అనే మూడంశాలతో హైకూ సజీవ సంబంధం కలిగి ఉంటుందని చేరా గారభిప్రాయం వేగంగా పరిగెడుతున్న కాలంలో ప్రయాణిస్తున్న పాఠ కుడికి, నిలబడి నిమ్మళంగా నించొని నీళ్ళు తాగటానికి కూడా టైం లేనంత బిజీగా ఉన్న కాలంలో ఇలాంటి రూపంలో చిన్నదైన హైకూను చదవటానికి కేవలం మూడు క్షణాలు సరిపోతాయి. కాని చదివాక అదిచ్చే శక్తిమాత్రం చెప్పలేనంత. మనసుకు ఊరట, బలహీనత, కొంత ఉత్తేజం కలిగిస్తాయి. ఆధునిక పాఠకునిలో పఠనాశక్తి తగ్గిపోతుంది అనేక అనుపాత్య మార్పులు ఇందుకు కారణం కావచ్చు. అలాంటి సమయంలో హైకూ పఠనాశక్తి ని కల్గించే, సులభంగా అర్థమయ్యే సాహిత్య ప్రక్రియ హైకూ.

హైకూ అంటే జీవితాన్ని గాఢంగా, తీవ్రంగా, తీక్షణతతో, మన పరిపూర్ణ అస్థిత్వంతో అనుభవించమే గాని మరొకటి కాదు. జీవతోత్సవంతో ఎగరేసిన జెండా హైకూ. మనం మన చుట్టూ ఉన్న అనేక సంగతులతో ప్రత్యక్ష, పరోక్ష సంబంధాల్ని కల్గి ఉంటాం. అలా ఉన్నవాటిలో సమన్వయం సాధించ గలిగితే జీవితం ఎంతో గొప్ప ఆనందంగా ఉంటుంది. సమన్వయం లేనప్పుడు సంవేదనలు, సంఘర్షణలే మిగులుతాయి. జీవితానందం శూన్యం.

మన చుట్టూ ఉన్న ప్రకృతి లోనూ, మనుష్యులతోనూ తన్మయత్వం చెందటమే హైకూ లక్ష్యం. ప్రతీ ఒక్కరూ జీవితాన్ని కూలంకషంగా జీవించాలి. మళ్ళీ ఎవరి జీవితాన్ని వాళ్ళే జీవించాలి. ఆస్వాదించాలి. జీవితం కాపీ కాదు. అది నిత్య నూతన సంఘటనలమయం. ఎవరికి వారు అర్థం చేసుకోవాల్సిందే. అర్థం చేసుకున్న వాళ్ళకు అర్థంచేసుకున్నంత. ఇలా జీవితం చుట్టూ అల్లుకున్న అనేక ముళ్ళ కంపల చిక్కుముడుల్ని విప్పుతూ, మనో వికాసం కలిగించే హైకూల్ని రత్నమాల గారు అందిం చాయి. పసితనం నుంచి, మరణించే దాకా మానవ జీవితం వివిధ దశల్ని హైకూలో చిత్రించారు.

ఇంతవరకూ తెలుగులో 'పూలు రాలాయి', 'దృశ్య కావ్యం', 'ఆకాశ దీపాలు', 'వెన్నల రాత్రి వాన' అనే హైకు కవితా సంపుటాలొచ్చాయి.

ప్రస్తుతం రత్నమాల అందించిన 'వెన్నెల రాత్రి వాన' హైకు కవితా సంపుటంలోని కొన్ని హైకూల్ని పరిచయం చేయడం ఈ వ్యాసోద్దేశం.

హైకూల్ని పరిచయం చేసేముందుగా రత్నమాలగారి గురించి రెండు మాటలు చెప్పాలి. పూర్తి పేరు యదపల్లి రత్నమాల. అక్టోబరు 10, 1973 లో జన్మించారు. సింతూరు తణుకు జియోలాజికల్ సర్వే ఆఫ్ ఇండియా లో ఉద్యోగం చేస్తున్నారు. హైకూ కవితను పరిచయం చేసిన కొప్పర్తి మాష్టారికి ఈ 'వెన్నల రాత్రి వాన' హైకూ కవితా సంపుటిని అంకితమిచ్చారు.

ఇస్మాయిల్ గారు ఈ పుస్తకానికి 'రత్నమాల మనోముకురం' అనే పేరుతో ముందుమాట రాశారు. అందులో "మనో వికారాన్ని క్షాళనం చేసుకుని హైకూ కవి తన హృదయాన్ని తుడిచిపెట్టిన అద్దంలా ఉంచాలి. అపుడు కావ్య విషయం అతని మనో ముకురంలో ప్రతిబింబిస్తుంది. అతని మనస్సూ, కావ్య వస్తువూ తాదాత్మ్యం చెందుతాయి. కవికీ, కావ్య వస్తువుకి భేదం చెరిగిపోతుంది. కవి తనలో కావ్య వస్తువును చూసుకుంటాడు. వస్తువు కవి కళ్ళతో తనను తాను చూసుకుంటుంది. ఇటువంటి ఐక్యానుభవాన్నించే హైకూ ఉద్భవిస్తుంది" అని అంటారు.

హైకూ కవి తన భావాల్ని పదచిత్రాల ద్వారా వ్యక్తీకరిస్తాడు. వాచ్యం అల్పంగా, వ్యంజనం / వ్యంగ్యం అధికంగా ఉంటుంది.

'హైకూల పరిశీలన'
"వెన్నెల రాత్రి వాన
నేనూ, చందమామా
గూడులోనే దాక్కున్నాం"

వెన్నల రాత్రిలో కురిసే వాన , వెన్నలని కప్పే మేఘాలు మనసునెంతో ఆహ్లాదపరుస్తాయి ఆకాశంలో వెలిసే ఇంద్ర ధనస్సును ఎంత హృద్యంగా చెప్పారో!

వర్షపు ఆనందాన్ని
ఏ చిత్రకారుడో
ఏడు రంగుల్లో చిత్రించాడు. వెన్నెల రాత్రి వాన. పు - 6.

ప్రకృతిలో అత్యంత సహజంగా సీతాకోకచిలుకా, పువ్వు రెండు రంగులు పులుముకుంటూ ఉన్నాయి. చంటిపిల్ల నాన్న చేతుల వైపు ఆత్రంగా చూడటం ఏదో తెచ్చుంటాడనే విషయం కోసమే.

ఒక్కొక్క హైకూలో ఒక్కొక్క విషయాన్ని చెబుతారు. చిన్ననాటి స్నేహితుల జ్ఞాపకం వైలు ప్రయాణం చేసే వ్యక్తి అనూహ్యంగా చేయి ఊపేది దాని కోసం ఎప్పట్నించో ఎదురు చూస్తుండే కుర్రాడి కోసమే.

పసిపాప
పాపాయి
ఏదిచ్చినా

నోటితోనే చూస్తుంది. 'పసిపిల్లలు ఏది చూసినా వారికేదిచ్చినా అన్నింటినీ నోట్లోనే పెట్టుకుంటారు. ఇది చిన్నపిల్లల్లో అత్యంత సహజమైన లక్షణం. అలాగే పాపాయి ఏడ్చినపుడు భుజం మీద పడుకోబెట్టుకుంటాం. ఆ పాపాయి నిద్రపోతుందో, మేలుకోనుందో ఎలా చూడ గలం. చూడలేం. చిన్న చిన్న జీవితానుభవాల్ని కూడా అద్భుతంగా చిత్రించారు రచయిత్రి. పాపాయి ఇప్పుడిప్పుడే మాట్లాడుతోందనీ, ఆ మాటలకు అర్థం ఏ పదకోశంలో ఉందని వెతకాలి' అనంటుంది. పాపాయి ఆడుకోవడం కాదు. పాపాయి నిద్రపోక మనమంతా ఆడుకున్నాం అంటుంది. అలాగే చంటిపిల్లలకు స్నానం అంటే చాలా సరదా. నీళ్ళలో ఆడుకోవటం చాలా యిష్టం. ఎంతసేపటికీ రారు. అక్కడే ఉండాలనుకుంటారు. అయితే పూర్తిగా స్నానం చేయరు. అదే విషయాన్ని చెబుతూ

ఎన్ని గంటలు స్నానం చేసిందో
బొట్టుకూడా చెరగనంత
శుభ్రంగా వచ్చింది చంటిది - వెన్నెల రాత్రి వాన. పు- 18

పాత డైరీ తెరిచినప్పుడల్లా కొత్త పరిమళం వస్తుంది. మనసులో అనుభూతుల్ని మొలిపించే హైకూ గురించి "వర్షమో వెన్నెలో కురిసింది.

అనుభూతి మొలకెత్తి హైకూ వచ్చిందని అంటారు. మనసులో మధురమైన అనుభూతుల్ని మొలిపించేదే హైకూ కవిత్వం

చీకటి :

రాత్రి మబ్బులు ఆకాశంలో చీకట్లో కలిసిపోయాయనీ, వర్షం రావడానికి సూచనగా గాలి వీస్తోందనీ రాత్రిపూటొచ్చే గాలివాన గురించి చెబుతుంది.

చీకటి భయంతో దీపం వెలుగిస్తే తన నీడే తన నిప్పుడు భయపెడుతోందట. మనిషికి చీకటన్నా భయం.

కొన్నిసార్లు తమ నీడను చూసి కూడా భయపడే వారుంటారు. ఇంకా

'అంతా చీకటే
నీ జ్ఞాపకం ఒక్కటే
వెలుగుతోంది.' పు-వెన్నెల రాత్రి వాన. 29. జీవితంలో ఎవరైనా కోల్పోయినప్పుడు మాత్రమే పలికే బరువైన మాట. నిజంగా జ్ఞాపకాలు చాలా బరువైనవి. కొన్నిసార్లు మోయలేం. మరుపే అత్యంత మధురమైంది. జ్ఞాపకాల జాడల వెనకే ఎంత దూరం వెళ్ళినా కొన్నిసార్లు దొరకవు. మాధుర్యాన్నందించే తీపి జ్ఞాపకం తలచుకుని, పట్టుకున్నా దొరకవు. అలాగే అలమర ఆఖరి అరతో జ్ఞాపకాల్ని దాచుకుంది.

చలిచీమల గురించి
'కరెంట్ చీమ
నామధేయం ఎవరు చేశారో
షాక్ లాగే కుట్టింది' - వెన్నెల రాత్రి వాన. పు- 32

అని చీమ లక్షణం గురించి చెబుతుంది. శ్రీశ్రీ అన్నట్లు చీమ విరిగిన కాలి చప్పుళ్ళు కూడా వినగల్గినవాడే కవి అని. ఈ విషయంలో రత్నమాల గారి విషయంలో అక్షరసత్యం.

పూలచెట్లు

పూలమొక్క తన పూలన్నీ రాలిపోయినా రాబోయే మొగ్గల్ని చూసి మురిసిపోతుంది. అప్పుడే వచ్చిన మొలక ఈ ప్రపంచాన్నంతటినీ ఆశ్చర్యంగా చూస్తుంటే ఆ మొక్కనే ఆశ్చర్యంగా చూస్తుంటుంది రచయిత్రి.

'తోటలోకి వెళ్ళాను
పూలుకోయబోయి
అక్షరాలు నింపుకొచ్చాను.' పూలతోటలో పూలు కోయకుండా అక్షరాలు నింపుకోవడం ఎంత అదృష్టం.

శిశిరం గురించి

'శిశిరం చెట్టు మోడైనా
ఆకుల సంగీతం' - వెన్నెల రాత్రి వాన. పు - 43.

శిశిరం చెట్లు ఆకులన్నీ రాలిపోతాయి. జీవితం చరమాంకం. మోడుబారిపోయిన బతుకు. అవసాన దశకు సంకేతం. ఇలా బాల్య దశ నుంచి చివరిదాక మానవ జీవితాన్ని ప్రతిబింబించే హైకుల్ని అందించారు రత్నమాల గారు.

ముగింపు

హైకు రెండక్షరాల ప్రభావితమైన సాహితీ ప్రక్రియ.,
ప్రపంచాన్ని
నిద్రలేపింది.

చిన్న పక్షి కూత - '43 అలాగే నిద్రిస్తున్న సాహితీ ప్రపంచాన్ని తన కూతతో పైకి లేపిన సజీవ పక్షి హైకూ నిత్య నూతన భావుకత్వం, సహజత్వం, సామాన్యత్వం, ఔన్నత్యం, అన్ని లక్షణాలను హైకూలో మనం చూడ వచ్చు. ఇలాంటి మంచి హైకూ కవితా సంపుటిని వెలువరించిన రత్నమాల గారు అభినందనీయులు.

ఉపయుక్త గ్రంథ సూచిక :

1. వెన్నెల రాత్రి వాన - రత్నమాల - గాయత్రి గ్రాఫిక్స్ - చిక్కడపల్లి హైదరాబాద్- 2000
2. స్వాతంత్ర్యానంతరం తెలుగు కవిత వస్తువు, రూపం, శిల్పం - డా॥ యస్ శరత్ జ్యోత్స్నారాణి - వేణు గ్రాఫిక్స్ -హైదరాబాదు- 2003.

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శ్రీపాద సుబ్రహ్మణ్యశాస్త్రి సాగర సంగమం కథ - దళిత చైతన్యం

- డా॥. గుండ్లూరు వెంకట రమణ, తెలుగు ఉపన్యాసకులు, ప్రభుత్వ డిగ్రీ కళాశాల, గణపవరం, ప.గో. జిల్లా.

'సాగర సంగమం' అనే కథను కథక చక్రవర్తి 'శ్రీపాద సుబ్రహ్మణ్య శాస్త్రి' రాశారు. మన భారతదేశం 19, 20 వ శతాబ్దాలు బ్రిటీష్ వారి పరిపాలనలోనే మగ్గిపోతూ వచ్చిందనే విషయం తెలిసిందే. అయితే వారి ప్రభావం పరోక్షంగా, కొన్నిసార్లు ప్రత్యక్షంగా తెలుగు సమాజం మీద, సాహిత్యం మీద కూడా పడింది.

బ్రిటిష్ వారు స్థానిక విషయాలలో పట్టు సాధించడం కోసం మన భారతీయ భాషలను నేర్చుకున్నారు. వారి ఇంగ్లీష్ భాషను మనకు నేర్పించారు. ఇదంతా ముద్రణా యంత్రం గొప్పతనమని వేరే చెప్పక్కర్లేదు. అదికూడా వారి పుణ్యమే. ఇంగ్లిష్ భాషను నేర్పే క్రమంలో బైబిల్‌ను ముద్రించి దాన్ని మన భారతీయ సమాజానికి పరిచయం చేశారు. ఇది కొన్ని వర్గాల వారిని ముఖ్యంగా దళిత వర్గాల్ని బాగా ఆకర్షించింది. ఎందుకంటే ఈ సమాజం అప్పటికే చాతుర్వర్ణ వ్యవస్థతో కుళ్ళి కంపుకొడుతూ ఉన్నది గనక. వాళ్ళని ఏ గుడిలోకీ, ఆలయంలోకి ప్రవేశించనిచ్చేవారు కాదు. కాబట్టి అగ్ర వర్ణాలవారికి అదొక మత ప్రచారంగా కనపడటం వల్ల వాళ్ళు అంతగా దానిపై సుముఖత చూపించి ఉండకపోవచ్చు. ఏదయినా కానీ ఒక కులం ఇంకో కులంతో కలవటానికి ఎవరూ ఒప్పుకొనని పరిస్థితుల్లో క్రైస్తవ్యం కొంత ఆ కులం బూజుని కొంత దులిపి పారేసిందని చెప్పవచ్చు. శ్రీపాద ఈ విషయాలు పట్టుకొని ఒక అద్భుతమైన కథను రాశారు. అదే ఈ సాగర సంగమం కథ.

ఇతివృత్తం : కాటం రాజు అనే ఒక మాల అబ్బాయి, సోమాలి అనే మాదిగ అమ్మాయి ఒక రెడ్డి ఇంట్లో పని చేస్తున్న క్రమంలో పరస్పరం ఒకరినొకరు ప్రేమించుకోగా, వారిరు వర్గాల కుల పెద్దలు అంగీకరించకుండా కులం నుండి వెలివేస్తామన్నప్పుడు వారి రెండు కుటుంబాలు దేవ సహాయం గారి సహాయంతో కిరస్థానీ మతం (క్రైస్తవ మతం) లో చేరి పెళ్ళి చేసుకోవడమే ఇందులోని ఇతి వృత్తం.

కాటం రాజు, సోమాలి పేరెడ్డి ఇంట్లో పనిచేస్తూ ఉంటారు. ఒకరి పట్ల ఒకరికి పరస్పర ఇష్టం ఉండటం వల్ల ఒకరిని విడిచి మరొకరు ఉండలేకపోతారు. అనేక సరదా కబుర్లు చెప్పుకుంటూ శ్రమ తెలీకుండా పని చేస్తుంటారు. సరిగ్గా ఇలాంటప్పుడు రంగమ్మ అక్కడికొచ్చి వాళ్ళను చూసి ముచ్చట పడి సరసంగా నాలుగు మాటలని వెళ్ళిపోగా వాళ్ళిద్దరూ పక్కున నవ్వుకుంటారు. పరస్పర ప్రేమికులు కాబట్టి. ఈ విషయాన్ని గంగన్నకు చెప్పకుండా "నీ కూతురికింకా పెళ్ళి చెయ్యవుటరా గంగడూ !" అంటుంది. సోమాలి నాన్న గంగన్న. చేయాలమ్మా, దానికి మీరే సాయం చేయ్యాలంటాడు. సరే చేస్తానని చెబుతుంది. అయితే సోమాలిని రోజూ ఇంటికి తప్పకుండా పంపించమంటుంది. పంపిస్తానని చెప్పి గంగయ్య పొలానికి వెళ్తాడు.

ఒకనాడు కాటంరాజు చెట్టెక్కి అందులో ఉండే యెండిన రెమ్మల్ని విరుస్తుండగా సోమాలి కిందుండి వాటిని పోగేస్తుంటుంది. దీన్ని గంగయ్య చూస్తాడు. వాళ్ళిద్దరూ ఒక్కసారిగా ఉలిక్కిపడతారు. ఆ రెమ్మల్ని మీ కోసమే తెంపానంటాడు. నువ్వు మంచోడివి బాబు. వచ్చే పెళ్ళాన్ని బాగా చూసుకో అంటూ గంగయ్య వెళ్ళిపోతాడు. సోమాలి కాటంరాజు ఊపిరిపీల్చుకుంటారు. కాటంరాజుని వదిలి వెళ్ళలేక 15సార్లు వెనక్కి తిరిగి చూస్తూ ఇంటికి చేరుకుంటుంది సోమాలి.

సోమాలి వేషం, ప్రవర్తన అన్నీ మారిపోతాయి. వంట ముసలమ్మ కబుర్లు సోమాలికి చాలా ఆసక్తిగా ఉండటం వల్ల ఆమెతోనే ఎక్కువ సమయం రెడ్డి గారింట్లోనే

గడుపుతుంది. ఎవరికీ బయట వాళ్లకు కనబడదు. రెడ్డి అరుగు మీద కూచునుండగా కాటం రాజు పాలం నుంచి ఇంటికొస్తాడు. రెడ్డి సోమాలిని చూపిస్తూ "ఓరేయి! సోమాలు పెళ్ళి కూతురులాగ వుందిరా." అనంటాడు. రంగమ్మ కలుగజేసుకుని కాటణ్ణి మీరు పెళ్ళి చేయండం టుంది. సోమాలి, కాటంరాజుల హృదయాలు ఉప్పొంగి పోతాయి.

కాటంరాజు తండ్రి నరిసీములు, తల్లి పొలమ్మ. వీరిది మాలపల్లి. కాటంరాజు సోమాలి ఇచ్చిన నీల్లు తాగాడని, ఆమె ఇచ్చిన పచ్చడి నంజుకున్నాడని, కుల పెద్దలందరూ సమకూడి కాటంరాజు కుటుంబాన్ని కులం నుండి వెలివేస్తామని అంటారు. అటు మాలలకీ, ఇటు మాదిగలకీ దూరం అయిపోతామని నరిసీములు బాధ పడ్తుండగా, పొలమ్మ వారి గత జీవితాన్ని గురించి చెప్పి ధైర్యం పోస్తుంది. నరిసీములు బొబ్బిలి కథ చక్కగా పాడటం వల్ల మనసుపడి పొలమ్మ అన్నల్ని, పదినల్ని, చివరకు భర్తనీ పదిలేసి వచ్చేస్తుంది. కోరుకున్న మొగుడు దొరికితే కులమెందుకని ప్రశ్నిస్తుంది పొలమ్మ. మాదిగ పల్లిలోనూ ఇలాగే గంగన్నను నిలదీసి సోమాలిని గురించి చెప్తారు. దానికేం తెలీదు చిన్నపిల్ల అనంటాడు గంగయ్య. "వారం రోజుల్లో నీ కూతురికి పెళ్ళి చెయ్యకపోతే కులంలో నుంచి నిన్ను కేటాయించేస్తా" మని ఖచ్చితంగా ఊరి పెద్దలందరూ గంగన్నతో అంటారు. గంగన్న నేరుగా రంగమ్మ దగ్గరకు ఈ విషయమై మాట్లాడటానికొస్తాడు. సోమాలి అక్కడే ఉంటుంది.

కాటంరాజు తల్లిదండ్రులు దేవసహాయం, మధురం అనేవాళ్లను ఈ విషయమై మాట్లాడటానికి సంప్రదిస్తారు. దేవయ్య మాల. మధురం వెలమ. వీల్లు కిరస్తానీ మతం పుచ్చుకుని కులభేదం లేకుండా పెళ్ళి చేసుకొని ఉంటారు. వీరిద్దరు క్రైస్తవమతం గురించి ఒకరి తర్వాత ఒకరు ఉపన్యాసాలిచ్చి క్రైస్తవ మతంలో కలిసేటట్లు చేస్తారు. గంగయ్య పెళ్ళి విషయం మాట్లాడ్డానికి రెడ్డి ఇంటికొచ్చి అన్నీ చెప్తాడు. పేరెడ్డి, రంగమ్మలు సోమాలికి కాటనితో పెళ్ళి జరిపించి ఇక్కడే ఉంచుకుంటామని ఏం భయమ వసరం లేదని చెప్తారు. రంగమ్మ సోమాలినడిగి ఆమె ప్రేమ విషయాలన్నింటినీ తెలుసుకుని కొంత ధైర్యాన్ని నూరిపోస్తుంది. కాటన్ని చేనుకొని సుఖవడుమని చెబుతుంది. అలా మనసుకు ఆసరా కల్పించి కాటంరాజు దగ్గరికెళ్ళి మాట్లాడమంటుంది. సోమాలి మెల్లిగా లేచి వెళ్ళి నూతి వైపు వెళ్తుంది. కాటంరాజు అక్కడ చెట్లకు నీళ్ళు కడుతూ ఉంటాడు. రెడ్డి గంగన్నకు మాట ఇవ్వడం వల్ల తాను కూడా సోమాలినిచ్చి పెళ్ళి చేయడానికి ఒప్పుకుంటాడు. నగలు చేయుమని రంగమ్మ సన్నాసి రెడ్డికి డబ్బులిచ్చి ఉంటుంది. సోమాలి పొంగిపోతుంది. అక్కడికి అప్పుడే దేవసహాయం వస్తాడు. ఇరువురు ఈ విషయం మాట్లాడుకుంటారు. ఇరువురికి పెళ్ళౌతుంది. ఒక వారం తర్వాత యాకూబూ, దావీదూ కాలువ గట్టున కూర్చుని "మాలాడికీ మాదిగదానికీ పెళ్ళా? ఎక్కడైనా జరిగిందా యిలాగా?" అని అనుకుటుంటారు. చివరికి "కిరస్తానీ మతం మంచిది కాదోస్" అనుకుంటారు.

శ్రీపాద వారు 1931లో ఈ కథను రాశారు. సాధా రణంగా మాలలకూ మాదిగలకూ సఖ్యత ఉండదు. ఒకరి నొకరు కలుపుకొనిపోరు. ఒకరి ఇళ్ళలోకి మరొకరు వెళ్ళరు, తినరు. ఇలాంటి సమయంలో క్రైస్తవ మతం ప్రవేశించటం వల్ల ఏ కుల, జాతి, మత భేదాలు లేకుండా అందరూ సమానంగా మెలుగుతూ, కొంతలో కొంత మార్పు అనేది సమాజంలో చోటు చేసుకుంది. ఇట్లా క్రైస్తవ మతంలో చేరితే ఏ భేదాలుండవని తెలిసి కాటంరాజు, సోమాలీ లిరువురు కిరస్తానం తీసుకుని పెళ్ళి చేసుకుంటారు. ఇదొక సామాజిక మార్పుకు నాందిగా చెప్పవచ్చు.

★★★

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"ఈ కోతి ఈ డ్రామాకు పనికొస్తుందా?" చూద్దాం రండి

– డా॥. గుండ్లూరు వెంకట రమణ, తెలుగు ఉపన్యాసకులు, S.Ch.V.P.M.R. ప్రభుత్వ డిగ్రీ కళాశాల,
గణపవరం, పశ్చిమ గోదావరి జిల్లా, ఆంధ్రప్రదేశ్.

'ఈ కోతి ఈ డ్రామాకు పనికొస్తుందా?' అనే ఈ అసంబద్ధ నాటికను నాయని కృష్ణమూర్తి గారు రాశారు. నాటికలోని అంశాలను చర్చించడానికంటే ముందుగా నాటకకర్త గురించి అయితే సాహిత్య లోకానికంతటికీ ఆయన సుపరిచితులు కాబట్టి ప్రత్యేకించి ఆయనను పరిచయం చేయాల్సిన పనిలేదు. అయితే ఆయనతో నాకున్న పరిచయాన్ని గురించి ఒకటి రెండు మాటలు ఖచ్చితంగా చెప్పాలి. నాకు మా గురువు ఆచార్య తుమ్మల రామకృష్ణ గారి ప్రమేయం వల్ల కృష్ణమూర్తి గారితో పరిచయం ఏర్పడింది. పరిచయమయ్యాక ఒకటి రెండు సార్లు కలవడం, వారితో అప్పుడప్పుడూ ఫోన్లో మాట్లాడుతుండటం వల్ల సాహిత్య సంబంధమైన స్నేహం ఏర్పడింది.

నాకు తెలిసినంతలో కృష్ణమూర్తి గారు మంచి స్నేహశీలి. నిగర్వి. వయోభేదం లేకుండా ఎవరితోనైనా కలిసిపోతారు. వారికున్న క్రమశిక్షణ, సమయాన్ని పాటించడం చూస్తే మనం నోరెళ్ళబెట్టాల్సిందే. ఎంత ఎదిగినా ఒదిగి ఉండే మహా మనీషి. ఆధునిక ఋషి, నేటి యువతకు ఆదర్శమూర్తి కృష్ణమూర్తి. ఓ ప్రాక్టికల్ లైఫ్‌కి, ఓ విజయానికి, ఓ ఐక్యతకు చిరునామా కృష్ణమూర్తి గారు. ఆయనో చిత్రమయిన మనిషి. ఆయన ఫోటోల్లో కొన్ని వెనక్కు నిల్చుని తీసుకున్నవి ఆయన పుస్తకాలకున్న వెనుక కవరు పేజీపై మనం చూడచ్చు. తెల్లని గడ్డం అంతే తెల్లని పల్చని బట్టలు, చేతిలో తెల్లని సిగరెట్టు, తెల్లని మనసు వెరసి కృష్ణమూర్తిగారి రూపు.

ఓసారి మా గురువుగారు, నేను హైదరాబాదు నుంచి ట్రైన్లో కలికిరికి వస్తున్నామని మా సార్ ఆయనకు ఫోన్ చేసి చెప్పిన వెంటనే ఆయన కారును పంపారు. మా గురువు గారితో ఆయనకున్న స్నేహ సంబంధం ఎంత గట్టిదో అప్పుడర్థమైంది నాకు. వాళ్ళింట్లో భోజనం చేయడం, ప్రెస్సును, దాంట్లోని అడ్వాన్స్‌డ్ టెక్నాలజీతో వచ్చిన కొత్త కొత్త మిషన్లను చూడడం, ఆయన వ్యక్తిగతంగా, ఏకాంతంగా గడపడానికి కట్టించుకున్న గుండ్రని ఇంట్లో రెండు రోజులుండటం, వారితో ఒకటి రెండు ఫోటోలు తీసుకోవడం, వారు రాసిన పుస్తకాలివ్వడం మొదలైనవి మరచిపోలేని జ్ఞాపకాలు.

కృష్ణమూర్తి గారు రామాయణ, మహాభాగవతాల్ని తెలుగులోకి అనువదించి సులభశైలిలో పాఠకలోకాని కందించారు. అలాగే రెండు కథా సంపుటాలు, మూడు నవలలు, రెండు నాటికలు వెలువరించారు. ఈ మధ్యనే ఏంలేదంటూనే 'ఏంలేదు' అనే కథల సంపుటిని అందించారు. 'ఈ కోతి ఈ డ్రామాకు పనికొస్తుందా?' అనే అసంబద్ధ నాటికను రాశారు. ఈ నాటికను స్థూలంగా పరిచయం చేయాలనే కాంక్షతోనే ఈ నాలుగు మాటలూ.

ఈ నాటికలో రచయిత టైటిల్ దగ్గర నుంచి చివరి పేజీలో అంకితం వరకూ కూడా ఒక కొత్త పద్ధతిని పాటించి నట్లు తెలుస్తుంది. ఈ కోతి ఈ డ్రామాకు పనికొస్తుందా అనేది ఒక విచిత్రమైన టైటిల్. అసలు కోతులే కదా డ్రామాకు పనికొచ్చేది. ప్రత్యేకించి 'ఈ కోతి ఈ డ్రామాకు పనికొస్తుందా?' అని అనడం వెనుక, అదొక ప్రత్యేకమైన డ్రామా అనీ, దానికి అలాంటి కోతినే కావాలని తెలుస్తుంది. ఇదొక సంకేతాత్మకమైన, ప్రతీకాత్మకమైన నాటిక. ఆధునిక సమాజంలోని ప్రతి మనిషీ ఒక కోతిలాగా డ్రామా ఆడతాడని చెప్పకనే చెబుతోంది నాటిక.

ఈ నాటిక లోని ఇతివృత్తం ఒక మేధావి (రచయిత, కవి, దర్శకుడు) ఆవకాశవాది చేత అక్రమాలు చేయించి, కిరీటి చేతిలోకి అధికారాన్ని ఇప్పించి, వెర్రిబాగుల

వీరయ్య అనే ప్రజలచేత విప్లవం, ఉద్యమాలు చేయించి, చివరికి ఎవరి అవకాశాలు వారు దక్కించుకొని, ఇదే అవకాశ వాదమని చెప్పి ప్రజాస్వామ్యాన్ని మరింత బంధించడమే.

రచయిత ఈ నాటిక మొదట్లోనే నాటిక వెనుక కథను స్థూలంగా చెప్పారు. సమాజంలోని బాధ్యతాయుతమైన ఒకు టీచరు తన విధుల్ని మరిచిపోయి రాజకీయ నాయకుల చుట్టూ తిరుగుతూ, చివరికి రచయిత పరోక్ష ప్రమేయం వల్ల M.L.O. అయ్యి పబ్బం గడుపుకుంటాడు. అదే టీచరు పలికిన "ఎప్పుడైనా ఈ కోతి వాళ్ల డ్రామాకు పనికొస్తుందనే" మాటే ఈ నాటిక రాయడానికి నేపథ్యం అయ్యిందని రచయిత పేర్కొన్నారు. ఈ నాటిక రచనా కాలం 1995.

ఈ నాటికలోని పాత్రలు ఐదంటే ఐదే. బహుశా మన చేతికున్న ఐదువేళ్ళకు (హస్తం) సంకేతం కావచ్చు. ఈ నాటికలోని పాత్రల పేర్లు అవకాశవాది, మేధావి, కిరీటి, వెర్రిబాగుల వీరయ్య, స్త్రీ. ఈ నాటికలో పాత్రలుగా ఈనాటి సమాజానికి సరిగ్గా సరిపడే విచిత్రమైన, వాస్తవికమైన పేర్లను అలాగే వాడుకున్నారు రచయిత. ఈ నాటిక చదువుతుంటే నాకు జాన్ బయ్యన్ రాసిన 'యాత్రికుని ప్రయాణం' గుర్తుకొస్తుంది. అందులోని పాత్రల పేర్లు కూడా చాలా విచిత్రంగా ఉంటాయి.. మెలకువ, మూర్ఖుడు, సువార్తికుడు, విశ్వాసి లాంటి పేర్లు 'యాత్రికుని ప్రయాణం' (The piligrim's progress) అనే నాటకంలో చూడవచ్చు.

అవకాశవాది మేధావి సలహాతో కిరీటిని చంపి పదవి చేపడతాడు. కిరీటి మేధావికి ఒక పదవినిస్తే అతను పెదవి విప్పడు. కట్టుకట్టుకొన్న వెర్రిబాగుల వీరయ్య ప్రజలకు సంకేతం. అతని కట్లు విప్పితే 'విప్లవం వర్ధిల్లాలి' అంటాడు. అందరూ అవకాశవాదులే. ప్రజాస్వామ్య ముసుగులో ఎవరి అవకాశాలు వాళ్ళు పొంది ప్రజల్ని పిచ్చోళ్లని చేస్తున్నారు. కుహనా రాజకీయ నాయకులు, ఆశలకు, ప్రలోభాలకు లంగిపోయే మేధావులు, నోర్లు లేని ప్రజలు. పంజరంలో బంధింపబడిన స్త్రీలు, స్వార్థ పూరిత మనుషులు, కుళ్ళికంపుకొడుతున్న మనుషులు, విలువలులేని టీచర్లు, పనికిరాని సిలబస్సు, సంస్కారం నేర్పని చదువులు... ఇలాంటి అనేక సామాజి కాంశాల్ని ఆయన ఈ నాటికలో చర్చించారు.

ఈ నాటిక అంకితం కూడా చిత్రమే చూడండి.

"నిజంగానే
మనమంతా
ప్రజాస్వామ్యయుతంగా
జీవస్తున్నామని
భ్రమపడుతున్న
గొఱ్ఱెల్లాంటి
భారతీయ
సోదర సోదరీ మణులకు"

♦♦♦♦♦

అంతా
అసంబద్ధమని తెలిసీ
నిర్లిప్తంగా ఉండే
జ్ఞానులకు -
నాటకాలాడుతూ
పబ్బం గడుపుకొనే
మేధావులకు -
????????

రచయిత ఈ నాటిక చివర్లో పైన రాసిన వాక్యాలు అక్షరసత్యాలు. అందుకే ముందు పేజీల్లో ఉండాల్సిన అంకితాన్ని చివర్లో ఇచ్చారు.

అవును నిజంగానే ఈ కోతి ఈ డ్రామాకు పనికొచ్చిందేమో. మా గురువు గారెప్పుడూ విద్యార్థులమైన మాతో ఒక మాట అంటుంటారు. "మీ రెవ్వరూ నా దగ్గర నటించద్దు. నేను మీ అందరికన్న గొప్ప నటుణ్ణి" అని. ఈ నాటిక చదివిన తర్వాత ఆ మాటలు నిజమేనేమో అనిపించాయి. ఎందుకంటే మనమంతా ఏదో ఒక 'రంగ'స్థలంపై నటులమే కదా !

డామిట్ కథ ముగిసింది. ★

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VISCOMETRIC STUDY ON BINARY LIQUID MIXTURES OF PROPIOPHENONE WITH ANILINE AND N-ALKYL SUBSTITUTED ANILINES, AT 303.15 TO 318.15 K

Nanduri Gayatri Devi[1,✉], N.V.N.B. Srinivasa Rao[2], D. Ramachandran[3], V. Nagalakshmi[1], and P. Sunila Rani[4]

[1]Department of Chemistry, Ch. S. D. St. Theresa's College (A) for Women, Eluru-534007, (Andhra Pradesh), India
[2]Department of Chemistry, DRG Government Degree College, Tadepallegudem, (AP) India
[3]Department of Chemistry, Acharya Nagarjuna University, Guntur, (AP) India
[4]Department of Microbiology, Ch. S. D. St. Theresa's College (A) for Women, Eluru-534007, (AP) India
✉Corresponding Author: gayatride081971@gmail.com

ABSTRACT

Densities and viscosities of binary mixtures of Propiophenone with Aniline, N-methylaniline, N, N- dimethylaniline, N, N- diethylaniline were measured over the entire composition range at T = (303.15 to 318.15) K (with 5K interval) and atmospheric pressure. Experimental data were used to calculate the deviation of viscosity Δη, excess Gibb's free energy G*E activation of viscous flow for each binary system, and these excess thermodynamic properties were fitted to the Redlich-Kister polynomial equation to obtain the fitting coefficients and standard deviations. McAllister's three-body /four-body interaction models were used for the correlation of viscosity data. The studied systems exhibit good intermolecular interactions due to hydrogen ion transfer and charge dispersion in the carbonyl group and NH2 groups of Aniline and Alkyl Substituted Anilines. Experimental results are useful in various pharmaceutical industries.

Keywords: Viscosity, Deviation in Viscosity, McAllister's Models, Viscosity Relations.

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INTRODUCTION

Viscosity properties of the binary liquid mixtures are important for fluid transport, chemical industries, pharmaceutical processes, and food products. Excess thermodynamic properties of the binary liquid mixtures of Propiophenone with Aniline, N-Methylaniline, N, N- Dimethyl aniline and N, N-Diethyl aniline were calculated based on the values of densities, ρ, and viscosities, η, over the entire composition range at T = (303.15 to 318.15) K. Propiophenone is used as an intermediate in the industrial processes.[1] Aromatic anilines and substituted alkyl anilines are also useful in making dyes. Literature survey reveals some studies on Aniline with other compounds.[2–7] Hence, no studies were made on the current binary mixtures. Measured values of density and viscosity data were used to calculate Δη, one interaction parameters of d12, G*E, Wvis/RT, H12, and T12, (Grunberg and Nissan, Gibb's free energy, Katti and Chaudhary, Hind et.al., and Tamara-Kurata respectively) for the studied binary liquid mixtures. McAllister's three and four body, Auslander and Jouyban-Acree relations for two and three adjustable interaction parameter equations were used to correlate and to understand the intermolecular interactions. Experimental viscosity data was compared with the calculated values of having no adjustable parameter relations such as Bingham, Arrhenius, Kendall and Monroe, and Kendall. The values of Δη and G*E of binary mixtures were fitted to the Redlich Kister polynomial equation to estimate the coefficients and standard deviations between the experimental and theoretical values.

EXPERIMENTAL

The purities of the selected solvents are as shown in Table-1 and they are purchased from S.D. Fine chemicals Ltd, India.

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Table -1: Provenance and Purity of the Materials Used

Chemicals	CAS number	Source	Mass Fraction Purity
Propiophenone (PPH)	93-55-0	S.D fine Chemicals, India	99.0%
Aniline (A)	62-53-3	S.D fine Chemicals, India	99.7%
N-Methylaniline (MA)	100-61-8	S.D fine Chemicals, India	99.5%
N,N-Diethylaniline (DMA)	91-66-7	S.D fine Chemicals, India	99.6%
N,N-Dimethylaniline (DEA)	121-69-7	S.D fine Chemicals, India	99.5%

The water content was less than 0.003 mass%. Mettler Toledo (ME204) balance was used to weigh the pure liquids and prepare the liquid mixtures, precision of ± 0.1 mg. The experimental and literature values of densities and viscosities of the liquids are given in Table-2, a[8], b[9], c[10], d[11], e[11], f[7], g[12], h[7], i[1], j[13], k[14], l[2], m[15], n[16], o[17], p[18], q[19], r[20].

Table -2: Comparison of Experimental Density and Viscosity of Pure Liquid with Literature Values

Compound	T(K)	Density (ρ)		ref	Viscosity(η)		ref
		Experimental	Literature		Experimental	Literature	
		gm/cm^3	gm/cm^3		mpa.s	mpa.s	
Propiophenone	303.15	1.0045	1.0044	j	1.5150	1.5100	h
	308.15	1.0015	1.0060	j	1.4690	1.4690	i
	313.15	0.9985			1.4230		
	318.15	0.9955			1.3770		
Aniline	303.15	1.0128	1.0130	a	3.191	3.746	n
			1.0128	b		3.770	n
			1.0128	e		3.190	l
			1.0129	l		3.190	q
			1.0132	r			
	308.15	1.0089	1.0087	l	2.811	2.800	l
	313.15	1.0049	1.0049	e	2.436	2.420	l
			1.0049	k			
	318.15	1.0009			2.065		
N-Methylaniline	303.15	0.9783	0.9817	c	1.963	1.965	c
			0.9782	e		1.963	d
			0.9783	m			
	308.15	0.9740	0.9742	p	1.811		
	313.15	0.9696	0.9696	e	1.658		
	318.15	0.9652			1.504		
N,N-DiMethylaniline	303.15	0.9479	0.9480	l	1.173	1.174	l
	308.15	0.9436	0.9517	f	1.078	1.090	l
			0.9518	g		1.111	l
			0.9436	l			
	313.15	0.9393	0.9394	l	0.981	0.982	l
	318.15	0.9351			0.885		
N,N-Diethylaniline	303.15	0.9260	0.9260	p	1.703	1.703	p
			0.9253	a		1.711	a
			0.9260	o		1.703	o
	308.15	0.9217	0.9213	a	1.554	1.548	a
			0.9219	o		1.550	o
	313.15	0.9176	0.9177	p	1.406	1.402	p
			0.9175	o			
	318.15	0.9134			1.263		

Apparatus and Procedures

Anton Paar (DSA 5000 M) oscillating u-tube densimeter, automatically thermostatic within ±0.01K, was used to measure the densities of the pure components and the binary mixtures over the whole composition range *T*= (303.15 to 318.15) K. Averages of five measurements were taken at temperatures from 303.15 to 318.15K with an increment of 5K under atmospheric pressure. The standard uncertainties were found to be ±0.001 $kg.m^{-3}$ and ±0.005 mPa.s for the measurements of density and viscosity respectively. The Ubbelohde viscometer was used to measure the Viscosity as per the method described earlier.[21]

The measured values of densities[22], viscosities, and calculated values of deviation in viscosity and Gibbs free energy values with respective mole fractions of the studied binary mixtures at *T*=303.15 to 318.15K are tabulated in Table-3 and Table-4.

RESULTS AND DISCUSSION

Negative values of deviation in viscosity (Δη) were observed and they were decreasing with the increase in temperature for all the studied binary mixtures. The difference in size and shape of the component molecules and the loss of dipolar association in pure components was the reason and it is in line with Fort and Moore (1966) and Pikkarainen (1983). The deviation in viscosity values are maximum at the mole fractions 0.5069, 0.4826, 0.4880 and 0.5447 are -0.0309, -0.0340, -0.0368 and -0.0416 for PPH+Aniline, PPH+MA, PPH+DMA and PPH+DEA at 303.15K, 313.15K and it is shown in the Figures-1-2. The order of interactions for deviation in viscosity is PPH+A>PPH+MA>PPH+DMA>PPH+DEA.

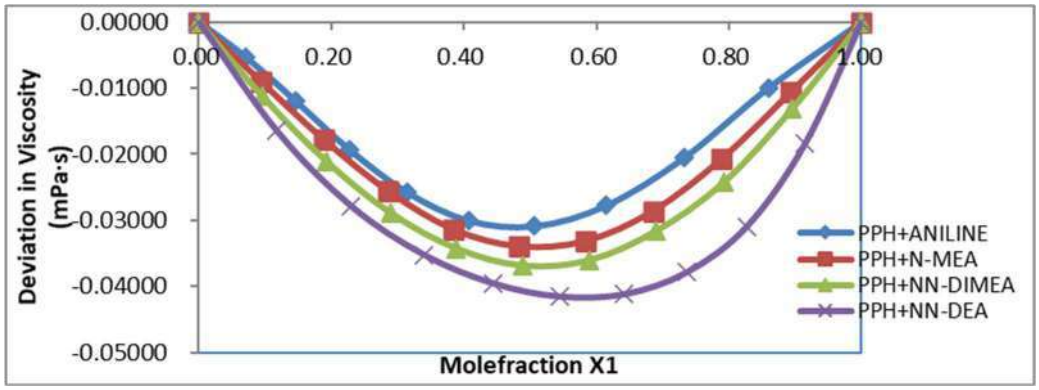

Fig.-1: Deviation in Viscosity Values of the Binary Mixtures Propiophenone with Aniline, N-Methylaniline, N, N-Dimethylaniline, N, N-Diethylaniline concerning their Mole Fraction Values at *T*= 303.15 K.

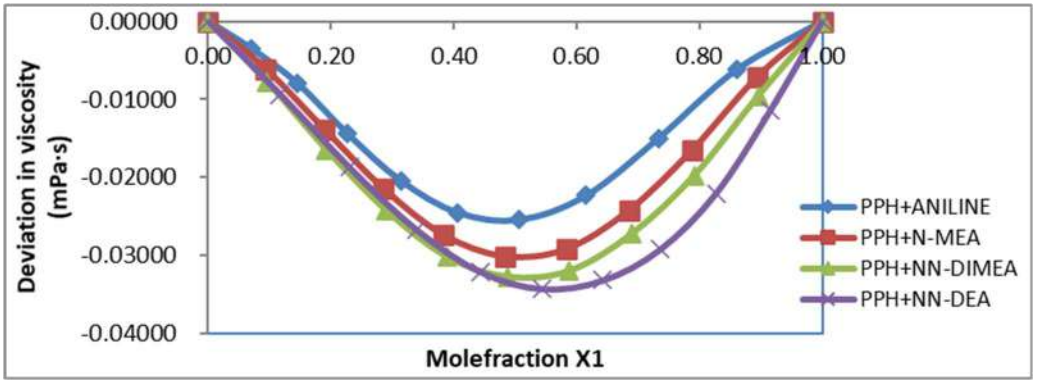

Fig.-2: Deviation in Viscosity Values of the Binary Mixtures Propiophenone with Aniline, N-Methylaniline, N, N-Dimethylaniline, N, N-Diethylaniline concerning their Mole Fraction Values at *T*= 313.15 K.

The presence of weak interactions between unlike molecules indicates a negative value of d12 and the presence of specific interactions indicates positive d12 values as per Moore et al[23] and Ramamoorthy.[24] Positive values of both deviations in viscosity, Δη, and Grunberg-Nissan parameter d12 indicates the

presence of strong specific interactions, negative Δη and positive d12 indicates weak specific interactions, negative values of both Δη and d12 indicates the absence of specific interactions as per Nigam and Mahal.[25]

Table -3 Density, Viscosity, Deviation in Viscosity and Gibbs Free Energy Values for the Binary Mixtures of Propiophenone with Aniline, N-Methylaniline, N, N-Dimethyl aniline & N, N-Diethyl aniline with respective Mole Fractions at T=(303.15- 308.15)K.

X1	303.15K				308.15K			
	ρ	η	Δη	G*E	ρ	η	Δη	G*E
	gm/cm^3	mPa·s	mPa·s	J/mol	gm/cm^3	mPa·s	mPa·s	J/mol
PPH+ANILINE								
0.0000	1.0128	3.1911	0.0000	0.0000	1.0089	2.8107	0.0000	0.0000
0.0708	1.0122	3.0067	-0.0053	0.4474	1.0083	2.6447	-0.0041	0.3695
0.1463	1.0115	2.8279	-0.0120	0.8470	1.0078	2.4844	-0.0095	0.6934
0.2270	1.0109	2.6517	-0.0193	1.1885	1.0072	2.3286	-0.0158	0.9623
0.3136	1.0101	2.4794	-0.0257	1.4669	1.0065	2.1832	-0.0212	1.1772
0.4066	1.0093	2.3112	-0.0300	1.6688	1.0059	2.0447	-0.0252	1.3237
0.5069	1.0085	2.1458	-0.0309	1.7765	1.0051	1.9131	-0.0259	1.3969
0.6152	1.0076	1.9831	-0.0277	1.7533	1.0043	1.7889	-0.0232	1.3682
0.7327	1.0066	1.8259	-0.0205	1.5388	1.0034	1.6743	-0.0164	1.2009
0.8605	1.0056	1.6709	-0.0099	1.0284	1.0025	1.5684	-0.0072	0.8049
1.0000	1.0045	1.5150	0.0000	0.0000	1.0015	1.4690	0.0000	0.0000
PPH+N-METHYL ANILINE								
0.0000	0.9783	1.9630	0.0000	0.0000	0.9740	1.8105	0.0000	0.0000
0.0939	0.9816	1.9036	-0.0091	-0.0157	0.9775	1.7530	-0.0072	-0.0251
0.1891	0.9848	1.8467	-0.0179	-0.0552	0.9809	1.7035	-0.0160	-0.0923
0.2856	0.9878	1.7930	-0.0256	-0.1061	0.9840	1.6604	-0.0236	-0.1619
0.3834	0.9907	1.7429	-0.0314	-0.1559	0.9870	1.6213	-0.0294	-0.2257
0.4826	0.9933	1.6967	-0.0340	-0.1857	0.9898	1.5864	-0.0320	-0.2616
0.5831	0.9958	1.6551	-0.0332	-0.1916	0.9924	1.5550	-0.0312	-0.2643
0.6852	0.9981	1.6175	-0.0286	-0.1646	0.9949	1.5274	-0.0265	-0.2216
0.7886	1.0003	1.5833	-0.0207	-0.1104	0.9972	1.5031	-0.0186	-0.1448
0.8935	1.0024	1.5501	-0.0106	-0.0455	0.9994	1.4844	-0.0089	-0.0572
1.0000	1.0045	1.5150	0.0000	0.0000	1.0015	1.4690	0.0000	0.0000
PPH+N, N-DIMETHYLANILINE								
0.0000	0.9479	1.1730	0.0000	0.0000	0.9436	1.0778	0.0000	0.0000
0.0958	0.9538	1.1985	-0.0112	-0.1640	0.9498	1.1068	-0.0089	-0.0966
0.1925	0.9599	1.2243	-0.0211	-0.3095	0.9560	1.1370	-0.0183	-0.2203
0.2900	0.9659	1.2511	-0.0289	-0.4217	0.9621	1.1688	-0.0261	-0.3217
0.3886	0.9717	1.2802	-0.0342	-0.4912	0.9681	1.2030	-0.0317	-0.3918
0.4880	0.9774	1.3124	-0.0368	-0.5176	0.9739	1.2402	-0.0343	-0.4159
0.5885	0.9830	1.3475	-0.0360	-0.4920	0.9796	1.2803	-0.0335	-0.3917
0.6899	0.9884	1.3863	-0.0316	-0.4146	0.9851	1.3233	-0.0291	-0.3210
0.7922	0.9937	1.4278	-0.0242	-0.3042	0.9906	1.3692	-0.0214	-0.2164
0.8956	0.9990	1.4713	-0.0131	-0.1529	0.9960	1.4180	-0.0109	-0.0951
1.0000	1.0045	1.5150	0.0000	0.0000	1.0015	1.4690	0.0000	0.0000
PPH+N,N-DIETHYLANILINE								
0.0000	0.9260	1.7030	0.0000	0.0000	0.9217	1.5544	0.0000	0.0000
0.1173	0.9340	1.6645	-0.0165	-0.1907	0.9300	1.5315	-0.0129	-0.1685
0.2302	0.9421	1.6318	-0.0279	-0.3321	0.9382	1.5114	-0.0234	-0.3152
0.3389	0.9502	1.6041	-0.0352	-0.4284	0.9464	1.4946	-0.0308	-0.4257
0.4437	0.9582	1.5800	-0.0396	-0.4932	0.9545	1.4807	-0.0358	-0.5040
0.5447	0.9661	1.5590	-0.0416	-0.5317	0.9626	1.4699	-0.0380	-0.5435
0.6422	0.9739	1.5411	-0.0412	-0.5406	0.9705	1.4624	-0.0372	-0.5402
0.7363	0.9816	1.5267	-0.0379	-0.5092	0.9783	1.4580	-0.0335	-0.4927
0.8272	0.9892	1.5166	-0.0309	-0.4252	0.9861	1.4574	-0.0264	-0.3904
0.9150	0.9968	1.5126	-0.0183	-0.2560	0.9938	1.4614	-0.0148	-0.2203

X1	303.15K				308.15K			
	ρ	η	Δη	G*E	ρ	η	Δη	G*E
	gm/cm^3	mPa·s	mPa·s	J/mol	gm/cm^3	mPa·s	mPa·s	J/mol
1.0000	1.0045	1.5150	0.0000	0.0000	1.0015	1.4690	0.0000	0.0000

Table -4 Density, Viscosity, Deviation in Viscosity and Gibbs Free Energy Values for the Binary Mixtures of Propiophenone with Aniline, N-Methylaniline, N, N-Dimethyl aniline & N, N-Diethyl aniline with respective Mole Fractions at T=(313.15- 318.15)K.

X1	313.15K				318.15K			
	ρ	η	Δη	G*E	ρ	η	Δη	G*E
	gm/cm^3	mPa·s	mPa·s	J/mol	gm/cm^3	mPa·s	mPa·s	J/mol
PPH+ANILINE								
0.0000	1.0049	2.4360	0.0000	0.0000	1.0009	2.0650	0.0000	0.0000
0.0708	1.0044	2.2874	-0.0035	0.2848	1.0005	1.9323	-0.0027	0.2034
0.1463	1.0040	2.1460	-0.0080	0.5292	1.0001	1.8071	-0.0072	0.3592
0.2270	1.0035	2.0118	-0.0144	0.7120	0.9997	1.6958	-0.0136	0.4566
0.3136	1.0029	1.8920	-0.0204	0.8449	0.9992	1.6011	-0.0196	0.5155
0.4066	1.0023	1.7806	-0.0245	0.9306	0.9987	1.5208	-0.0237	0.5455
0.5069	1.0016	1.6833	-0.0254	0.9676	0.9982	1.4540	-0.0246	0.5539
0.6152	1.0009	1.5968	-0.0223	0.9456	0.9976	1.4060	-0.0215	0.5414
0.7327	1.0002	1.5251	-0.0150	0.8404	0.9970	1.3756	-0.0142	0.4968
0.8605	0.9994	1.4689	-0.0062	0.5711	0.9963	1.3690	-0.0054	0.3565
1.0000	0.9985	1.4230	0.0000	0.0000	0.9955	1.3770	0.0000	0.0000
PPH+N-METHYL ANILINE								
0.0000	0.9696	1.6577	0.0000	0.0000	0.9652	1.5040	0.0000	0.0000
0.0939	0.9733	1.6049	-0.0061	-0.0386	0.9691	1.4573	-0.0047	-0.0429
0.1891	0.9768	1.5639	-0.0138	-0.1165	0.9727	1.4254	-0.0123	-0.1413
0.2856	0.9801	1.5304	-0.0215	-0.2070	0.9762	1.4026	-0.0197	-0.2471
0.3834	0.9832	1.5027	-0.0274	-0.2869	0.9794	1.3862	-0.0259	-0.3431
0.4826	0.9862	1.4788	-0.0301	-0.3300	0.9825	1.3727	-0.0286	-0.3894
0.5831	0.9889	1.4575	-0.0292	-0.3264	0.9855	1.3629	-0.0276	-0.3796
0.6852	0.9915	1.4401	-0.0242	-0.2671	0.9882	1.3557	-0.0226	-0.3073
0.7886	0.9940	1.4272	-0.0165	-0.1715	0.9908	1.3526	-0.0149	-0.1942
0.8935	0.9963	1.4210	-0.0072	-0.0614	0.9933	1.3591	-0.0060	-0.0670
1.0000	0.9985	1.4230	0.0000	0.0000	0.9955	1.3770	0.0000	0.0000
PPH+N, N-DIMETHYLANILINE								
0.0000	0.9393	0.9807	0.0000	0.0000	0.9351	0.8850	0.0000	0.0000
0.0958	0.9459	1.0134	-0.0077	-0.0388	0.9419	0.9209	-0.0062	0.0509
0.1925	0.9522	1.0481	-0.0165	-0.1248	0.9485	0.9600	-0.0146	0.0074
0.2900	0.9584	1.0849	-0.0243	-0.2106	0.9548	1.0019	-0.0223	-0.0569
0.3886	0.9645	1.1243	-0.0302	-0.2787	0.9609	1.0463	-0.0284	-0.1152
0.4880	0.9704	1.1666	-0.0328	-0.2990	0.9670	1.0937	-0.0312	-0.1363
0.5885	0.9763	1.2117	-0.0320	-0.2784	0.9730	1.1438	-0.0303	-0.1218
0.6899	0.9820	1.2598	-0.0273	-0.2120	0.9788	1.1968	-0.0257	-0.0736
0.7922	0.9876	1.3107	-0.0197	-0.1300	0.9846	1.2525	-0.0179	-0.0143
0.8956	0.9931	1.3654	-0.0096	-0.0392	0.9902	1.3124	-0.0083	0.0296
1.0000	0.9985	1.4230	0.0000	0.0000	0.9955	1.3770	0.0000	0.0000
PPH+N,N-DIETHYLANILINE								
0.0000	0.9176	1.4064	0.0000	0.0000	0.9134	1.2626	0.0000	0.0000
0.1173	0.9260	1.3990	-0.0094	-0.1316	0.9220	1.2686	-0.0074	-0.1010
0.2302	0.9344	1.3915	-0.0187	-0.2745	0.9305	1.2722	-0.0167	-0.2517
0.3389	0.9427	1.3853	-0.0267	-0.4017	0.9389	1.2767	-0.0247	-0.3834
0.4437	0.9509	1.3816	-0.0321	-0.4915	0.9473	1.2832	-0.0301	-0.4748
0.5447	0.9591	1.3812	-0.0343	-0.5294	0.9555	1.2926	-0.0323	-0.5108
0.6422	0.9671	1.3839	-0.0332	-0.5148	0.9637	1.3049	-0.0312	-0.4925
0.7363	0.9751	1.3894	-0.0292	-0.4537	0.9718	1.3196	-0.0272	-0.4277
0.8272	0.9830	1.3981	-0.0220	-0.3415	0.9798	1.3372	-0.0200	-0.3115

X1	313.15K				318.15K			
	ρ	η	Δη	G*E	ρ	η	Δη	G*E
	gm/cm^3	mPa·s	mPa·s	J/mol	gm/cm^3	mPa·s	mPa·s	J/mol
0.9150	0.9908	1.4101	-0.0115	-0.1756	0.9877	1.3578	-0.0095	-0.1413
1.0000	0.9985	1.4230	0.0000	0.0000	0.9955	1.3770	0.0000	0.0000

Computed values of parameters (d12, Wvis/RT, H12, T12) are given in Table-5 at temperatures 303.15 K and 313.15 K for the binary mixtures of Propiophenone with Aniline, N-Methylaniline, N, N-Dimethylaniline and N, N-Diethylaniline.

Table-5: Grunberg - Nissan d12, Katti-chaudhari Wvis/RT, Hind et.al H12, and Tamara-Kurata T12 Constants for the Binary Mixtures of Propiophenone with Aniline, N-Methylaniline, N,N-Dimethylaniline and N,N-Diethylaniline computed by using Viscosity Data over the entire Composition Range at T=303.15K and 313.15K.

X1	d_{12}	W_{vis}/RT	H_{12}	T_{12}	d_{12}	W_{vis}/RT	H_{12}	T_{12}
	303.15K				313.15K			
PPH+ANILINE								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0708	0.1993	0.2734	2.3125	2.4964	0.1018	0.1740	1.9029	2.0211
0.1463	0.1998	0.2725	2.3051	2.4684	0.0991	0.1703	1.8975	2.0020
0.2270	0.2010	0.2721	2.2981	2.4403	0.0931	0.1630	1.8885	1.9793
0.3136	0.2041	0.2738	2.2933	2.4141	0.0891	0.1577	1.8821	1.9588
0.4066	0.2098	0.2779	2.2909	2.3902	0.0878	0.1550	1.8787	1.9413
0.5069	0.2191	0.2855	2.2913	2.3696	0.0899	0.1555	1.8787	1.9275
0.6152	0.2328	0.2976	2.2945	2.3522	0.0966	0.1605	1.8824	1.9180
0.7327	0.2525	0.3157	2.3008	2.3385	0.1103	0.1724	1.8912	1.9143
0.8605	0.2827	0.3442	2.3119	2.3305	0.1309	0.1911	1.9037	1.9150
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PPH+N-METHYL ANILINE								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0939	-0.0243	-0.0074	1.6858	1.7163	-0.0327	-0.0182	1.5045	1.5232
0.1891	-0.0306	-0.0145	1.6807	1.7066	-0.0449	-0.0305	1.4952	1.5112
0.2856	-0.0366	-0.0209	1.6763	1.6977	-0.0552	-0.0408	1.4877	1.5008
0.3834	-0.0420	-0.0265	1.6726	1.6898	-0.0631	-0.0488	1.4824	1.4926
0.4826	-0.0453	-0.0299	1.6710	1.6842	-0.0673	-0.0531	1.4800	1.4876
0.5831	-0.0470	-0.0317	1.6708	1.6805	-0.0680	-0.0540	1.4803	1.4856
0.6852	-0.0462	-0.0307	1.6727	1.6793	-0.0638	-0.0497	1.4842	1.4876
0.7886	-0.0425	-0.0266	1.6768	1.6808	-0.0555	-0.0413	1.4909	1.4930
0.8935	-0.0354	-0.0192	1.6835	1.6853	-0.0400	-0.0259	1.5027	1.5036
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PPH+N, N-DIMETHYLANILINE								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0958	-0.0731	-0.0761	1.2791	1.2770	-0.0111	-0.0180	1.1572	1.1539
0.1925	-0.0759	-0.0800	1.2762	1.2741	-0.0255	-0.0323	1.1489	1.1459
0.2900	-0.0779	-0.0823	1.2737	1.2716	-0.0348	-0.0411	1.1430	1.1401
0.3886	-0.0786	-0.0831	1.2719	1.2699	-0.0409	-0.0471	1.1383	1.1357
0.4880	-0.0788	-0.0832	1.2703	1.2684	-0.0422	-0.0481	1.1362	1.1339
0.5885	-0.0775	-0.0816	1.2696	1.2679	-0.0405	-0.0462	1.1358	1.1337
0.6899	-0.0744	-0.0779	1.2702	1.2688	-0.0343	-0.0398	1.1382	1.1365
0.7922	-0.0717	-0.0742	1.2704	1.2694	-0.0264	-0.0317	1.1419	1.1408
0.8956	-0.0644	-0.0657	1.2740	1.2735	-0.0118	-0.0168	1.1507	1.1501
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PPH+N,N DIETHYLANILINE								
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1173	-0.0884	-0.0740	1.5295	1.5219	-0.0643	-0.0511	1.3695	1.3722
0.2302	-0.0891	-0.0753	1.5302	1.5243	-0.0753	-0.0622	1.3619	1.3642
0.3389	-0.0902	-0.0768	1.5304	1.5259	-0.0850	-0.0720	1.3552	1.3573
0.4437	-0.0934	-0.0803	1.5288	1.5255	-0.0930	-0.0800	1.3497	1.3517

X1	d_{12}	W_{vis}/RT	H_{12}	T_{12}	d_{12}	W_{vis}/RT	H_{12}	T_{12}
	303.15K				313.15K			
0.5447	-0.0993	-0.0861	1.5252	1.5228	-0.0988	-0.0858	1.3456	1.3476
0.6422	-0.1080	-0.0945	1.5193	1.5179	-0.1031	-0.0900	1.3425	1.3443
0.7363	-0.1193	-0.1054	1.5114	1.5107	-0.1071	-0.0939	1.3395	1.3411
0.8272	-0.1341	-0.1195	1.5009	1.5007	-0.1093	-0.0960	1.3376	1.3388
0.9150	-0.1479	-0.1323	1.4911	1.4912	-0.1042	-0.0907	1.3409	1.3415
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table-6: The Standard Deviation Percentages (%) for the Binary Systems at *T*=303.15K to 318.15K calculated from the Kendall-Monroe, Bingham, Arrhenius-Eyring's, Kendall Equations.

T/K	Kendall-Munroe	Bingham	Arrhenius	Kendall	Kendall-Munroe	Bingham	Arrhenius	Kendall
	σ (%)	σ (%)	σ (%)	σ (%)	σ (%)	σ (%)	σ (%)	σ (%)
		PPH+ANILINE				PPH+N-MEA		
303.15k	2.22	0.85	8.15	3.74	0.94	1.33	0.17	0.74
308.15K	1.59	0.77	6.65	2.75	1.05	1.31	0.27	0.92
313.15K	0.83	0.82	4.92	1.64	1.14	1.28	0.60	1.07
318.15K	0.17	0.88	3.06	0.56	1.23	1.27	0.94	1.21
		PPH+NN-DMA				PPH+NN-DEA		
303.15k	1.54	1.92	1.57	1.34	1.85	1.93	2.24	1.81
308.15K	1.29	1.85	1.26	1.01	1.79	1.81	2.00	1.78
313.15K	1.04	1.85	0.92	0.64	1.67	1.67	1.67	1.67
318.15K	0.71	1.84	0.47	0.22	1.61	1.66	1.33	1.59

Under the current study, the binary mixture of PPH+Aniline shows positive values of d12 and fewer negative values of Δη, it indicates weak specific interactions whereas the other three binary mixtures are having negative values of both Δη and d12 which indicates the absence of specific interactions. Hence, The PPH+Aniline have weak specific interactions, while the other three have no specific interactions, therefore the structural effect is dominant. Under the current study, positive values of G*E for the binary mixture PPH+Aniline indicate dipole-dipole interactions between the component molecules. The negative values of G*E for the remaining three binary mixtures show the dispersion forces and it is supported by Reed and Taylor.[26] The negative values of the single adjustable parameter of Katti-Chaudhary (Wvis/RT) suggest weak interactions and positive values for strong interactions. The values Wvis/RT of binary liquid mixture PPH+Aniline are less positive for the entire range of composition, whereas values of Wvis/RT for the other three binary liquid mixtures PPH+MA, DMA and DEA are negative.

The single interaction parameter values of Tamara-Kurata, T12, and Hind et.al, H12, don't change considerably from each other. This is in agreement with the Fort and Moore[23]. Positive values are observed for all the four binary liquid mixtures over the entire composition range and the values are decreasing with an increase in temperatures from 303.15 to 318.15K. Hence, it shows weak specific interactions.

Average standard deviation percentage (σ%) values were calculated and tabulated in Table-5. Amongst all, mixed results were observed. Standard deviation percentage values of Bingham viscosity relation in PPH+A binary mixture, Arrhenius-Eyring's values in PPH+N-MEA binary mixture and Kendall values in PPH+NN-DMA and PPH+NN-DEA binary mixtures are in good agreement with the experimental data, as their σ% values are nearest to zero. McAllister's three/four body equations, Auslander and Jouyban–Acree relations were used to correlate the viscosity data. Two and three adjustable parameters and the standard deviations were calculated with the method of least squares. Interaction coefficients from these relations and standard deviation values are tabulated in Table-7 and Table-8.

Comparatively, obtained standard deviation values are much better with McAllister's four-body model and Jouban-Acree relations and are having a good agreement with the experimental data with the three adjustable interaction parameters. These parameters are very much useful for the chemical and industrial process and design of equipment. With this study, an increase in adjustable parameters reduces the standard deviation and enhances the correlating ability for the binary liquid mixtures.

Table-7:Calculated Values of Interaction parameters of McAllister three body and Four Body Equations for the Binary Mixtures of Propiophenone with Aniline, N-Methylaniline, N, N-Dimethylaniline and N, N-Diethylaniline.

Binary Mixture	T/K	McAllister Three Body			McAllister Four Body			
		a	b	σ	A	B	C	σ
PPH+ANILINE	303.15	2.1503	2.6499	0.0019	1.9815	2.3434	2.8042	0.0002
	308.15	1.962	2.3726	0.0023	1.8386	2.1237	2.5022	0.0002
	313.15	1.7823	2.0974	0.0025	1.699	1.8978	2.205	0.0002
	318.15	1.6107	1.8267	0.0024	1.5627	1.6775	1.9094	0.0001
PPH+N-MEA	303.15	1.6273	1.7869	0.0009	1.6065	1.6877	1.8381	0.0001
	308.15	1.5547	1.6631	0.0018	1.5387	1.5836	1.7161	0.0001
	313.15	1.4671	1.5527	0.0018	1.471	1.4803	1.5938	0.0002
	318.15	1.3867	1.4353	0.0022	1.4021	1.3775	1.47	0.0001
PPH+NN-DMA	303.15	1.3589	1.2442	0.0005	1.4007	1.2928	1.2297	0.0001
	308.15	1.3017	1.1721	0.0012	1.3514	1.2192	1.1559	0.0001
	313.15	1.2432	1.0975	0.0017	1.2989	1.1471	1.0777	0.0001
	318.15	1.1848	1.0254	0.0023	1.2471	1.0756	1.0016	0.0002
PPH+NN-DEA	303.15	1.5209	1.6135	0.0054	1.498	1.574	1.6146	0.0002
	308.15	1.4422	1.4986	0.0034	1.4397	1.4674	1.504	0.0001
	313.15	1.3643	1.3849	0.0014	1.3815	1.3624	1.3937	0.0002
	318.15	1.2906	1.2753	0.0017	1.3185	1.2641	1.2804	0.0003

Table-8**:** Calculated Values of Interaction Parameters of Auslander and Jouyban-Acree equations for the Binary Mixtures of Propiophenone with Aniline, N-Methylaniline, N, N-Dimethylaniline and N, N-Diethylaniline.

Binary Mixture	T/K	Auslander Equation				Jouyban-Acree Equation			
		B12	A21	B21	σ	Ao	A1	A2	σ
PPH+ANILINE	303.15	1.0157	0.9482	0.9854	0.0026	66.1868	16.8143	0.7687	0.0002
	308.15	1.0175	0.9471	0.9853	0.0027	48.6729	11.5753	1.0882	0.0002
	313.15	1.022	0.9356	0.9778	0.0033	28.1379	6.6402	2.2588	0.0002
	318.15	0.0707	0.0696	12.5029	0.0031	7.5925	3.0158	5.8035	0.0001
PPH+N-MEA	303.15	0.3648	0.299	2.3848	0.0011	-13.8701	-2.7334	-2.7884	0.0001
	308.15	0.1779	0.1543	4.2745	0.0013	-17.7313	-2.4692	-4.581	0.0001
	313.15	0.102	0.101	5.5888	0.0016	-21.2056	-2.0448	-7.5051	0.0002
	318.15	0.135	0.14	2.1938	0.0016	-24.3984	-1.6514	-11.6921	0.0001
PPH+NN-DMA	303.15	0.8609	1.4279	1.0046	0.0006	-23.7882	-0.0562	-73.3776	0.0004
	308.15	4.8666	7.0244	0.1798	0.0011	-19.0828	-0.1516	-66.5628	0.0003
	313.15	1.1144	1.5136	0.8517	0.0021	-13.2524	-0.1754	-83.4016	0.0002
	318.15	1.1806	1.5136	0.8237	0.0027	-4.9297	0.0324	627.197	0.0004
PPH+NN-DEA	303.15	6.0009	3.2874	-0.1735	0.0005	-29.2444	-10.0341	1.0303	0.0002
	308.15	4.2828	1.7901	-0.8049	0.0002	-30.3602	-9.5487	0.2949	0.0001
	313.15	-8.0608	1.9897	4.8771	0.0003	-30.2132	-9.1968	-0.6052	0.0002
	318.15	3.5332	13.5872	0.1175	0.0011	-29.9469	-8.9747	-1.2021	0.0003

The values of deviations in viscosity (Δη) and excess Gibbs Energy (G*E) concerning the mole fraction at temperatures from 303.15K to 318.15 K were fitted to the Redlich–Kister Equation[27]of the type are tabulated in Table-9.

Table -9: Coefficients of Redlich-Kister Polynomial Equation and Standard **D**eviation of **B**inary **S**ystems.

Property	Temp (K)	A0	A1	A2	A3	A4	σ	A0	A1	A2	A3	A4	σ
		PPH+ANILINE						PPH+N-METHYL ANILINE					
Δη (mPa.s)	303.15	-0.1238	0.0137	0.0654	-0.0096	0.0033	0.0001	-0.1365	-0.0074	0.0460	0.0084	-0.0037	0.0000
	308.15	-0.1043	0.0117	0.0699	-0.0016	-0.0006	0.0001	-0.1286	-0.0056	0.0548	0.0046	0.0094	0.0001
	313.15	-0.1023	0.0148	0.0978	-0.0108	-0.0255	0.0002	-0.1211	-0.0063	0.0747	0.0085	-0.0004	0.0001

Property	Temp (K)	A0	A1	A2	A3	A4	σ	A0	A1	A2	A3	A4	σ
	318.15	-0.0990	0.0151	0.0978	-0.0120	-0.0119	0.0001	-0.1149	-0.0053	0.0838	0.0046	0.0042	0.0001
G^{*E} (J/mol)	303.15	7.0901	1.0985	1.0537	0.2667	0.1203	0.0009	-0.7584	-0.2921	0.6914	0.1932	-0.0328	0.0006
	308.15	5.5759	0.6412	1.0269	0.3030	0.0694	0.0009	-1.0615	-0.2614	0.8621	0.1753	0.1423	0.0016
	313.15	3.8616	0.2794	1.3568	0.1672	-0.2768	0.0018	-1.3336	-0.2521	1.2408	0.2468	-0.0224	0.0010
	318.15	2.2112	0.0123	1.4521	0.0998	-0.1562	0.0016	-1.5690	-0.2009	1.4756	0.1769	0.0376	0.0018
		PPH+NN-DIETHYLANILINE						PPH+NN-DIMETHYLANILINE					
Δη (mPa.s)	303.15	-0.1637	-0.0375	-0.0607	-0.0140	0.0160	0.0001	-0.1474	-0.0102	0.0164	0.0058	0.0042	0.0001
	308.15	-0.1490	-0.0408	-0.0232	-0.0028	0.0172	0.0001	-0.1374	-0.0107	0.0329	0.0044	0.0160	0.0000
	313.15	-0.1345	-0.0432	0.0142	0.0045	0.0162	0.0002	-0.1317	-0.0110	0.0509	0.0051	0.0071	0.0001
	318.15	-0.1263	-0.0436	0.0157	0.0062	0.0477	0.0002	-0.1251	-0.0121	0.0628	0.0046	0.0114	0.0001
G^{*E} (J/mol)	303.15	-2.0682	-0.7376	-0.9036	-0.2330	0.2601	0.0015	-2.0636	0.1271	0.4005	0.0556	0.0939	0.0020
	308.15	-2.1178	-0.7576	-0.3429	-0.0269	0.2994	0.0017	-1.6601	0.1236	0.7365	-0.0541	0.2863	0.0012
	313.15	-2.0691	-0.7584	0.3070	0.0936	0.2748	0.0032	-1.1975	0.0997	1.0999	-0.1101	0.1270	0.0023
	318.15	-1.9984	-0.7323	0.4176	0.0925	0.7941	0.0046	-0.5470	0.0206	1.3803	-0.2472	0.2620	0.0013

CONCLUSION

Densities and viscosities values were measured for the studied binary liquid mixtures at temperatures, T = (303.15 to 318.15) K. The G*E, Wvis/RT, H12, and d12 values were positive for Propiopheone + Aniline mixtures over the experimental temperature range, while they were negative for Propiophenone+N-Methylaniline, Propiophenone+N, N-Dimethylaniline and Propiophenone+N, N-Diethylaniline. The positive G*E, Wvis/RT, H12, and d12 values were attributed to the formation of the new complex, whereas negative values were due to the consequence of dominating effect. The calculated values of Δη and G*E were correlated with the Redlich-Kister polynomial equation to compute the coefficients and standard deviations. Viscosity data compared with several viscosity relations like Kendall-Monroe, Bingham, Arrhenius, Kendall and calculated the two / three adjustable interaction parameters and respective standard deviations by correlating with the McAllister three/four body models, Jouban-Acree and Auslander equations. The obtained results are useful in various industrial and chemical processes.

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Assay of Tiagabine.Hcl (Tia) Using Chromogenic Reagents by Spectrophotometric Methods

[1] V.Nagalakshmi, [2]G.Srinivasa Rao, [3]K.Subhashini, [4]N.Madhavi, [5]NVNB SrinivasaRao, [6]A.Nirmala Jyotsna [7]N.Gayatri D Devi

[1,2,3,4,7]Department of chemistry, Ch.S.D. St. Theresa's college for women, Eluru-534003,
[6]Department of physics, Ch.S.D.St. Theresa's college for women, Eluru-534003
[5]S.Ch.V.P.M.R Government Degree College, Ganapavaram
Address:Associate Professor in Chemistry, Ch.S.D. St. Theresa's college for women(A), Eluru-534003

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ABSTRACT
Simple, accurate and reproducible UV-Visible spectrophotometric methods were established for the assay of TIA based on the redox reaction and internal salt formation. Redox reaction of the TIA with NBS/CB.reagent is proposed in method A. Method B includes internal salt formation of the TIA with Citric acid/ Acetic anhyddride reagent .The optical characteristics such as Beers law limits, molar absorptivity and Sandell's sensitivity for the methods (A-B) are given. Regression analysis using the method of least squares was made to evaluate the slope(b), intercept(a) and correlation coefficient (r) and standard error of estimation (Se) for each system. Determination of TIA in bulk form and in pharmaceutical formulations were also incorporated

KEY WORDS : Redox, Tiagabin, Complex formation , Anticonvulsant

I. INTRODUCTION:

Tiagabine.HCl (TIA) [1-3], is an anticonvulsant drug used to help control some types of seizures in the treatment of epilepsy. This medicine cannot cure epilepsy and will only work to control seizures for as long as you continue this drug. Its official status has been presented in Table 1.The characteristics, therapeutic importance, chemical names, structure, analytically useful functional groups and commercially available formulations of TIA are presented in (Tables 1& 2).

A very few physico-chemical methods appeared in the literature for the determination of TIA in pharmaceutical formulations LC-MS[4,5]and HPLC[6,7]. As the analytically important functional groups of TIA were not fully exploited, there is a scope to develop sensitive and flexible suitable spectrophotometric and HPLC methods. Based on the above feature the author had attempted to develop new UV-Visible Spectrophotometric and HPLC methods for its determination in bulk and pharmaceutical formulations.

The methods developed by the author are based on the different chemical reactions (reactivity of functional groups) of TIA with various dyes and chromgenic reagents that produced colored species with reasonable stability paving the possibility for visible spectrophotometric determination of TIA in its bulk form and in pharmaceutical formulations. A reported spectroscopic method was chosen as reference method for compa ring the accuracy of the results obtained by the proposed methods.

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TABLE 1:STURCTURAL FEATURES OF TIAGABINE HCL

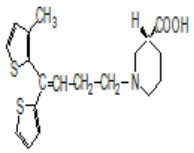
SI. No	Generic Name	Category	Chemical Name	Structure	Analytical important moieties/functional groups
1	Tiagabine Hcl	Anti convulsant	Piperdine carboxylic,1-[4,4-bis(3-methyl-2-thienyl)-3-butenyl]-,3(R)		Aliphatic Carboxylic, Tertiary nitrogen and Sulphur groups.

TABLE – 2:PHYSICO CHEMICAL CHARACTERISTIC AND THERAPEUTIC IMPORTANCE OF TIAGABINE HCL

Category	Characteristics	Mode of action and therapeutic use
Anticonvulsant	Molecular formula: Formula Weight : 412.0 g/moles Appearance: White, odorless, crystalline powder. Solubility: Practically insoluble in heptane; sparingly soluble in water, and soluble in aqueous base.	It is used to help control some types of seizures in the treatment of epilepsy. This medicine cannot cure epilepsy and will only work to control seizures for as long as you continue to take it.

II. EXPERIMENTAL

2.1 Instruments used:

An Elico, UV – Visible digital spectrophotometer with 1cm matched quartz cells were used for the spectral and absorbance measurements. An Elico LI-120 digital pH meter was used for pH measurements.

2.2 Preparation of standard drug solutions:

An 1mg/mL of TIA was prepared by dissolving 100mg of it in 100mL with distilled water. This solution was further diluted step wise with distilled water to obtain working standard solution of corresponding concentrations 200 μgmL^{-1} [M_1, M_2,]

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2.3 Proposed procedures:

After systematic and detailed study of the various parameters involved, the following procedures [Methods (M_1) NBS/CB; Citric Acid-acetic anhydride reagent(M_2);] were recommended for the assay of TIA in bulk samples and pharmaceutical formulations.

2.4.1 **For Bulk samples**

2.4.1.1 Method – M_1

Aliquots of standard TIA solution (0.5-3.0mL, 200μg.mL^{-1}) were transferred into a series of 25mL calibrated tubes. Then 1.25mL (5.0M) of HCI and 2.5mL (5.618x10^{-4} M) of NBS were added. The volume was brought to15mL with distilled water. After 10min, 10mL (5.50 x 10^{-4}M) of CB solution was added and mixed thoroughly. The absorbance was measured after 5min at 540nm against distilled water. The blank (omitting drug) and dye (omitting drug and oxidant) solutions were prepared in a similar manner and their absorbance's were measured at 540nm against distilled water. The decrease in absorbance corresponding to consumed NBS and in turn the drug concentration was obtained by subtracting the decrease in absorbance of the test solution (dye-test) from that of the blank solution (dye-blank). The amount of TIA was computed from its calibration graph (Fig. 3).

2.4.1.2 Method – M_2

Aliquots of standard TIA solution (0.5 - 3.0mL, 200μg.mL^{-1}) were taken into a series of 25mL graduated tubes and gently evaporated on a boiling water bath to dryness. To this 10.0mL (6.245x10^{-2}M) citric acid - acetic anhydride reagent was added and the flasks were immersed in a boiling water bath for 30 min. The tubes were cooled to room temperature and made up to the mark with acetic anhydride. The absorbance of the colored solutions was measured after 15min at 580nm against a reagent blank. The amount of TIA was calculated from the calibration graph (Fig. 4).

2.4.2 Pharmaceutical formulations:

An accurately weighed portion of tablet content equivalent to about 100 mg of TIA was transferred into a 100mL volumetric flask. Added about 80mL of warm isopropyl alcohol and shaken well for about 20min. The contents were diluted with isopropyl alcohol up to the mark and mixed thoroughly. The solution was filtered. The filtrate was evaporated to dryness. The residue was used for the preparation of formulation solutions for different methods as given under standard solutions preparations. These solutions were analyzed as under procedures described fro bulk solutions.

III. RESULTS AND DISCUSSIONS:

3.1 Spectral Characteristics:

In order to ascertain the optimum wavelength of maximum absorption (λ_{max}) of the colored species formed in the above methods, specified amounts of TIA were taken and colors were developed separately by following the above procedures. The absorption spectra were scanned on a spectrophotometer in the wave length region of 340 to 900nm against similar reagent blank or distilled water. The reagent blank absorption spectrum of each method was also recorded against distilled water. The results were graphically represented in Fig. 1&2,. The absorption curves of the colored species in each method show characteristics absorption maxima where as the blank in each method has low or no absorption in this region.

3.2 Optimum conditions fixation in procedures:

3.2.1 Method – M_1[NBS/CB]

The procedure involves two steps. The first step in the procedure is the reaction of TIA with an excess of NBS giving products involving oxidation, substitution or addition and the estimation of unreacted NBS using a known excess of CB (second step). The excess dye remaining was then measured with a spectrophotometer. The effect of reagent concentration (acidity, NBS and CB), waiting period in each step with respect to maximum sensitivity, minimum blank, adherence to Beer's law, reproducibility and stability of final color were studied by means of control experiments varying one parameter at a time and the optimum conditions are incorporated in (Table 3).

3.2.2 Method – M_2 [Citric acid – Ac_2O]

This method involves the formation of internal salt between TIA and aconite anhydride (dehydration product of citric acid). The optimum conditions in this method were fixed based on the study of the effects of various parameters such as strength and volume of the reagent, heating time, solvent used for final dilution and the stability of colored species. The results are incorporated in (Table 2).

3.3 Optical Characteristics:

In order to test whether the colored species formed in the above methods, adhere to Beer's law the absorbance's at appropriate wave lengths of a set of solutions containing varying amounts of TIA and specified amounts of reagents (as given in the

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recommended procedures for each method) were recorded against the corresponding reagent blanks. The Beer's law plots of these systems are recorded against the corresponding reagent blanks and are recorded graphically (Figs. 3to 4). Beer's law limits, molar absorptivity, Sandell's sensitivity and optimum photometric range for TIA in each method developed. With mentioned reagents were calculated. Least square regression analysis was carried out for getting the slope, intercept and correlation coefficient values (Table 3).

3.4 Precision:

The precision of each proposal methods was ascertained from the absorbance values obtained by actual determination of six replicates of a fixed amount of TIA in total solution. The percent relative standard deviation and percent range of error (at 0.05 and 0.01 confidence limits) were calculated for the proposed methods (Table 3).

3.5 Accuracy:

To determine the accuracy of each proposed method, different amounts of bulk samples of TIA within the Beer's law limits were taken any analyzed by the proposed method. The results (percent error) are recorded in (Table 3).

3.6. Interference studies:

The effect of wide range of execipients and other active ingredients usually present in the formulations for the assay of TIA in methods M_1, M_2 under optimum conditions were investigated. The commonly used execipients and other active ingredients usually present in formulations did not interfere even if they were present in amount than they usually exist.

TABLE 3: OPTICAL AND REGRESSION CHARACTERISTICS, PRECISION AND ACCURACY OF THE PROPOSED METHODS FOR TIA

Parameter	M_1	M_2
λ_{max} (nm)	750	470
Beer's law limits (µg/mL)	2-12	4 – 24
Detection limit (µg/mL)	0.7475	2.093
Molar absorptivity (1 $mol^{-1}.cm^{-1}$)	1.423 10^4	7.205 x 10^3
Sandell's sensitivity (µg.cm^{-2}/0.001 absorbance unit)	0.1027	1.550 x 10^{-1}
Optimum photometric range (µg/mL)	5.0-12	12-20
Regression equation (Y=a+bc) slope (b)	0.0302	0.02075
Standard deviation on slope (S_b)	1.1335 x 10^{-3}	7.901 x 10^{-4}
Intercept (a)	4.999 x 10^{-12}	5.5 x 10^{-3}
Standard deviation on intercept (S_a)	7.519 x 10^{-3}	10.48 x 10^{-3}
Standard error on estimation (S_e)	7.169 x 10^{-3}	9.994 x 10^{-3}
Correlation coefficient (r)	0.9999	0.9966
Relative standard deviation (%)	1.557	1.222
% Range of error (confidence limits)		
0.05 level	1.79	1.405
0.01 level	2.80	2.203
% error in Bulk samples **	-0.260	-0.241

* Average of six determinations considered
** Average of three determinations

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Fig. 1.: Absorption spectrum of TIA with NBS - CB (M_1)

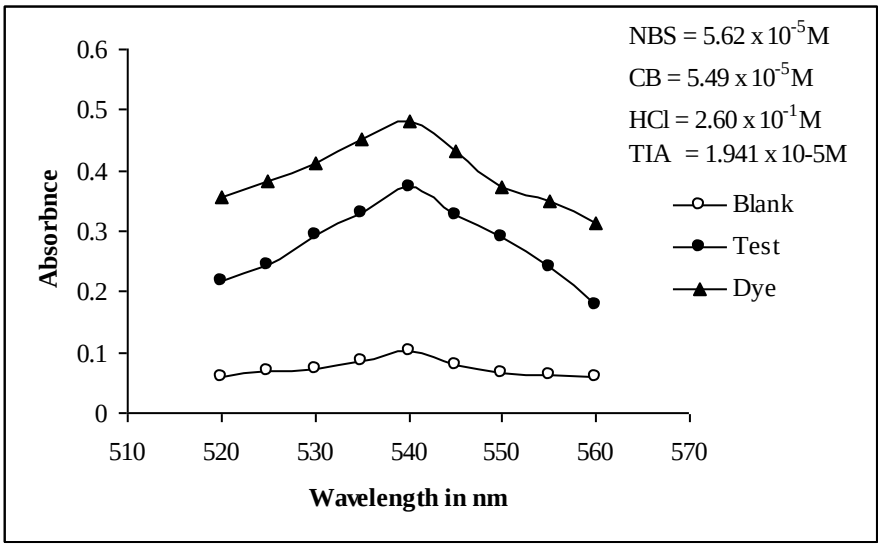

Fig. 2: Absorption spectrum of TIA with Citric acid – AC_2OH (M_2)

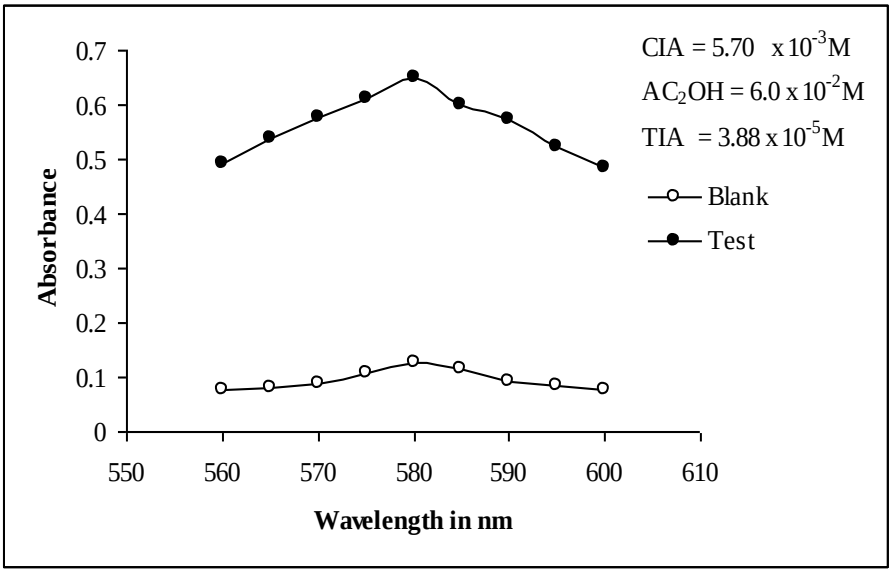

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FIG. 3: BEER'S LAW PLOT OF TIA WITH NBS-CB (M_1)

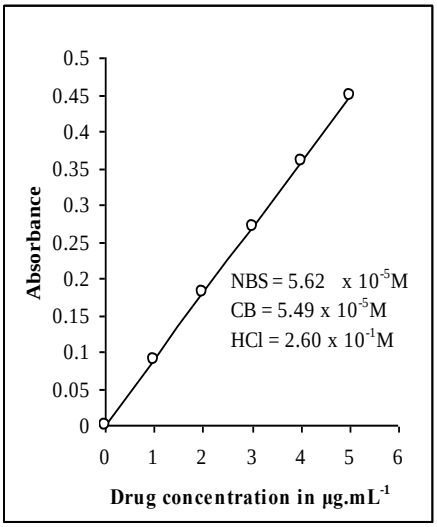
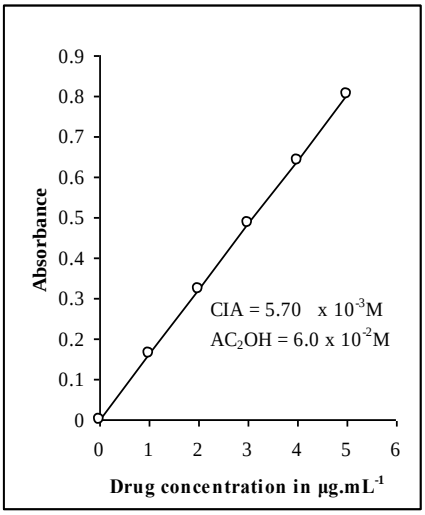


FIG. 4: BEER'S LAW PLOT OF TIA WITH Citric acid – AC_2OH (M_2)



IV. CONCLUSIONS

It can be observed from the results presented above, that the proposed methods have the good sensitivity ε_{max} and higher λ_{max}. Statistical analysis of the results sows that the proposed procedures have good precision and accuracy. Results of the analysis of pharmaceutical formulations reveal that the proposed methods are suitable for their analysis with virtually no interference of the usual additives present in pharmaceutical formulations. The order of sensitivity (ε_{max}) among the proposed methods is: $M_2 > M_1$. All the proposed methods are simple, sensitive and reliable and can be used for routine determination of TIA in bulk samples and pharmaceutical formulations depending upon the need of specific situation.

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VALIDATED SPECTROPHOTOMETRIC METHOD FOR THE ESTIMATION OF TIAGABINE HCl IN BULK AND FORMULATIONS

[1]V.Nagalakshmi,[2] G.Srinivasa Rao,[3] K.Subhashini , [4]NVNB SrinivasaRao [5] N.Gayatri D Devi

[1]Associate Professor,[2]Assistant Professor,[3]Assistant Professor,Lecturer,Associate Professor
[1]Department of chemistry, Ch.S.D.St. Theresa's college for women, Eluru-534003.

Abstract : Simple, accurate and reproducible UV-Visible spectrophotometric methods were established for the assay of Tiagabine HCl(TIA) based on ion association complex reactions. Ion association complex reaction of the TIA with SFNO and MB is proposed in method 1 and 2. The optical characteristics such as Beers law limits, molar absorptivity and Sandell's sensitivity for the methods (1-2) are given. Regression analysis using the method of least squares was made to evaluate the slope(b), intercept(a) and correlation coefficient (r) and standard error of estimation (Se) for each system. Determination of TIA in bulk form and in pharmaceutical formulations were also incorporated

Keywords - Estimation, Tiagabine, Spectrophotometric method , Validation, Chromogenic rearents.

INTRODUCTION

Tiagabine.HCl (TIA) (K.E.Andersen etal., 1993; C.L.Faingold etal., 1994; Mengel and Helle, 1994) is an anticonvulsant drug used to help control some types of seizures in the treatment of epilepsy. This medicine cannot cure epilepsy and will only work to control seizures for as long as you continue this drug. **A** very few physico-chemical methods appeared in the literature for the determination of TIA in pharmaceutical formulations LC-MS(L.E.Gustavson and S.chu, 1992)and HPLC (Chollet, D.F etal., 1999, Rustum etal., 1998). As the analytically important functional groups of TIA were not fully exploited, there is a scope to develop sensitive and flexible suitable spectrophotometric and HPLC methods. The aim of this study was to develop and validate two UV-Visible spectrophotometric methods for the determination of tiagabine in the presence of formulation The methods developed by the author are based on the different chemical reactions (reactivity of functional groups) of **TIA** with various dyes and chromgenic reagents that produced colored species with reasonable stability paving the possibility for visible spectrophotometric determination of TIA in its bulk form and in pharmaceutical formulations. A reported spectroscopic method was chosen as reference method for comparing the accuracy of the results obtained by the proposed methods.

Methods and Materials

Apparatus: An Elico, UV-Visible digital spectrophotometer (SL - 159) with 1cm matched quartz cells were used for the spectral and absorbance measurements. An Elico LI-120 digital pH meter was used for pH measurements.

Reagents and standards:The stock solution (1mg/mL) of TIA was prepared by dissolving 100mg of it in 100mL with distilled water. This solution was further diluted step wise with distilled water to obtain working standard solution of corresponding concentration 100 μgmL^{-1}[, **M_1 , M_2]**

Method 1& 2: SFNO solution :

Prepared by dissolving 200mg of safranin O in 100mL of distilled water and subsequently washed with chloroform.

MB solution : Prepared by dissolving 200mg of MB in 100mL of distilled water and subsequently washed with chloroform.

Buffer solution (pH 9.8)NH_4OH – NH_4 Cl: 7gms of NH_4Cl and 6.8mL of liquid Ammonia solutions were mixed and diluted to 100mL with distilled water and pH was adjusted to 9.8.

Analysis of Pharmaceutical formulation:

Twenty tablets were powdered and mixed thoroughly. An amount equivalent to 20 mg of Tiagabine was weighed accurately and extracted with isopropyl alcohol to eliminate any interference from excipients. It was filtered through Whatmann No. 42 filter paper and the residue was washed well with isopropyl alcohol for complete recovery of the drug. The isopropyl alcohol was evaporated to dryness and the drug was dissolved in doubly distilled water and diluted to 100 mL with doubly distilled water. It was further diluted if needed and then analyzed following the recommended procedures.

Method 1 & 2:Aliquots of standard drug solution for method M_{22a} & M_{22b} (0.5-3.0mL, 100µg.mL^{-1}) and 1.0mL of pH 9.8buffer solution were placed separately in a series of 125mL separating funnels. A volume of 1.0mL of Safranin o (for method M_{22a}) and 0.5mL of MB (for method M_{22b}) was added respectively. The total volume of aqueous phase in each funnel was adjusted to 10.0mL with distilled water. Then 10.0mL of chloroform was added in each separating funnel and the contents were shaken for 2min and allowed to separate. The organic layer was collected through cotton plug and the absorbance was measured immediate at 520nm (for method M_{22a}) and at 650nm (for method M_{22b}) against reagent blank. Both the colored species were stable for 2 hours. The amount of drug (**TIA**) in a sample was obtained from the Beer's Lambert plot. (**Fig. 3** for M_1 ;, M_2 for **Fig.4**).

Results and Discussions:

The optimum conditions in these methods were fixed based on the study of the effects of various parameters such as type of acid for buffer, conc. of acid, conc. of dye SFNO (M_1) or MB (M_2), choice of organic solvent, ratio of organic phase to aqueous phase, shaking time, temp, intensity and stability of the colored species in organic phase. The author performed controlled in pediments by measuring absorbance at λmax 530nm (M_1) or 655nm (M_2) of a series of solutions varying one and fixing the other parameter and the results are recorded in (**Table 1**).**In** order to ascertain the optimum wavelength of maximum absorption (λ_{max}) of the colored species formed in the above methods, specified amounts of **TIA** were taken and colors were developed separately by following the above procedures. The absorption spectra were scanned on a spectrophotometer in the wave length region of 340 to 900nm against similar reagent blank or distilled water. The reagent blank absorption spectrum of each method was also recorded against distilled water. The results were graphically represented in **Fig. 1&2,** The absorption curves of the colored species in each method show characteristics absorption maxima where as the blank in each method has low or no absorption in this region.

Fig. 1: Absorption spectrum of TIA with SFNO (M_1)

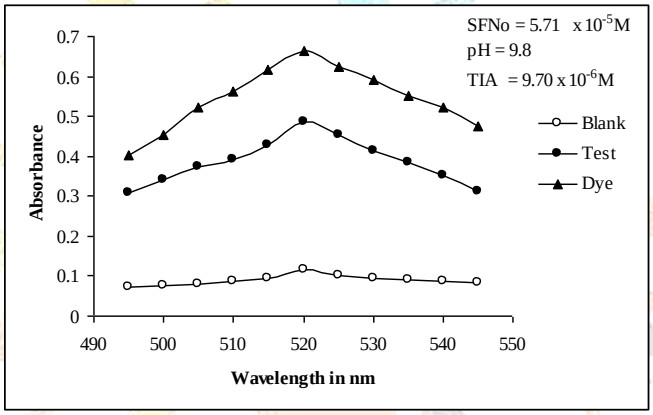


Fig. 2: Absorption spectrum of TIA with TIA with MB (M_2)

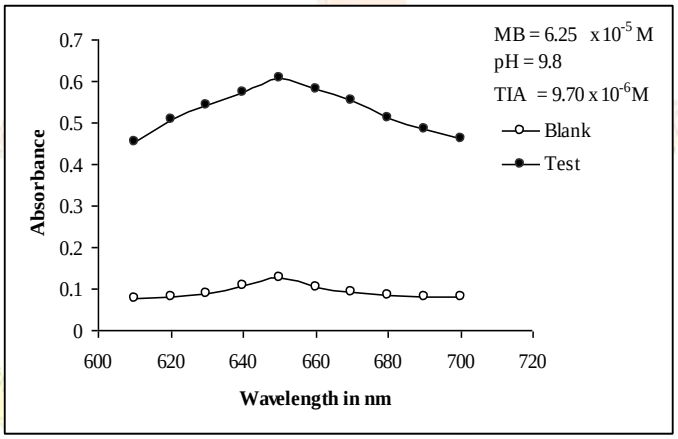


Fig. 3: Beer's Law plot of TIA with SFNO (M_1)

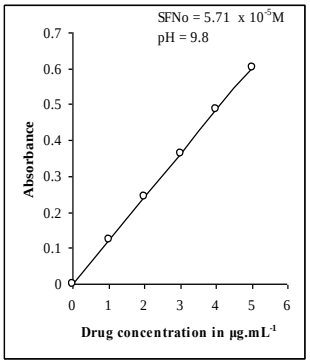
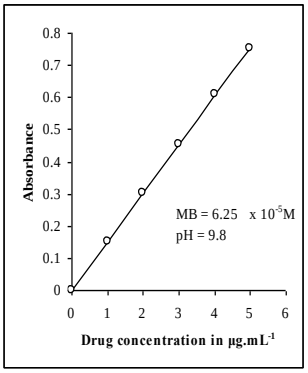


Fig. 4: Beer's Law plot of TIA with MB (M_2)



The accuracy of the methods was ascertained by comparing the results of proposed and reference methods statistically by the t-test and F-tests. The comparison shows that there is no significant difference between the results of studied methods and those of the reference ones as in Table 3. The similarity of the results is obvious evidence of the fact that during the application of these methods, the excipients are usually present in pharmaceutical formulations do not interfere in the assay of proposed methods. As an additional check of accuracy of the proposed methods, recovery experiments were carried out. The recovery of the added amounts of standard drug was studied at 3 different levels. Each level was repeated for 6 times. From the amount of drug found, the %recovery was calculated in the usual way. The higher λ_{max} values of the proposed methods have a advantage since the interference from associated ingredients should be generally less at higher wavelengths than at lower wavelengths. Thus the proposed visible spectrophotometric methods are simple and sensitive with reasonable precision and accuracy and used better alternatives to the existing ones to the routine determination of Tiagabine HCl in bulk forms and pharmaceutical formulations.

Table 1

Optical and regression characteristics, precision and accuracy of the proposed methods for TIA

PARAMETER	**M_1**	**M_2**
λ_{max} (nm)	540	620
Beer's law limits (µg/mL)	20 – 120	5 – 30
Detection limit (µg/mL)	5.994	3.158
Molar absorptivity (1 $mol^{-1}.cm^{-1}$)	1.664×10^3	5.295×10^3
Sandell's sensitivity (µg.cm^{-2}/0.001 absorbance unit)	0.4296	0.1907
Optimum photometric range (µg/mL)	45-105	12.6 – 30
Regression equation (Y=a+bc) slope (b)	9.209×10^{-3}	0.0143
Standard deviation on slope (S_b)	1.026×10^{-3}	7.654×10^{-3}
Intercept (a)	5.749×10^{-3}	2.25×10^{-3}
Standard deviation on intercept (S_a)	6.806×10^{-2}	1.269×10^{-1}
Standard error on estimation (S_e)	6.490×10^{-2}	1.210×10^{-1}
Correlation coefficient (r)	0.9993	0.9998
Relative standard deviation (%)*	0.9905	1.584
% Range of error (confidence limits)		
0.05 level	1.1389	1.822
0.01 level	1.7860	2.856
% error in Bulk samples **	0.348	-0.143

* Average of six determinations considered ** Average of three determinations

Table 2:Assay of TIA in Pharmaceutical Formulations

Formulations*	Amount taken (mg)	*Amount found by proposed Methods***		Reference method	Percentage recovery by proposed methods***	
		M_{22a}	**M_{22b}**		**M_{22a}**	**M_{22b}**
Tablet I	10	9.90±0.07 F=2.93 t=0.72	9.90±0.08 F=2.25 t=0.69	9.94±0.12	99.59±0.91	99.59±0.38
Tablet II	12	11.82±0.11 F=4.37 t=0.91	11.84±0.15 F=2.35 t=0.63	11.91±0.23	99.24±0.39	99.41±0.84

* Tablets from four different pharmaceutical companies.

** Average ± standard deviation of six determinations, the t-and F-test values refer to comparison of the proposed method with the reference method. Theoretical values at 95% confidence limit, F = 5.05, t = 2.262

*** Recovery of 10mg added to the preanalysed pharmaceutical formulations (average of three determinations).

Conclusions: It can be observed from the results presented above, that the proposed methods have the good sensitivity **ε_{max}** and higher **λ_{max}.** Statistical analysis of the results sows that the proposed procedures have good precision and accuracy. Results of the analysis of pharmaceutical formulations reveal that the proposed methods are suitable for their analysis with virtually no interference of the usual additives present in pharmaceutical formulations. The order of sensitivity (**ε_{max}**) between the methods is: **M_2>M_1**.These proposed methods are simple, sensitive and reliable and can be used for routine determination of **TIA** in bulk samples and pharmaceutical formulations depending upon the need of specific situation.

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SPECTROPHOTOMETRIC METHODS FOR THE ASSAY OF TIAGABINE HCl USING CHROMOGENIC REAGENTS

[1]V.Nagalakshmi, [2]G.Srinivasa Rao, [3]N.Madhavi, [4]NVNB SrinivasaRao [5]N.Gayatri D Devi

[1,2,3,5]Department of chemistry, St. Theresa's college for women, Eluru-534003,
[4]S.Ch.V.P.M.R Government Degree College, Ganapavaram
Address: Associate Professor in Chemistry, Ch.S.D. St. Theresa's college for women (A), Eluru-534003

Abstract: **Simple, accurate and reproducible UV-Visible spectrophotometric methods were established for the assay of Tiagabine HCl (TIA) based on the redox and complex reactions. Redox reaction of the TIA with NBS/PMAP-SA is proposed in method A. Method B includes complex formation of TIA with SNP-HA. The optical characteristics such as Beers law limits, molar absorptivity and Sandell's sensitivity for the methods (A-B) are given. Regression analysis using the method of least squares was made to evaluate the slope (b), intercept (a) and correlation coefficient (r) and standard error of estimation (Se) for each system. Determination of TIA in bulk form and in pharmaceutical formulations were also incorporated.**

Keywords: Estimation, Tiagabine, Spectrophotometric method, Validation, Chromogenic rearents

I. INTRODUCTION

Tiagabine.HCl (TIA) [1-3], is an anticonvulsant drug used to help control some types of seizures in the treatment of epilepsy. This medicine cannot cure epilepsy and will only work to control seizures for as long as you continue this drug. **A** very few physico-chemical methods appeared in the literature for the determination of TIA in pharmaceutical formulations LC-MS[4,5]and HPLC[6,7]. As the analytically important functional groups of TIA were not fully exploited, there is a scope to develop sensitive and flexible suitable spectrophotometric and HPLC methods. The aim of this study was to develop and validate two UV-Visible spectrophotometric methods for the determination of tiagabine in the presence of formulation The methods developed by the author are based on the different chemical reactions (reactivity of functional groups) of **TIA** with various dyes and chromgenic reagents that produced colored species with reasonable stability paving the possibility for visible spectrophotometric determination of TIA in its bulk form and in pharmaceutical formulations. A reported spectroscopic method was chosen as reference method for comparing the accuracy of the results obtained by the proposed methods.

II. Methods and Materials

Apparatus: An Elico, UV-Visible digital spectrophotometer (SL - 159) with 1cm matched quartz cells were used for the spectral and absorbance measurements. An Elico LI-120 digital pH meter was used for pH measurements.

Reagents and standards:

The stock solution (1mg/mL) of TIA was prepared by dissolving 100mg of it in 100mL with distilled water. This solution was further diluted step wise with distilled water to obtain working standard solution of corresponding concentration 200 μgmL^{-1}[, $\mathbf{M_A}$, $\mathbf{M_B}$]

Method A:

NBS solution: Prepared by dissolving 88mg of N-Bromo succinimide in 100mL of distilled water and standardized iodometrically.

PMAP solution: Prepared by dissolving 300mg of p-N-methylaminophenol sulphate in 100mL of distilled water.

SA solution: Prepared by dissolving 200mg of sulphanilamide in 2.5mL of 0.05M HCI followed by dilution to 100mL with distilled water.

Method B:

SNP solution: Prepared by dissolving 500mg of sodium nitroprusside in 100mL of distilled water.

HA solution: Prepared by dissolving 500mg of hydroxylamine hydrochloride in 100mL of distilled water.

Na_2CO_3 solution: Prepared by dissolving 10gms of sodium carbonate in 100mL of distilled water

Analysis of Pharmaceutical formulation:
Twenty tablets were powdered and mixed thoroughly. An amount equivalent to 20 mg of Tiagabine was weighed accurately and extracted with isopropyl alcohol to eliminate any interference from excipients. It was filtered through Whatmann No. 42 filter paper and the residue was washed well with isopropyl alcohol for complete recovery of the drug. The isopropyl alcohol was evaporated to dryness and the drug was dissolved in doubly distilled water and diluted to 100 mL with doubly distilled water. It was further diluted if needed and then analyzed following the recommended procedures.

Method A:

Aliquots of standard TIA solution (1.0-5.0mL, 200µg.mL^{-1}) were transferred into a series of 25mL calibrated tubes. Then 0.5mL (8.75 x 10^{-1}M) of AcOH and 2.0mL (4.94 x 10^{-3}M) of NBS solutions were added and kept aside for 15min at room temperature. Then 1.5mL (8.71 x 10^{-3}M) of PMAP solution was added. After 2min, 2.0mL (1.16 x 10^{-2}M) of SA solution was added. The volume was made up to the mark with distilled water. The absorbance was measured after 10min. at 520nm against distilled water. A blank experiment was also carried out omitting the drug. The decrease in the absorbance and in turn the drug concentration was obtained by subtracting the absorbance of the test solution from the blank. The amount of **TIA** was computed from its calibration graph (Fig 3).

Method B:

Aliquots of standard TIA solution (1.0-6.0mL, 200µg.mL^{-1}) were transferred into a series of 25mL-calibrated tubes. Then 1.0mL (1.678 x 10^{-2}M) of SNP and 1.0mL (7.195 x 10^{-2}M) of HA were added successively and kept aside for 5min. Then 1.0mL (9.43 x 10^{-1}M) of Na_2CO_3 solution was added and shaken for 15min. The volume was made up to the mark with distilled water. The absorbance was measured after 10min at 580nm against a similar reagent blank. The amount of **TIA** was computed from its calibration graph (Fig4).

In the above methods, a calibration curve was prepared by plotting the absorbance versus the concentration and the unknown was read from the calibration curve or deduced using a regression equation calculated from Beer's law data.

III Results and Discussions:

Method A is an indirect spectrophotometric method which involves two steps, oxidation of the TIA with NBS (first step) and estimation of the unconsumed NBS with PMAP-SA reagent (second step).In the first step, the volume of NBS required for oxidation of drug, the time and temperature for oxidation of the drug and volume of acetic acid were established through control experiments. In the second step, the volume of PMAP and the intermittent time between additions, volume of SA and the solvent for final dilution colored species were found by varying one parameter at a time and the optimum conditions are incorporated in Table 2.

The method B involves the reaction of TIA with SNP in the presence of hydroxyl amine hydrochloride. The optimum conditions in this method were fixed based on the study of the effects of various parameters such as volume of SNP solution, volume of HA, nature and volume of base, order of addition of reagents, time and temperature of the reaction, solvent for final dilution, the intensity and stability of colored species formed. The optimum conditions developed and the actual conditions chosen for the procedure are incorporated in **Table 1.**

In order to ascertain the optimum wavelength of maximum absorption (λ_{max}) of the colored species formed in the above methods, specified amounts of **TIA** were taken and colors were developed separately by following the above procedures. The absorption spectra were scanned on a spectrophotometer in the wave length region of 340 to 900nm against similar reagent blank or distilled water. The reagent blank absorption spectrum of each method was also recorded against distilled water. The results were graphically represented in **Fig. 1&2,** the absorption curves of the colored species in each method show characteristics absorption maxima whereas the blank in each method has low or no absorption in this region.

Fig. 1: Absorption spectrum of TIA with NBS – PMAP - SA (M_A)

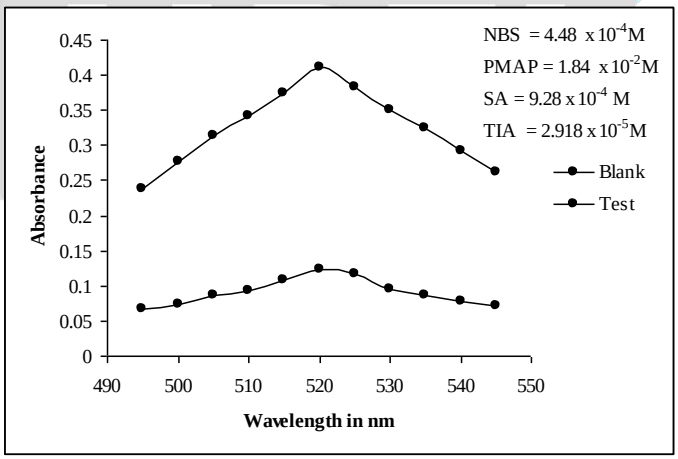


Fig. 2: Absorption spectrum of TIA with SNP – NH_2OH (M_B)

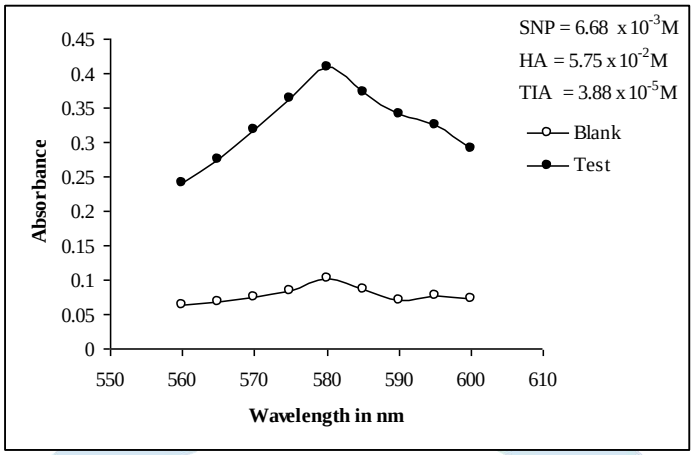


Fig. 3: Beer's Law plot of TIA with NBS – PMAP-SA (M_A)

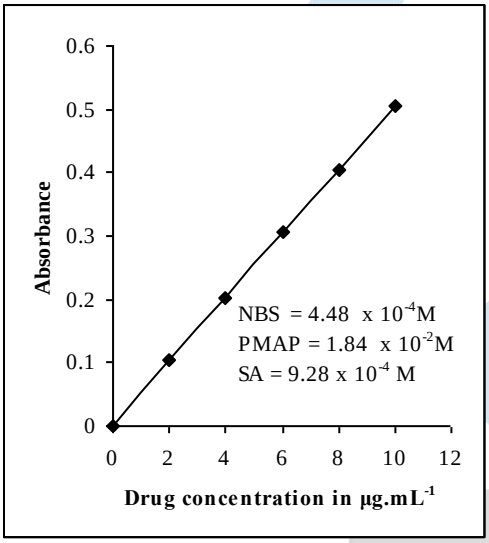
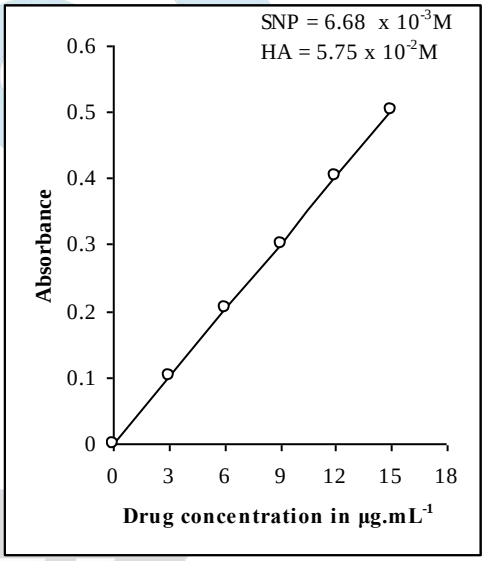


Fig. 4: Beer's Law plot of TIA with SNP-NH_2OH (M_B)



The accuracy of the methods was ascertained by comparing the results of proposed and reference methods statistically by the t-test and F-tests. The comparison shows that there is no significant difference between the results of studied methods and those of the reference ones as in Table 3. The similarity of the results is obvious evidence of the fact that during the application of these methods, the excipients are usually present in pharmaceutical formulations do not interfere in the assay of proposed methods. As an additional check of accuracy of the proposed methods, recovery experiments were carried out. The recovery of the added amounts of standard drug was studied at 3 different levels. Each level was repeated for 6 times. From the amount of drug found, the %recovery was calculated in the usual way. The higher λ_{max} values of the proposed methods have a advantage since the interference from associated ingredients should be generally less at higher wavelengths than at lower wavelengths. Thus the proposed visible spectrophotometric methods are simple and sensitive with reasonable precision and accuracy and used better alternatives to the existing ones to the routine determination of Tiagabine HCl in bulk forms and pharmaceutical formulations.

Table 1
Optical and regression characteristics, precision and accuracy of the proposed methods for TIA

PARAMETER	M_9	M_{19a}
λ_{max} (nm)	520	520
Beer's law limits (µg/mL)	4-24	0.8-4.8
Detection limit (µg/mL)	0.9330	0.2007
Molar absorptivity (1 $mol^{-1}.cm^{-1}$)	5.945×10^3	7.015×10^4
Sandell's sensitivity (µg.cm^{-2}/0.001 absorbance unit)	0.1838	3.546×10^{-2}
Optimum photometric range (µg/mL)	5-17.78	1.6-4.4
Regression equation (Y=a+bc) slope (b)	0.0137	0.1561
Standard deviation on slope (S_b)	2.980×10^{-4}	3.811×10^{-3}
Intercept (a)	9.999×10^{-4}	4.999×10^{-3}
Standard deviation on intercept (S_a)	3.953×10^{-4}	10.11×10^{-3}
Standard error on estimation (S_e)	3.769×10^{-3}	9.642×10^{-3}
Correlation coefficient (r)	0.9993	0.9992
Relative standard deviation (%)*	1.807	0.5311
% Range of error (confidence limits)		
0.05 level	2.07	0.6116
0.01 level	3.25	0.9576
% error in Bulk samples **	0.102	0.139

* Average of six determinations considered ** Average of three determinations

Table 2: Assay of TIA in Pharmaceutical Formulations

Formulations*	Amount taken (mg)	*Amount found by proposed Methods***		Reference method	Percentage recovery by proposed methods***	
		M_A	M_B		M_A	M_B
Tablet I	10	9.85±0.07 F=2.938 t=1.64	9.88±0.08 F=2.25 t=1.03	9.94±0.12	99.09±0.63	99.39±0.36
Tablet II	12	11.80±0.18 F=1.63 t=0.92	11.84±0.13 F=3.13 t=0.67	11.91±0.23	99.07±0.28	99.41±0.69

* Tablets from two different pharmaceutical companies.
** Average ± standard deviation of six determinations, the t-and F-test values refer to comparison of the proposed method with the reference method. Theoretical values at 95% confidence limit, F = 5.05, t = 2.262
*** Recovery of 10mg added to the preanalysed pharmaceutical formulations (average of three determinations).

IV Conclusions: It can be observed from the results presented above, that the proposed methods have the good sensitivity **ε_{max}** and higher **λ_{max}.** Statistical analysis of the results sows that the proposed procedures have good precision and accuracy. Results of the analysis of pharmaceutical formulations reveal that the proposed methods are suitable for their analysis with virtually no interference of the usual additives present in pharmaceutical formulations. The order of sensitivity (**ε_{max}**) between the methods is: **$M_A > M_B$**.These proposed methods are simple, sensitive and reliable and can be used for routine determination of **TIA** in bulk samples and pharmaceutical formulations depending upon the need of specific situation.

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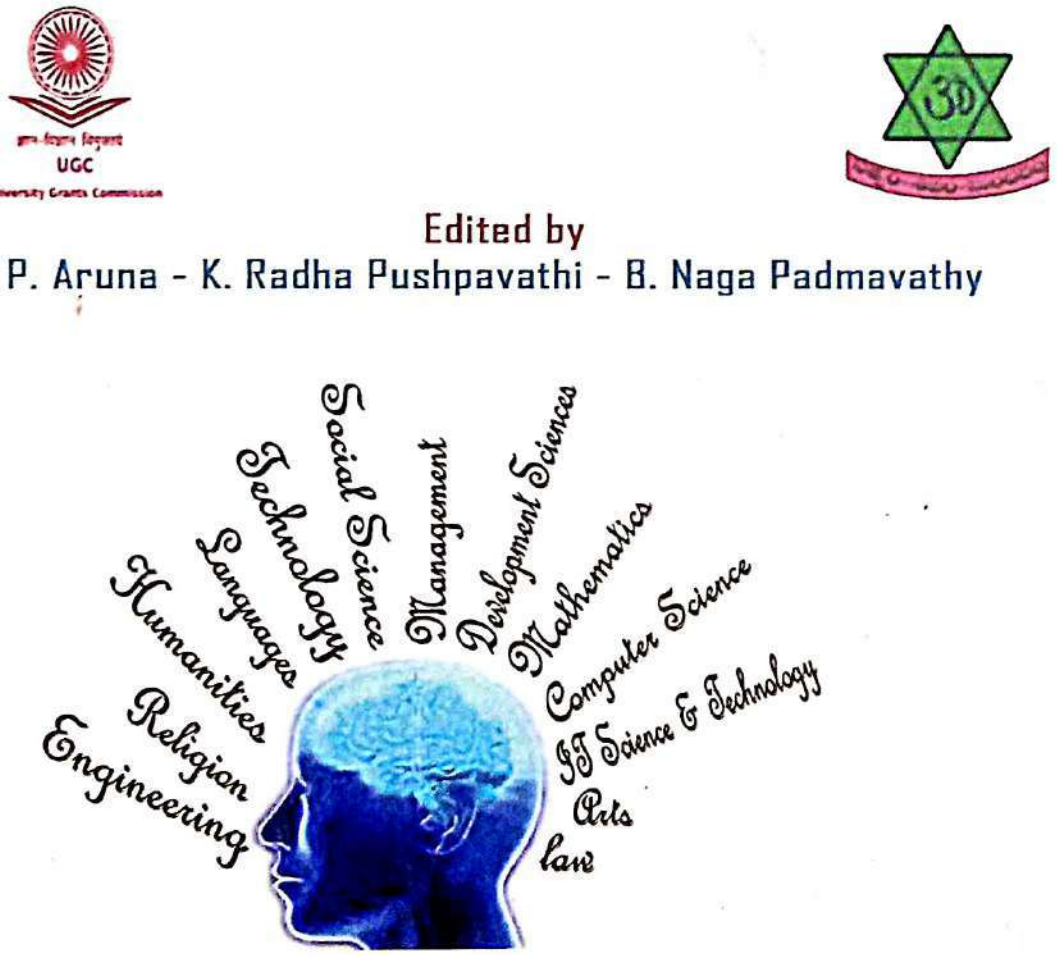

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Make in India-prospects and challenges

P.Aravind Swamy, Lecturer in Economics,
GDC, Ganapavaram, West Godavari Dt.-534198.

Abstract : India is the fastest growing economy and third-largest economy in the world regarding its purchasing power parity according to the World Bank with the GDP of over USD 2.1 trillion. It was named amongst the top 10 Foreign Direct Investment (FDI) destinations in 2015. Looking at these statistics, one cannot deny that India has an incredible potential to rise as an economic power with a prosperous future. But on the other hand India ranked low on the World Bank's report of 'Ease of Doing Business', having been cited to have a myriad of regulations and bureaucratic red tape. The desired dynamism in the manufacturing sector has remained elusive. The share of manufacturing has largely remained stagnant averaging around 15.5% of GDP over the last 35 years. India is still struggling for a manufacturing led export growth to take root. India has an added advantage with numerous favorable conditions such as cheap abundant labour, rich availability of raw materials, domestic consumer market etc., for the success of Make in India initiative. Low rank regarding 'Ease of Doing Business', multi-tier regulatory frameworks and complex procedures making, lack of clear-cut policies on land acquisition, lack of R&D and multiple tax regime are the main impediments for "Make in India initiative". . If India can overcome the challenges and provide world class infrastructure and logistics, the Make in India initiative can turn India into the world largest economy very soon.

Key words: Make in India, 'Ease of Doing Business, dynamism

Introduction

India is the fastest growing economy in the world today – an impressive position it has held since it overtook China in the year 2015 – with the International Monetary Fund (IMF) predicting that India is likely to retain this status till 2020. With the Gross Domestic Product (GDP) of the country growing at more than 7% since 2014, the IMF has kept projections for India's growth in 2016-2017 at 7.5%, which is remarkable since there has been a forecast of the global growth predicted at 3.4% in 2016 and 3.6% in 2017, as reported by the national daily, The Hindu. India is also the third-largest economy in the world regarding its purchasing power parity according to the World Bank with the GDP of over USD 2.1 trillion. It was named amongst the top 10 Foreign Direct Investment (FDI) destinations in 2015.The country is home to the 2nd largest English-speaking population in the world after the Unites States. It also has the largest youth population in the world at 650 million with more than half the population below 25 years of age. This demographic is arguably India's greatest strength.

Looking at these statistics, one cannot deny that India has an incredible potential to rise as an economic power with a prosperous future. A decade-long study by Harvard University's Centre for International Development predicts the country's GDP will continue to expand at an average of over 7% which means

nominal GDP will nearly double to around USD 4.50 trillion (at current exchange rate) in 2025. India's purchasing power parity in 2025 will thus be around USD 15 trillion by a similar calculation. It is also set to be the 5th largest consumer market by the same year.

But on the other hand India ranked low on the World Bank's report of 'Ease of Doing Business', having been cited to have a myriad of regulations and bureaucratic red tape. While India has metamorphosized from an agrarian economy into an economy driven by the services sector, the desired dynamism in the manufacturing sector has remained elusive. The share of agriculture in India's GDP has declined from 35% in 1980 to 18% in 2013 and the corresponding share of services has risen from 40% to 57%; however the share of manufacturing has largely remained stagnant averaging around 15.5% of GDP over the last 35 years. The share of manufacturing in India's GDP stood at a meagre 12.8% in 2013. India is still struggling for a manufacturing led export growth to take root. Of India's export basket, 62% comprise of manufacturing exports (as of 2013) which is the lowest among most Asian economies (China 94%, Japan 88%, Phillipines 77%, Singapore 70% and Thailand 74%). Harnessing India's manufacturing potential is the key to ensure a sustainable long term growth. The government of India has already taken several steps for some much-needed change in the country. Numerous national developmental projects such as Digital India, Start Up India, Skill India, Pradhana Mantri Jan-Dhan Yojana, Smart City, National Manufacturing Policy (NMP) etc., have been launched in the recent years that cover a wide array of sectors to initiate economic reform as well as target social change.

With the country already witnessing an increase in FDI by nearly 44% since the launch of such initiatives, India seems on its way to achieving its stated target with the government leading the way. 'Make in India' is the proof that the nation is willing to embrace growth by adopting changes on the journey to becoming an economic superpower. Reinforcing the vision to develop India into a global manufacturing giant, Prime Minister Narendra Modi unveiled a national program of 'Make in India' on 25th September 2014' with an aim to facilitate investments, foster innovation and build world class manufacturing infrastructure. . Under the 'Make in India' initiative, the government has, since its inception, announced several steps to improve the business environment by easing processes to do business in the country. It represents a comprehensive overhaul of processes and policies. It represents a complete change of the Government's mindset - a shift from issuing authority to business partner, in keeping with Prime Minister Modi's tenet of 'Minimum Government, Maximum Governance'.

With the objectives of making India a global manufacturing hub, encouraging Domestic companies and Multinationals to manufacture their products in India, creating millions of jobs in the country and attracting foreign investment, the initiative focuses on 25 sectors of the economy for job creation and skill enhancement. Some of these sectors are automobiles, chemicals, IT, pharmaceuticals, textiles, ports, aviation, leather, tourism and

hospitality, wellness, railways, design manufacturing, renewable energy, mining, bio-technology and electronics. The initiative hopes to increase GDP growth and tax revenue. It also aims at high quality standards and minimizing the impact on the environment. It hopes to attract capital and technological investment in India. The envisaged creation of smart cities and investment corridors, allowing higher FDI in sectors such as defence and railways, actions to foster project execution including faster approvals and clearances, appeasing investor sentiment, correcting inverted duty structures amongst others, have been some of the encouraging efforts that the Government has undertaken over the last few months.

India has an added advantage with numerous favorable conditions for the success of Make in India initiative. Cheap abundant labour gives India a natural comparative advantage in low-value added, labour intensive manufacturing goods .With a population of 1.2 bn people, and the world's highest youth population (India has 572 mn people under the age of 24); labour is a vital factor of production for India. India's harnessing of its manufacturing potential will lie in tapping its low cost labour. India fairs as the most competitive economy in terms of both average monthly wages and minimum monthly wages as compared to its Asian peers. Cheap semi-skilled and unskilled labour intensive products give India a natural competitive advantage .

India has rich availability of raw materials inputs such as cotton, coal and iron ore. India has the world's 5 largest coal reserves, India is the fourth largest iron ore producer accounting for 5% of global production, and is likely to overtake China as the largest cotton producer. Abundant raw materials give India a comparative advantage in terms of low-cost manufacturing inputs, reducing the overall cost of production. Further, domestic availability of raw materials can insulate India's manufacturing sector from global commodity cycles. There is a room for India in the global markets to export labour intensive products like clothing, textiles, footwear, furniture, plastic products, bags and toys. India's domestic demand offers tremendous potential to tap economies of scale in manufacturing consumer goods segment. India's domestic consumer market is the most rapidly growing consumer market in Asia. The new aspiring Indian middle class is expected to touch 267 mn over the next 5 years as per National Council of Applied Economic Research (NCAER), presenting tremendous opportunities to realize economies of scale for fast moving manufacturing consumer goods. With consumerism and disposable incomes on the rise, retail sector can experience rapid growth in the coming decades with many global players entering the Indian market.

Inspite of prospects discussed above, there are several problems for the success of Make in India initiative. India ranked low on the World Bank's report of 'Ease of Doing Business', having been cited to have a myriad of regulations and bureaucratic red tape. According to World Bank's 'Ease of Doing Business' survey 2014, India ranks 142 out of a total of 189 countries, significantly behind its Asian peers (Singapore ranks 1, Hong Kong ranks 3, Malaysia 18, China 90, Philippines 95 and Indonesia 114), highlighting that the procedures

and costs of doing business are particularly cumbersome for India. Start up procedures to register a business requires 12 days in India as compared to 5 days in OECD nations and 8 days in Low and Middle Income nations. Further, 1420 days are required to enforce a contract in India as compared to 527 days in OECD nations and 655 days in Low and Middle income nations. India is characterized by multi-tier regulatory frameworks and complex procedures making it tedious for investors to venture into manufacturing projects. Relative labour productivity in India falls behind its global peers, despite a cheap and abundant labour resource. As a result of poor education, labour productivity remains low in India, serving as a deterrent for attracting investment and manufacturing opportunities. Infrastructure and logistics in India lag far behind international standards adding significantly to the cost of doing business. Highways, bridges, world-class airports, reliable power and clean water are in short supply. Indian ports have a vessel turnaround time of 3-5 days as against only 4-6 hours in Singapore and Hong Kong.

Lack of clear-cut policies on land acquisition, multiplicity of authorities and bureaucratic hurdles lead to delays in the implementation of industrial and infrastructure projects in India. India's expenditure on R&D as a share of GDP is a paltry 0.8% as compared to 2.4% in OECD nations and 1.2% in Low & Middle income nations. Currently the taxation regime faces challenges such as double taxation, inverted duty structure and lower incentives which have rendered the manufacturing sector uncompetitive. The indirect taxation regime is riddled with double taxation such as sales tax on cenvat, sales tax on central sales tax, entry tax on sales tax, and income tax on service tax. Further, the current direct tax structure is a major impediment towards building an investor friendly ambience and boosting consumer sentiment. Taxes on income profits and capital gains comprise 45% of total revenues in India with comparable ratios at 23% in OECD nations and 21% in low income nations, reflecting disincentives the current tax structure at present imposes.

Today, India's credibility is stronger than ever. There is visible momentum, energy and optimism. Make in India is opening investment doors. Multiple enterprises are adopting its mantra. The world's largest democracy is well on its way to becoming the world's most powerful economy. If India can overcome the challenges and provide world class infrastructure and logistics, the Make in India initiative can turn India into the world largest economy very soon.

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RESEARCH ARTCLE

IMPACT OF RURAL NON-FARM EMPLOYMENT AND FACTORS BEHIND THE GROWTH OF RURAL NON-FARM EMPLOYMENT-EVIDENCE FROM THE HOUSEHOLD SURVEY IN WEST GODAVARI DISTRICT OF ANDHRA PRADESH

P. ARAVIND SWAMY
Asst. Professor of Economics, S CH V P M R Govt. Degree College, Ganapavaram,(A.P.)
swamy.pa2506@gmail.com

P. ARAVIND SWAMY

Abstract

The present paper is an attempt to study the impact of rural non-farm employment on the standard of living of the sample rural non-farm workers from eight villages of West Godavari district. It also attempts to find out the factors behind the growth of non-farm employment in the study villages. A sample of 845 respondents were administered a structured schedule, and the data was collected, quantified, analyzed and interpreted. The study reveals the fact that level of income, expenditure and standard of living of rural non-farm workers increased after entering into non-farm employment as the non-farm sector is capable of providing gainful employment and regular income. The study also signifies that the growth of rural non-farm employment in the district is mainly distress oriented or push effect

Introduction:

It is a universally accepted fact that agricultural sector is by itself, incapable of creating additional opportunities of gainful employment in the wake of increasing population. In most developing countries like India, the rural labour force is growing rapidly, but employment opportunities are not keeping pace with it. Rural non-farm sector (RNFS) is being given wide recognition in recent years as an instrument for alleviating rural poverty and providing gainful employment to the growing rural workforce. The significance of the Rural Non-Farm Sector can hardly be denied when seen in relation with the increasing saturation in growth of agricultural employment and the growing rural-urban divide in a globalizing India. The sector helps in creating "insight jobs" associated with higher wages, which can also create opportunities especially for women and can act as the vehicle for reduction of gender gaps in the rural India.(M.Jatav and S,Sen, 2013).

Definition of Rural Non-Farm Activities:

It is very difficult to identify non-farm activities in rural areas due to variations in definitions. The World Bank (1978) in its publication also mentioned the difficulties in presenting a clear cut classification of farm and non-farm activities due to lack of well-established and consistent set of definitions. Several research scholars have defined the non-farm sector from different point of views.

According to Kumar Manoj (2004), Rural Non-Farm sector takes into account the activities carried on by the rural people. The term 'non-farm' encompasses all the non-crop agricultural activities; it includes manufacturing activities, mining and quarrying, transport, trade and services in rural areas or we can say that 'non-farm' refers to those activities that are not primarily agriculture ar forestry or fisheries. However, 'non-farm' does include trade or processing of agricultural products.

According to Mukhopadhyay, Gangopadhyay and Nayas (2008), farm activity means agricultural activity and non-farm activity is used synonymously with non-agricultural activity.

The Census of India categorizes all rural workers into nine 'industrial' categories. Farm workers are those who engages mainly only for 183 days in a year in categories I to III. (I) being cultivators, (II) agricultural labour and (III) is agricultural allied activities i.e. livestock rearing, forestry, fishing, plantation, orchards and allied activities. Non-farming activities consists of: (IV) mining and quarrying; (V) manufacturing, processing, servicing and repairs in household (HH) industry and other than household industry; (VI) construction; (VII) trade and commerce; (VIII) transport, storage and communication and (IX) other services.

According to Mahajan and Fisher (1997), Rural Non-Farm Sector comprises all non- agricultural activities, mining and quarrying, household and non-household manufacturing, processing, repairs, construction, trade, transport and other services undertaking in village and rural towns up to 50000 population undertaken by enterprises varying in size from household own account enterprises all the way to factories.

For our study, we shall define a RNF worker as: 'engaged in non-farm activities', any worker within a household who has, as a primary occupation one or several of the activities covered by the Census of India 1991 occupational categories (IV-IX). In other words, all those who work in a primary occupation in any field of economic activity, other than cultivation or agricultural labour who, in turn, are deemed as 'non-farm workers'.

Context of the study:

Agriculture has been a way of life and continues to be the single most important livelihood of the masses in India. It is the main stay of the Indian economy, as it constitutes the backbone of rural India which inhabitants around 70% of total Indian population. But in recent times the share of agriculture in national income has been on the decline. During the post independent period, the share of primary sector in the national income varied from the maximum of 57.20% in 1951 to the minimum of 15.11% in 2011. On the other hand the share of manufacturing sector increased from 8.90% to 31.21% and that of tertiary sector increased from 28.00% to 53.77% during the same period. In Andhra Pradesh also the share of agricultural sector in GSDP is decreasing while that of secondary and tertiary sectors is increasing. The share of primary sector has come down from 63.49% to 34.00% during the period 1960-61 and 2014-15. But in the case of manufacturing and service sectors, it was showing an increasing trend from11.50% to 22.00% and 25.00% to 44.00% respectively. A significant fact is that the share of agricultural sector in employment generation is also decreasing over the years. During the post independent period, the share of primary sector in employment generation varied between74.005 to 48.80% during197273 to 2011-12. The share of manufacturing sector in employment increased

from 11.2% to 23.45% and that of service sector increased from 14.65% to 27.75% during the same period. The declining share of agriculture in GNP and employment generation has aggravated the unemployment and under employment situation in India. At this juncture, non-farm sector in terms of increasing shares of manufacturing and service sectors both in national income and employment generation plays a prominent role in rural Indian economy.

The present study is an attempt to find out the impact of non-farm employment on the household income and living standards of Rural Non-Farm Workers in West Godavari District of Andhra Pradesh. It also pays a special attention to find out the factors responsible to access the non-farm employment in the study area.

Methodology

Data Base

For the present study, the researcher concentrated only on Rural Non-Farm Employment. The data for the research study were collected from both primary and secondary sources as per the details given below.

Secondary data sources:

Census data is used for estimating trends in aggregate and sub-sector RNFE at state and district level. The data refers to main workers only, i.e those who had worked for the major part of the year (183 days) or more. The most important secondary data sources are the Census of Andhra Pradesh published by the Census of India (1991, 2001 and 2011), Series-2. NSSO data is also used to some extent. Other data sources are from the Directorate of Economics Statistics, Government of A.P, Hyderabad, from the Centre for Ecnomic and Social Studies (CESS), Hand Book of Statistics, Chief Planning Officer, West Godavari District, Records and Registers maintained by the DRDA and village panchayats.

Primary data source:

After identifying the key sectors of the rural non-farm economy and the relative position of the West Godavari district in terms of share of rural non-farm employment in the rural area, a primary survey has been conducted to find out the household level determinants of participation in rural non-farm employment. The researcher has adopted multiple random sampling techniques. West Godavari district consists of four revenue divisions namely Eluru, Narsapuram, Kovvur and Jangareddy Gudem. The researcher purposively selected one mandal from each revenue division where there is more number of non-farm employment. Thus four mandals namely Akividu, Pedapadu, Koyyalagudem and Attili mandals were randomly selected for the study. After selecting the mandals, two villages from each mandal were randomly selected for the field survey. Thus eight villages namely Ajjamuru and Chinakapavaram from Akividu mandal, Kothuru and Koniki villages from Pedapadu mandal, Kommara and Gummampudi from Attili mandal and Vedentapuram and Chopparamannagudem from Koyyalagudem mandal were selected for the survey. 30 per cent of the rural non-farm workers from each village are selected as sample. Total sample respondents from the 8 villages are 845. The data were collected by personally interviewing the selected respondents from the villages with the help of a structured schedule. The schedule was prepared after consultation and discussion with experts. It contains all the objectives and dimensions of the study. The field study has covered both male and female respondents without any discrimination of age, sex, caste and religion.

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Profile of the respondents:

The sample respondents include casual labour (54.67%, permanent labour (8.40%) and self-employed (36.92%). Among the sample respondents, about 32.66% were land owners while 67.34% are landless. The sample covers both genders with 75.38% men and 24.62% women. They belong to different age groups: 20-30(32.67%), 30-40(44.85%), 40-50(14.67%), 50-60(5.91%) and above 60(1.90%). 91% of the respondents are educated but their level of education varies: Illiterates(9.00%), Primary(20.47%), Upper Primary(27.46%), Secondary(24.61%), Inter(12.31%), Degree and above(5.44%) and technical education(0.71%).

Objectives of the study:

- To find out the impact of non-farm employment on the income and expenditure levels of non-farm workers.
- To find out the factors behind the growth of non-farm employment.
- To find out the impact of push and pull factors on the growth of rural non-farm employment.

Hypothesis Statements:

- There is a positive correlation between non-farm employment and household income and standard of living
- Poverty and unemployment are the push factors significantly contribution to non-farm employment

Research Tools:

Research tools are standardized instruments that are necessary to collect data for interpretation and analysis. The present study used both conventional and statistical research tools in the process of gathering data, analyzing the results and finally achieving the stated objectives. In differential analysis, K-S (Kolmogorov-Smirnov) Statistic was used to test whether there is any significant difference between income of the respondents before and after entering non-farm employment.

IMPACT OF NON-FARM EMPLOYMENT

Impact of non-farm employment is explained in terms of earning levels and expenditure levels of the non-farm workers in the study area.

Earning levels of non-farm workers

Level of income is undoubtedly an important determinant of standard of living of the workers. Earning levels decide the level of living of a family. There is a greater scope to maintain a better standard of living if the income levels are optimum. It is also viewed that low levels of income are responsible for poverty and low standard of living.

Table 1
Earning levels of Casual Labour (462)

Income per month in Rupees	Before Entering Non-Farm Employment	After Entering Non-Farm Employment
Below 5000	257 (55.62)	84 (18.18)
5000-10000	155 (33.55)	209 (45.24)
10000-15000	42 (9.09)	137 (29.65)
Above 15000	8 (1.73)	32 (6.93)
Total	462 (100)	462 (100)

Table 1 gives the information regarding the monthly income of the casual labour. The table shows that before entering non-farm employment 257 respondents come under the low income category of Rs. Below 5000. Maximum number of respondents i.e., about 55.62% are in this category. 155 respondents (33.55%) come under the income category of Rs.5000-10000. 42 respondents (9.09%) earn

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Rs.10000-15000. Only 8 respondents (1.73%) earn above Rs. 15000. It is evident from the fact that most of the respondents (89.17%) earn below Rs. 10000 per month. The reason is that majority of the respondents are daily wage workers and they do not get employment throughout the month. They remain unemployed for two to three days per week.

After entering non-farm employment, the number of respondents come under the low income category of below Rs.5000 is reduced to 18.18 %. The number of respondents in the category of Rs.5000-10000 is increased to 45.24 %. The number of respondents in the category of Rs.10000-15000 is increased to 29.65% and the respondents in the income group of above Rs.15000 are increased to 6.93%. It is evident from the table that the earning levels casual non-farm workers are increased after entering non-farm employment. The reason is that the respondents are able to get employment for 20-25 days per month after entering non-farm employment.

To test whether there is any significant difference between income of the casual non-farm workers before and after entering non-farm employment, **Kolmogorov-Smirnov** test was used.

H_o: There is no significant difference between the income of the casual non-farm workers before and after entering non-farm employment.

(A)

Income per month in Rupees	Before entering Non-Farm employment	C.F	F_B
Below 5000	257	257	0.162
5000-10000	155	412	0.260
10000-15000	42	454	0.286
Above 15000	8	462	0.292
Total	462	1568	1.000

(B)

Income per month in Rupees	After Entering Non-Farm Employment	C.F	F_A	D_n
Below 5000	84	84	0.066	*0.096*
5000 to 10000	209	293	0.231	0.029
10000 to 15000	137	430	0.339	0.053
Above 15000	32	462	0.364	0.072
Total	462	1269	1.000	0

K-S Statistic : Dn =max | F_A - F_B | = 0.096.

The table value for Dn for n=4 and α =0.05 is 0.624. Since the table value of Dn (0.624) is greater than the calculated value of Dn (0.096), the null hypothesis is accepted. This implies that regarding the income of casual non-farm workers, there is no significant difference between before entering non-farm employment and after entering non-farm employment.

Table 2
Earning levels of Permanent Labour

Income per month in Rupees	Before entering Non-Farm Employment	After entering Non-Farm Employment
Below 5000	37 (52.11)	7 (9.86)
5000-10000	19 (26.76)	26 (36.62)
10000-15000	14 (19.72)	34 (47.89)
Above 15000	1(1.41)	4 (5.63)
Total	71 (100)	71 (100)

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Table 2 shows the monthly income of the permanent non-farm workers. The table shows that before entering non-farm employment 37 respondents (52.11%) come under the low income category of below Rs.5000. 19 respondents (26.76%) come under the income category of Rs.5000-10000. 14 respondents (19.72%) earn Rs.10000-15000. Only 1 respondent (1.41%) earn above Rs.15000. It is evident from the fact that most of the respondents (78.87%) earn below Rs.10000 per month.

After entering non-farm employment, the number of respondents come under the low income category of below Rs.5000 is reduced to 9.86 %. The number of respondents in the category of Rs.5000-10000 is increased to 36.62 %. The number of respondents in the category of Rs.10000-15000 is increased to 47.89% and the respondents in the income group of above Rs.15000 are increased to 5.63%. The earning levels of permanent non-farm workers increased after entering non-farm employment. It is evident from the table that 84.51% of the respondents earn between Rs.5000- Rs.15000 per month after entering non-farm employment where as it was only 46.48% before entering non-farm employment. The reason is that permanent non-farm workers come under regular employment and they are able to get employment throughout the month and throughout the year.

To test whether there is any significant difference between income of the permanent non-farm workers before and after entering non-farm employment, **Kolmogorov-Smirnov** test was used.

H_o: There is no significant difference between the income of the permanent non-farm workers before and after entering non-farm employment.

(A)

Income per month in Rupees	Before Entering Non-Farm Employment	C.F	F_B
Below 5000	37	37	0.158
5000-10000	19	56	0.239
10000-15000	14	70	0.299
Above 15000	1	71	0.303
Total	71	234	1.000

(B)

Income per month in Rupees	After Entering Non-Farm Employment	C.F	F_A	D_n
Below 5000	7	7	0.039	*0.119*
5000-10000	26	33	0.185	0.054
10000-15000	34	67	0.376	0.077
Above 15000	4	71	0.399	0.096
Total	71	178	1.000	0

K-S Statistic : Dn =max $| F_A - F_B | =$ 0.119.

The table value for Dn for n=4 and α =0.05 is 0.624. Since the table value of Dn (0.624) is greater than the calculated value of Dn (0.119), the null hypothesis is accepted. This implies that regarding the income of permanent non-farm workers, there is no significant difference between before entering non-farm employment and after entering non-farm employment.

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Table 3
Earning levels of Self- Employed (312)

Before Entering Income per month in Rupees	Non-Farm Employment	After Entering Non-Farm Employment
Below 5000	153 (49.09)	31 (9.94)
5000-10000	110 (35.26)	41 (13.14)
10000-15000	35 (11.22)	188 (60.26)
Above 15000	14 (4.48)	52 (16.66)
Total	312 (100)	312 (100)

Table- 3 gives the information regarding the earning levels of self-employed non-farm workers. Before entering non-farm employment 153 respondents (49.04%) come under the low income category of below Rs.5000. 110 respondents (35.26%) come under the income category of Rs.5000-10000. 35 respondents (11.22%) fall under the category of Rs.10000-15000. Only 14 respondents (4.48%) earned above Rs.15000 per month. It is evident from the table that 84.30 % of the respondents earn below Rs.10000 per month before entering non-farm employment.

After entering non-farm employment, the number respondents in the low income category of below Rs.5000 is reduced to 9.94 % and that of Rs.5000-10000 category also reduced to 13.14%. The number of respondents in high income categories of Rs, 10000-15000 and above Rs.15000 is increased to 60.26% and 16.66 % respectively. It is evident from the table that the earning levels of self-employed workers increased considerably after entering non-farm employment. Among the earning levels of three types of labour i.e. casual labour, permanent labour and self-employed, the number of respondents in the low income category of below Rs.5000 is high before entering non-farm employment. After entering non-farm employment, the number of respondents in the low income category of below Rs.5000 is reduced and the number of respondents in the second and third categories is increased.it is evident from the table that in these two categories i.e. of Rs.5000-10000 and Rs.10000-15000, there is a significant change in the earning levels. A slight increase in the earning level is observed in the last category of above Rs.15000.

To test whether there is any significant difference between income of the self-employed non-farm workers before and after entering non-farm employment, Kolmogorov-Smirnov test was used.

H_o: There is no significant difference between the income of the self-employed non-farm workers before and after entering non-farm employment.

(A)

Income per month in Rupees	Before Entering Non-Farm employment	C.F	F_B
Below 5000	153	153	0.149
5000-10000	110	263	0.256
10000-15000	35	298	0.291
Above 15000	14	312	0.304
Total	312	1026	1.000

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(B)

Income per month in Rupees	After Entering Non-Farm Employment	C.F	F_A	D_n
Below 5000	31	31	0.046	0.103
5000-10000	41	72	0.107	0.149
10000-15000	188	260	0.385	0.094
Above 15000	52	312	0.462	*0.158*
Total	312	675	1.000	0

K-S Statistic: Dn =max | F_A - F_B | = 0.158.

The table value for Dn for n=4 and α =0.05 is 0.624. Since the table value of Dn (0.624) is greater than the calculated value of Dn (0.158), the null hypothesis is accepted. This implies that regarding the income of self-employed non-farm workers, there is no significant difference between before entering non-farm employment and after entering non-farm employment.

In general, it is inferred that due to prevailing severe unemployment situation in farm sector, people are shifting from farm to non-farm employment. Even though people are getting employment in the non-farm sector, their income is more or less the same as they get in farm sector because majority of them are belonging to casual labour force. But people are able to get regular income in non-farm sector when compared to farm sector. Therefore it can be concluded that there exists a positive correlation between non-farm employment and the household income and standard of living.

Expenditure Levels of Non-Farm Workers

Level of expenditure is an important indicator of wealth status and standard of living of the workers. Earning levels decide the level of living of a family. The average amount spent per month on various goods and services by the households shows the wellbeing of the household members. There is a greater scope to maintain a better standard of living if the expenditure levels are optimum. It is also viewed that low levels of expenditure are the indicators of poverty and low standard of living.

Table 4
Expenditure levels of Casual Labour

Expenditure per month in Rupees	Before entering Non-Farm employment	After entering Non-Farm Employment
Below 2000	302 (65.37)	175 (37.88)
2000-4000	138 (29.87)	220 (47.62)
4000-6000	16 (3.46)	47 (10.17)
Above 6000	6 (1.30)	20 (4.33)
Total	462 (100)	462 (100)

The amount of expenditure on various food and non-food items differs depending on size and nature of the family. Table 4 shows the total monthly expenditure of casual labour on various food and non-food items. Before entering non-farm employment, 65.37% of the respondents (302 persons) spend merely below Rs.2000 per month, 29.87% of the respondents (138 persons) spend Rs.2000-4000 and 3.46% of the respondents (16 persons) spend Rs.4000-6000 per month. Only 1.30% of the respondents spend above Rs.6000 per month. It is evident from the table that the expenditure level of casual labour is low before entering non-farm employment. This is because of the low level of employment and low level of income of the casual labour.

After entering non-farm employment the respondents spend below Rs.2000 per month is decreased to 37.88% as against 65.37% before entering non-farm

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employment. The number of respondents spending Rs.2000-4000 per month increased to 47.62% as compared to 29.87% before entering non-farm employment. The table shows that the number of respondents spending Rs. 4000-6000 and above Rs.6000 increased to 10.17% and 4.33% respectively as against 3.46% and 1.30% before entering non-farm employment. It is evident from the table that the spending capacity of the respondents is increased after entering into non-farm employment. The increase is high in the category of Rs.2000-Rs.4000. The spending capacity of the respondents is also high in the category of Rs.4000-Rs.6000. the reason is that they can get more employment days in non-farm employment when compared to farm employment. High level of employment and high level of income leads to high level of purchasing power of the workers.

Table 5
Expenditure levels of permanent Labour

Expenditure per month in Rupees	Before entering Non-Farm Employment	After entering Non-Farm Employment
Below 2000	32 (45.07)	12 (16.90)
2000-4000	27 (38.03)	21 (29.58)
4000-6000	11 (15.49)	33 (46.48)
Above 6000	1 (1.41)	5 (7.04)
Total	71 (100)	71 (100)

The information regarding the expenditure levels of permanent non-farm workers is given in table 5. The table shows that before entering non-farm employment, 45.07% of the respondents spend below Rs.2000 per month, 38.03% of the respondents spend Rs.2000-4000 and about 15.49$ of the respondents spend Rs.4000-6000 per month. It is observed from the table that only 1.41% of the respondents spend above Rs.6000 per month. The table shows that maximum number of respondents i.e. about 83.10% are in the categories of below Rs.2000 and Rs.2000-4000 per month. Low level of income is responsible for low level of expenditure in these categories.

After entering non-farm employment, only16.90% of the respondents fall under the category of below Rs.2000 per month. The number of respondents in the category of Rs.2000-4000 is reduced from 38.03% to 29.58%. The number of respondents in the category of Rs.4000-6000 is increased to 46.48% as against 15.49% before entering non-farm employment. It is observed that about 7.04% of the respondents spend above Rs.6000 per month. It is evident from the table that significant percent of the respondents i.e. about 76.06% spend between Rs2000-6000 per month. This indicates that after entering non-farm employment the spending capacity of the respondents is increased considerably. The reason is that the permanent labour is able to get regular employment and income in non-farm sector.

Table -6
Expenditure levels of Self-employed

Expenditure per month in Rupees	Before Entering Non-Farm Employment	After Entering Non-Farm Employment
Below 2000	124 (39.78)	90 (28.85)
2000-4000	159 (50.96)	109 (34.94)
4000-6000	25 (8.01)	98 (31.41)
Above 6000	4 (1.28)	15 (4.80)
Total	312 (100)	312 (100)

Table 6 gives the information regarding the expenditure levels of self-employed labour. The table shows that before entering non-farm employment 39.75% of the respondents spend below Rs.2000 per month,

50.96% of the respondents spend Rs.2000-4000 and about 8.01% of the respondents spend Rs.4000-6000 per month. It is evident from the table that the number of respondents spending more than Rs.6000 per month is only about1.28%. the table shows that about two thirds of the respondents' spending capacity is low.

The purchasing power of the respondents is increased after entering non-farm employment. The number of respondents spending below Rs.2000 per month is reduced to 28.85% as against 39.75% before entering non-farm employment. The number of respondents spending Rs.2000-4000 per month is also reduced to 34.94%. as against 50.96% before entering non-farm employment. It is observed from the table that the number of respondents spending Rs.4000-6000 per month is increased from 8.01% to 31.41% after entering non-farm employment. The number of respondents spending above Rs.6000 per month is also increased to 4.80% as against 1.28%.

Level of income and expenditure levels are considered to be the main determinants of standard of living. In this study, it is found that the standard of living of the sample non-farm workers increased slightly as compared to before entering non-farm employment. No vast differences are found in the standard of living of the non-farm workers.

FACTORS BEHIND THE GROWTH OF RURAL NON-FARM EMPLOYMENT IN THE STUDY AREA

Non- farm employment is gaining prominence in rural areas of Andhra Pradesh as well as in India in recent times. The factors behind the growth of rural non-farm employment can be divided into two. They are push factors like poverty, unemployment etc., and pull factors like education, urbanization etc. The study proposes to pursue the research question whether the growth of Rural Non-Farm employment in West Godavari district is caused by push factors or pull factors. In the field study information has been collected for the contemporary growth of non-farm employment in the rural areas.

Table- 7
Factors led to Rural Non-Farm Employment

Activity	Factors led to Non-farm Employment		Total
	Pull Effect	Push Effect	
Manufacturing and Processing	78	158	236
	33.05	66.95	100
	29.55	27.19	27.93
Trade and Commerce	113	221	334
	33.83	66.17	100
	42.80	38.04	39.53
Manual And Mechanized transport	18	49	67
	26.87	73.13	100
	6.82	8.43	7.93
Repair Services	21	71	92
	22.83	77.17	100
	7.95	12.22	10.88
Other Services	34	82	116
	29.31	70.69	100
	12.88	14.11	13.73
Total	264	581	845
	31.24	68.76	100
	100	100	100

The data pertaining to the factors behind the growth of rural non- farm employment is provided in table 7. The data shows that 68.76 per cent of respondents' entry into non-farm activities was the stress induced or push affect oriented and 31.24 per cent of respondents' entry was pull effect oriented. The data reveals the fact that in almost all categories of rural non-farm activities in the study area, employment growth is mainly push effect oriented. Factors like poverty, low wages in the farm sector, non-availability of employment in the farm sector etc., mainly induced the respondents to

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join in the non- farm activities. Pull factors like growing urbanization, education, welfare policies of the Government and certainty of income also inducing the respondents to go for non- farm activities.

Table-8
Effect of Pull Factors

Activity	Pull Factor				Total
	Urbanization	Education	Welfare policies of the Govt.	Certainty of Income	
Manufacturing and Processing	8	25	3	42	78
	10.26	32.05	3.85	53.84	100
	27.59	30.86	30.00	29.17	29.55
Trade and Commerce	11	37	5	60	113
	9.73	32.74	4.42	53.11	100
	37.93	45.68	50.00	41.66	42.80
Manual and Mechanized transport	3	5	1	9	18
	16.67	27.78	5.55	50.00	100
	10.34	6.17	10.00	6.25	6.82
Repair Services	2	4	0	15	21
	9.52	19.05	0.00	71.43	100
	6.90	4.94	0.00	10.42	7.95
Other Services	5	10	1	18	34
	14.70	29.41	2.94	52.94	100
	17.24	12.35	10.00	12.50	12.88
Total	29	81	10	144	264
	10.98	30.68	3.79	54.55	100

Information regarding the contribution of various pull factors for the growth of rural non-farm employment is furnished in Table 8. It is observed that among the pull factors inducing the growth of non- farm employment in the study area, certainty of income contributes about 55 per cent, education contributes about 30 per cent, urbanization contributes about 10 per cent and government policies contribute about 4 per cent. This phenomenon is observed for almost all categories of non-farm activities in the study area.

Table-9
Effect of Push Factors

Activity	Push Factor				Total
	Poverty	Unemployment	Under Employment	Natural Calamities	
Manufacturing and Processing	87	41	26	4	158
	55.06	25.95	16.45	2.54	100
	27.19	26.97	27.66	26.66	27.19
Trade and Commerce	120	59	33	9	221
	54.30	26.70	14.93	4.07	100
	37.50	38.81	35.11	60.00	38.04
Manual and Mechanized transport	25	14	9	1	49
	51.02	28.57	18.37	2.04	100
	7.81	9.22	9.57	6.67	8.43
Repair Services	41	17	13	0	71
	57.75	23.94	18.31	0.00	100
	12.81	11.18	13.83	0.00	12.22
Other Services	47	21	13	1	82
	57.32	25.62	15.84	1.21	100
	14.69	13.82	13.83	6.67	14.11
Total	320	152	94	15	581
	55.08	26.16	16.18	2.58	100
	100	100	100	100	100

Information regarding the contribution of various push factors for the growth of rural non-farm employment in the study area is furnished in Table 9. As far as the push factors behind the growth of non- farm employment are concerned poverty contributes about 55 per cent followed by unemployment with 26.16 per cent, under employment with 16.18per cent and natural calamities with 2.58 per cent.

Thus the analysis signifies that the growth of rural non-farm employment in the district is mainly distress oriented or pushes effect oriented.

Findings and suggestions

The findings from the current study in regard to first objective reveals that even though people are getting employment in non-farm sector, their level of income and expenditure is slightly increased as majority of them are belonging to casual labour force. But people are able to get regular income in non-farm sector when compared to farm sector. Pertaining to second and third objectives, the study reveals that the growth of rural non-farm employment in the district is mainly distress oriented or push effect oriented. Poverty, unemployment and under employment are the major push factors and certainty of income and level of education are the major pull factors for the growth of rural non-farm employment. Under these circumstances, it is suggested that the government intervention is urgently required to sustain the growth of rural non-farm employment which in turn can reduce the severity of poverty and unemployment in rural areas.

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RESEARCH ARTCLE

DETERMINANTS OF RURAL NON-FARM EMPLOYMENT IN WEST GODAVARI DISTRICT OF ANDHRA PRADESH

P. ARAVINDSWAMY
Asst. Professor of Economics,
S CH V P M R Govt. Degree College, Ganapavaram,(A.P.)

P. ARAVINDSWAMY

ABSTRACT

The present paper is an attempt to find out the factors behind the growth of rural non-farm employment and to analyse the determinants of rural non-farm employment in the sample villages of West Godavari District of Andhra Pradesh. A sample of 845 respondents were administered a structured schedule, and the data was collected, quantified, analyzed and interpreted. It is observed from the literature that agricultural development, infrastructure, urbanization, literacy, commercialization of agriculture, public investment, irrigation etc. are the prominent factors behind the growth of rural non-farm employment. The regression result for the total sample reveals the fact that the explanatory variables like level of education of the non-farm workers and size of household are highly significant with positive impact on on-farm employmentwhile age of the respondents is highly significant with negative impact on rural non-farm employment.

Introduction

Poverty, unemployment and underemployment are the prominent problems faced by the rural economy in most of the less developed countries in the world. It is a well-known fact that agriculture or farm sector has always been considered as the core of economic growth of these economies.It occupies a pivotal place in the national economy of these countries both in terms of its contribution to GDP and employment generation and it represents a major source of foreign exchange, supplies the bulk of basic food and provides subsistence and income to the large rural population.But this sector is now unable to provide additional opportunities of gainful employment in the wake of increasing population. In most developing countries like India, the rural labour force is growing rapidly, but employment opportunities are not keeping pace with it. At this juncture the development of various non-farm activities offers great potential for creating additional rural job opportunities and hence for stimulating the further growth of rural economies.The significance of the Rural Non-Farm Sector can hardly be denied when seen in relation with the increasing saturation in growth of agricultural employment and the growing rural-urban divide in a globalizing India.The sector helps in creating "insight

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jobs" associated with higher wages, which can also create opportunities especially for women and can act as the vehicle for reduction of gender gaps in the rural India.(M. Jatav and S, Sen, 2013).

Definition of Rural Non-Farm Activities:

The Census of India categorizes all rural workers into nine 'industrial' categories. Farm workers are those who engages mainly only for 183 days in a year in categories I to III. (I) being cultivators, (II) agricultural labour and (III) is agricultural allied activities i.e. livestock rearing, forestry, fishing, plantation, orchards and allied activities. Non-farming activities consists of: (IV) mining and quarrying; (V) manufacturing, processing, servicing and repairs in household (HH) industry and other than household industry; (VI) construction; (VII) trade and commerce; (VIII) transport, storage and communication and (IX) other services.

For our study, we shall define a RNF worker as: 'engaged in non-farm activities', any worker within a household who has, as a primary occupation one or several of the activities covered by the Census of India 1991 occupational categories (IV-IX). In other words, all those who work in a primary occupation in any field of economic activity, other than cultivation or agricultural labour who, in turn, are deemed as 'non-farm workers'.

Structural changes in Rural Non-Farm Employment in India

The Indian economy, from the point of view of the locus of the working population, is predominantly rural, and during the past few decades we notice considerable dynamism within the rural production and employment structures. One of the significant changes in the rural production structure is the growing share of the non-farm sector, which increased from 37% in 1980-81 to 67% in 2011-12 (Table 1), and thus shows that in terms of value of production, rural is no longer merely agricultural.

Table 1.Sector-wise Composition of Rural NDP (%) in India

Industry	1980-81	1993-94	2004-05	2011-12
I. Agriculture	64.36	48.91	34.45	32.88
II. Non-agriculture	35.64	51.09	65.55	67.12
Manufacturing	9.16	13.74	14.12	13.28
Construction	4.05	4.19	9.32	11.92
Trade, hotels and restaurants	6.68	10.34	12.74	14.24
Transport, storage and communication	1.32	4.74	7.31	6.76

Source: NSS Rounds of 38th, 50th, 61st and 68th, Papola et al. (2013)

It is evident from the Table 2 that agriculture and allied activities accounts the highest share of rural employment all throughout the periods. The share of employment in agricultural sector has been declining but still it occupies the majority share. Between 1980-81 and 2011-12 the share of agriculture in rural employment declined from 81% to 64 % and the pace of decline in the last quinquennium was much faster. The share of non-farm sector increased from 19 % to 36% during the same period. The asymmetry noticed between the shifts in production structure and the employment structure in the overall Indian economic development persists in rural India as well. Within the rural employment structure, however, there has been considerable shift in favor of non-farm employment.

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Table2.Sector-wise Composition of Rural Employment (%) in India

Industry	1980-81	1993-94	2004-05	2011-12
I. Agriculture	81	78.00	73.00	64.00
II. Non-agriculture	19.00	22.00	27.00	36.00
Manufacturing	37.00	32.00	29.00	22.00
Construction	9.00	11.00	18.00	29.00
Trade, hotels and restaurants	19.00	20.00	23.00	20.00
Transport, storage and communication	9.00	7.00	9.00	9.00
Community and social services	26	25	17	15

Note : Figures rounded to nearest integer, Source: NSS Rounds of 38th, 50th, 61st and 68th, Papola et al. (2013).

Among non-farm sectors, manufacturing sector accounts the highest share in the overall employment in 1980-81 followed by Community, social and personal services. However in 2011-12, construction sector occupies the majority share of employment. Trade, hotels and restaurants sector and manufacturing sector contributes the majority share among the non-farm sectors to the GDP of India.

Context of the study:

Agriculture continues to be the single most important livelihood of the masses in India and it constitutes the backbone of rural India which inhabitants around 70% of total Indian population. But in recent times the share of agriculture in national income has been on the decline. During the post independent period, the share of primary sector in the national income varied from the maximum of 57.20% in 1951 to the minimum of 15.11% in 2011. On the other hand the shares of manufacturing sector and tertiary sectors increased from 8.90% to 31.21% and from 28.00% to 53.77% respectively during the same period. In Andhra Pradesh also the share of agricultural sector in GSDP is decreasing while that of secondary and tertiary sectors is increasing. The share of primary sector has come down from 63.49% to 34.00% during the period 1960-61 and 2014-15. But in the case of manufacturing and service sectors, it was showing an increasing trend from11.50% to 22.00% and 25.00% to 44.00% respectively.

A significant fact is that the share of agricultural sector in employment generation is also decreasing over the years. During the post independent period, the share of primary sector in employment generation varied between74.00% to 48.80% during1972-73 to 2011-12. The share of manufacturing sector in employment increased from 11.2% to 23.45% and that of service sector increased from 14.65% to 27.75% during the same period. The declining share of agriculture in GNP and employment generation has aggravated the unemployment and under employment situation in India. This underscores the need for alternative avenues for employment generation in rural areas. At this juncture, non-farm sector in terms of increasing shares of manufacturing and service sectors both in national income and employment generation plays a prominent role in rural Indian economy.

The present study is an attempt to find out the causes and determinants of non-farm employment growth in the rural areas. It also attempts to find out the impact of non-farm employment on the household income and living standards.

Methodology

Data Base

For the present study, the researcher concentrated only on Rural Non-Farm Employment. The data for the research study were collected from both primary and secondary sources as per the details given below.

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Secondary data sources: Census data is used for estimating trends in aggregate and sub-sector RNFE at state and district level. The most important secondary data sources are the Census of Andhra Pradesh published by the Census of India (1991, 2001 and 2011), Series-2. NSSO data is also used to some extent. Other data sources are from the Directorate of Economics Statistics, Government of A.P, Hyderabad, from the Centre for Ecnomic and Social Studies (CESS), Hand Book of Statistics, Chief Planning Officer, West Godavari District, Records and Registers maintained by the DRDA and village panchayats.

Primary data source: After identifying the key sectors of the rural non-farm economy and the relative position of the West Godavari district in terms of share of rural non-farm employment in the rural area, a primary survey has been conducted to find out the household level determinants of participation in rural non-farm employment. The researcher has adopted multiple random sampling techniques.

West Godavari district consists of four revenue divisions namely Eluru, Narsapuram, Kovvur and Jangareddy Gudem. The researcher purposively selected one mandal from each revenue division where there is more number of non-farm employment. Thus four mandals namely Akividu from Narsapuram division, Pedapadu fromEluru division, Koyyalagudem from JangareddyGudem division and Attili fromKovvur division were selected for the study. After selecting the mandals, two villages from each mandal were randomly selected for the field survey. Thus eight villages namely Ajjamuru and Chinakapavaram from Akividumandal, Kothuru and Koniki villages from Pedapadumandal, Kommara and Gummampudi from Attilimandal and Vedentapuram and Chopparamannagudem from Koyyalagudemmandal were selected for the survey. 30 per cent of the rural non-farm workers from each village are selected as sample. Total sample respondents from the 8 villages are 845. The data were collected by personally interviewing the selected respondents from the villages with the help of a structured schedule. The schedule was prepared after consultation and discussion with experts. It contains all the objectives and dimensions of the study. The field study has covered both male and female respondents without any discrimination of age, sex, caste and religion.

Profile of the respondents:

The sample respondents include casual labour (54.67%), permanent labour (8.40%) and self-employed (36.92%). Among the sample respondents, about 32.66% were land owners while 67.34% are landless. The sample covers both genders with 75.38% men and 24.62% women. They belong to different age groups: 20-30(32.67%), 30-40(44.85%), 40-50(14.67%), 50-60(5.91%) and above 60(1.90%). 91% of the respondents are educated but their level of education varies: Illiterates(9.00%), Primary(20.47%), Upper Primary(27.46%), Secondary(24.61%), Inter(12.31%), Degree and above(5.44%) and technical education(0.71%).

Objectives of the study

1. to find out the factors behind the growth of non-farm employment; and
2. toanalyse the determinants of non-farm employment in the study area.

Hypothesis Statement

H_0: Education does not play a positive role to determine the non-farm employment.

H_1: Education plays a positive role to determine the non-farm employment.

Research Tools: The present study used Multiple regression analysis to find out the determinants of non-farm employment in the study area.

Determinants of Rural Non-Farm Employment-Theoretical frame work

A number of essential and congenial socio-economic conditions are must for the advancement of rural non-farm sector (RNFS). In other words, the development of social and physical infrastructure is a pre-requisite for the development of this sector. The available literature advocates a number of factors and processes which have a bearing on the development of this sector.

Mellor's proposed agriculture first (AF) strategy is expected to contribute to RNFE through a strategic shift in favour of agricultural development based on small and medium sized farmers. Thus agricultural biased pattern of development would create strong mass demand linkages to RNFE. The growth of production in agriculture leads to increasing demand for the supply of seeds, fertilizers, pesticides and repair services which are produced or supplied by non-farm activities.

The degree of commercialization of the rural economy would seem to be a major factor affecting the scale, and location of and technology used in rural non-farm activity. Sankarnarayan (1980) argues that it is the degree of commercializing of agriculture that determines the level of non-farm activity in rural areas.

Most of the studies on rural non-farm employment find a significant relationship between the development of infrastructure and the proportion of non-farm workers in the rural areas at cross-section level. Shukla (1992) has pointed out that infrastructural facilities like roads, electricity, posts and telegraphs have significant positive influence on the level and density of rural non-farm employment.

Urbanization is one of the major pull factors which influence the rural non-farm sector. Unni (1990) argues that the proximity to or existence of, a large urban population in the regions may facilitate the growth of non-farm employment in rural areas.

Level of literacy can be expected to positively associated with RNFE. Chada (1993) argues that levels of education can also play a significant role in raising the capability of entrepreneurs to see local opportunities, to promote workers' skills and to forge better rural-urban or agriculture non-agriculture relations. He finds positive links of education to overall rural non-farm employment.

Ho (1985) states that a strong inverse relationship exists between farm size per household and non-farm activity. As farm size declines, farm households become more involved in non-farm activities in terms of both income earned and employment time associated to, non-farm activities.

The degree of commercialization of the rural economy would seem to be a major factor affecting the scale, and location of and technology used in rural non-farm activity. Sankarnarayan (1980) argues that it is the degree of commercializing of agriculture that determines the level of non-farm activity in rural areas.

Public investment in rural areas is also considered to be one of the main sources of rural non-farm employment. Public expenditure on rural infrastructure like agricultural marketing, roads and bridges and irrigation facilities generally stimulate rural non-farm employment (Shukla, 1992).

Irrigation is also considered to be an important factor which leads to an increase in the labour requirement in the non-farm sector.

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The increase in irrigation leads to production in agriculture and increases demand for the supply of seeds, fertilizers, pesticides and sprays and repair services which are produced or supplied by non-farm activities.

Determinants of RNFE in the study area-Regression analysis

To analyse the determinants of RNFE among the sample respondents and to attribute a weight to these determinants, we have used multiple regression analysis. In this model the dependent variable i.e. RNFE is expressed in terms of monthly income of the respondents involved in non-farm activities. Due attention has been paid in collecting the data regarding the monthly incomes of the non-farm workers in the study area.

A list of explanatory variables used in the regression model along with some description notes is given in the table 3.

Table 3. Description of Explanatory variables

Variable	Variable notation	Description of the variable
Y	Dependent variable (Non-Farm Employment)	Monthly income of the respondents involved in non-farm employment
X_1	Gender	Male-1, Female-2
X_2	Age	Non-farm workers age in years
X_3	Level of Education	Level of educational attainment in terms of years of schooling
X_4	Household Size	Number of family members in the household
X_5	Size of land holding	Number of acres operated by the household
X_6	Migration	Migration of family members to urban centres. If the household has a migrated family member it takes the value-1, otherwise it is-0.

Gender(X_1): Gender is an important factor determining participation pattern in Rural Non-Farm Employment. Women are less likely than men to become involved in RNFE. Generally women are expected to have lower participation in non-farm sector than men (Coppart,2001).

Age (X_2): We expect that the age of the worker is inversely related to non-farm income. Aged people generally engage in low earning non-farm activities as they are unskilled and untrained labour. But younger generations with better levels of education have more skills and technological knowledge generally they are expected to have engaged in high earning non-farm activities when compared to older people. Therefore we expect a negative relationship between age of the worker and non-farm income. Hence, the sign of the coefficient of age is expected to be negative.

Level of Education (X_3): Education isa potentially important determinant of RNFE. Education improves an individual's prospect for non-farm jobs as well as increases his ability to allocate time to work efficiently among income producing activities. Less educated households rely on low paying and low productive non-farm pursuits (Lanjouw and Shariff, 2004). So we expect a positive relationship between level of schooling and non-farm income.

Household Size (X_4): The expected relationship between the household size and rural non-farm income and employment is positive. When household size is large, it is more likely to participate in RNF activities (Simmons and Supri, 1995).

Size of Land holding(X_5): The size of agricultural land holding operated by the household measured in acres can tell us about the economic status of the household member. As agricultural land becomes scarce,

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households must find out alternative earnings in non-farm sector. For this reason, landless households mostly depend on non-farm earnings (Anderson and Leiserson, op.cit). However, the effect of landholding on participation and earning from RNF activity is complex. A household with a large land holding may be more committed to agriculture, thus, exhibiting a negative relationship of landholding with non-farm income. We expect the regression to provide information as to whether large holdings tend to raise the propensity to work in RNFS and thereby non-farm income.

Migration (X_6): migration of the family members to urban centres does have an impact on RNFE. Agricultural poverty in rural areas stimulates household members to migrate to urban centres for better employment opportunities. They generally engage in high earning activities in urban areas and send some part of their income to the family members in the rural areas. These incomes enable the rural households to start up some sort of rural non-farm activity and thereby increasing non-farm earnings.

The multiple regression model to be estimated for identifying the determinants of RNFE can be specified as follows.

$$Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+\mu$$

Where **a** is the intercept and $b_1, b_2, b_3, b_4, b_5, b_6$ are the regression coefficients to be estimated and **μ** is the error term.

Primary data is collected from eight villages, viz., Ajjamuru, Chinakapavaram, Kotturu, Koniki, Gunnampudi, Kommara, Vedentapuram and Chopparamannagudem on 845 randomly selected non-farm workers using a structured questionnaire.

The Multiple Linear Regression Model as specified above is estimated for the entire sample and the results are given in Table 1.

Table.4. Regression Results for total sample

Variable	Coefficients	Standard Error	t-ratio	p-value
Intercept	9640.71	584.34	16.49	0.000***
X_1	196.95	140.56	1.40	0.161
X_2	-129.64	8.54	-15.17	0.000***
X_3	259.40	23.84	10.88	0.000***
X_4	837.62	69.53	12.04	0.000***
X_5	-78.93	32.64	-2.42	0.015**
X_6	176.96	129.70	1.36	0.172
No of observations			845	
R-Squared			0.737	
Adjusted R-squared			0.735	
F value			391.40	
Significance F(p-value(F))			0.000***	

** indicates significance at 5% level,
*** indicates significance at 1% level.

Regression results for the total sample are given in table 1. The table shows that the value of R-square is around 0.74 which indicates that about 74% of the variations in the income of the non-farm workers is explained by the independent variables considered in the study.

The overall significance of the regression model is validated by the value of F statistic. The table shows the value of F as 391.404 at 1% level of significance. Hence, we deduce that the regression model is a good fit. The co-efficient of gender is positively related with non-farm income, but it is not statistically significant. It indicates that if a household's participation in RNFE increases by a male member, it may increase monthly household income by around Rs.197. Age of the respondent is negatively related with non-farm income i.e. if the age of the respondent increases by 1 year, it may decrease monthly household income by around Rs.129. Co-efficient of respondent's age is statistically significant at 1% level. According to Rehman, 2011 individuals with higher levels of schooling had a higher probability of participating in economic activities. Probable reason for positive relation might be that with higher education people become more conscious about getting higher income, being

more skilled and use their expertise in their particular occupation. In the study area, the researcher found positive relationship between years of schooling and monthly household income of the non-farm workers. The co-efficient of education is statistically significant at 1% level and it reveals that if education of the non-farm worker increased by 1 year, it may increase monthly household income by around Rs.259. Household size is positively related with RNF income i.e. if household size increased by 1 member, it may increase monthly household income by around Rs.837. Co-efficient of household size is statistically significant at 1% level. The co-efficient of land holding is negatively related with non-farm income and yet it is statistically significant at 5% level. Ibekwe et al., 2010 also supported this result. Probably this is because when a person has more land may feel reluctant to involve in other economic activities and generally it is well known that land holding may less contribute in their household income generation. The co-efficient of migration is positively related with non-farm income of the households, but it is not statistically significant. The positive co-efficient of migration indicates that households with migrated family members earn around Rs.177 more per month than the households without migrated family members. From this discussion, it can be concluded that some variables are significant, but others are not. For non-farm respondents age of the respondents, years of schooling, household size and size of land ownership has significant impact on non-farm income of the respondents.

It is evident from the regression results for the total sample, that level of education is the most significant factor having positive impact on non-farm income of the respondents. The co-efficient of education is statistically significant at 1% level and it reveals that if education of the non-farm worker increased by 1 year, it may increase monthly household income by around Rs.259. **Thus the study got evidence in favor of alternative hypothesis (H_1: Education plays a positive role to determine the non-farm employment) and it is accepted.**

Findings and suggestions

Infrastructure, urbanization, literacy, commercialization of agriculture, public investment, irrigation etc. are the prominent factors contributing for the growth of rural non-farm employment. Under these circumstances it is suggested that the government intervention is urgently required to sustain the growth of rural non-farm employment which in turn can reduce the severity of poverty and unemployment in rural areas.Government should initiate skill oriented training programmes to enhance employability in rural non-farm sector. It should encourage the entrepreneurs to start up MSMEsin rural areas which are capable of providinglarge scale employment opportunities to the rural youth.The government should take adequate policy measures for the development of the farm sector in the rural areas because development of the farm activities will accelerate the development of the non-farm based activities.

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EMPOWERING WOMEN AND STRENGTHENING COMMUNITY HEALTH: A STUDY ON "OSTEOPOROSIS" IN DIFFERENT AGE GROUPS OF PEOPLE IN ELURU, W.G.DT, A.P

K. S. V. K. S. Madhavi Rani[1]*, N. Lakshmi Prasanna[2], V. Sandhya[3] and K. Mrudula[4]

[1]Associate Professor, Ch.S.D.St.Theresa's College for Women(A), Eluru.
[2]Assistant Professor, Ch.S.D.St.Theresa's College for Women(A), Eluru.
[3]Assistant Professor, S.C.H.V.P.M.R. Government Degree College, Ganapavaram.
[4]Post Graduate, Pathology, Alluri Sita Rama Raju Academy of Medical Sciences, Eluru.

***Corresponding Author: K. S. V. K. S. Madhavi Rani**
Associate Professor, Ch.S.D.St.Theresa's College for Women(A), Eluru.

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ABSTRACT
Menopause is described as a period of psychological difficulties that changes the lifestyle of women in multiple ways. Menopausal women require more information about their physical and psychosocial needs. Empowerment during the menopause can contribute to improving the perception of this stage and the importance of self-care. The National osteoporosis Foundation says that one in two women and one in eight men over 50 will have an osteoporosis related fracture in their life time. This study can help to understand, recognize about the causes, symptoms, treatment and prevention of Osteoporosis. The aim of this study was to promote women's empowerment for better health outcome of community.

KEYWORDS: Osteoporosis, Menopause, Women Empowerment.

INTRODUCTION
The fundamental right to the highest attainable standard of health including physical, mental and social well being has been recognized in many global, regional and national declarations and charters. There is now substantial evidence that healthy populations are a foundation for sustainable social, economic and environmental development and for peace and security and vice versa.

Osteoporosis is often called the Silent disease, because bone loss occurs without symptoms. People often don't know that they have the disease until a bone breaks, frequently in a minor fall that wouldn't normally cause a fracture. Many people confuse osteoporosis with arthritis and believe they can wait for symptoms such as swelling and joint pain to occur before seeing a doctor. It should be stressed that the mechanisms that cause arthritis are entirely different from those in osteoporosis which usually becomes quite advanced before its symptoms appear. The National osteoporosis Foundation says that one in two women and one in eight men over 50 will have an osteoporosis related fracture in their life time. Thirty-three percent of women over 65 will experience a fracture of the spine and as many as 20% of hip fracture. This is a major health problem for older adults, who comprise an increasingly greater proportion of the general population. Over 10 million adults in the United States are estimated to have osteoporosis and an additional 43 million to have low bone mass.[7] Osteoporosis poses a serious worldwide health economics issue, though secular and temporal trends differ considerably by region.[2]

LITERATURE
"Osteoporosis" meaning "porous bones", is a disease that causes structural deterioration of the bone tissue with no detectable symptoms. It is related to the loss of bone mass that occurs as a part of the natural process of aging. It results in conditions where there is excess bone loss without adequate replacement. It becomes apparent in a dramatic fashion, causing fractures even after a normal activity such as bending or twisting or falling from the standing position. The broken bones, affect the daily life causing disability to do the daily tasks. Women of all ages and men over age 50 suffer from this disease. Millions of women and men are already at risk for osteoporosis. This is a major health problem for older adults, which comprise an increasingly greater proportion of the general population.[6,8]

Pathophysiology of bone loss and fractures
Low bone mass is a major feature of Osteoporosis. An inverse relationship exists between "Bone mass Density"

(B.M.D) and susceptibility to fracture. B.M.D is the primary indicator of fracture risk in patients. The over all architecture of bone is divided in to cancellous bone (also called as trabecular bone) and cortical bone. The cortical bone forms a compact shell around the more delicate cancellous bone. It is formed by an inter connective lattice work of trabecular. In general, the appendicular skeleton is composed of cortical bone and the axial skeleton is composed of both cancellous bone and cortical bone. The surface area of cancellous bone is more than that of cortical bone, and is metabolically active. So the cancellous bone is severely effected. During the accelerated period of bone loss, immediately after menopause,cancellous bone loss increases three fold, while rates of cortical bone loss are slower.The vertebrae are rich in cancellous bone. So vertebral fractures are common in the early post menopausal years, while hip fractures occur in later years. Bone strength is related to bone mass density (BMD) and other factors such as remodelling frequency (Bone turn over), bone size and area, bone micro architecture and degree of bone mineralization.

After linear growth stops, bone is in a constant state of remodelling with repeated cycles of bone resorption followed by deposition of new bone. In normal conditions bone resorption followed by bone formation is sequential without over loss of bone. This bone turn over is necessary for general bone health as it repairs micro fractures and remodels the bone architecture. Bone has remodelling units. They combine the sequential action of osteoclasts which resorb bone, leaving a cavity or lacuna and the subsequent action of osteoblasts synthesise new bone. When there are aberrations in bone remodeling, thinning of trabeculae occurs and they become disrupted. It is also described as loss of connectivity. It weakens the structural integrity of the bone. Bone is a major reservoir of calcium. In various physiological and pathological conditions, bone mass may be sacrificed to satisfy intracellular and extracellular calcium needs. Because of all these reasons, bones become weak, fragile and porous leading to osteoporosis.

Types of Osteoporosis

Osteoporosis can be classified in various ways, based on diagnostic categories, etiology. Osteoporosis can be classified as primary osteoporosis and secondary osteoporosis. Primary osteoporosis includes age, gender, race, figure type, life style, diet and lack of sunlight. Secondary osteoporosis includes genetic disorders, hypogonadal states, endocrine disorders, hematological disorders, nutritional deficiencies, drugs.

Factors that cause osteoporosis

- Osteoporosis is related to the loss of bone mass that occurs as part of the natural process of aging.
- It results when there is excess bone loss without adequate replacement.
- It is far more prevalent in women after menopause due to the loss of the hormone estrogen.
- It is common in persons.

- Having small thin body.
- Having a family history of osteoporosis.
- Being over 65 years old.
- Not getting enough exercise.
- Long term use of some medecines like glucocorticoids, antiseizure medecines, thyroid hormone replacements etc.

Consequences of osteoporosis

Though osteoporosis is often called as a silent disease, there are some symptoms like.

- Increased risk of fractures with minor trauma.
- Pain in the bones and muscles.
- Breaks in the hip, wrist, spine.
- Sloping shoulders.
- Back pain
- Compressed vertebrae.
- Protruding abdomen
- .Hunched posture.
- Person becomes stooped with a bent back called

Called dowager's hump (kyphosis)

Diagnosis

The diagnosis of osteoporosis is usually made by the doctor using a combination of a complete medical history and physical examination. In order to properly diagnose osteoporosis the bone density must be measured. This can be done using a test measuring the density of the bones in the areas most likely affected by the disease such as spine, hip and wrists.

There are tests that can get to find out the bone density. This is related to how strong or fragile the bones are. One test is called dual-energy x-ray absorptiometry (D X A). A D X A scan takes x-rays of the bones.

Treatment

Treatment for osteoporosis includes eating a diet rich in calcium and vitamin D, getting regular exercise, and taking medication to reduce bone loss and increase thickness. In man Alendronate and triparatide have been approved to treat osteoporosis in men. Calcitonin may work in men, treatment with testosterone increases bone density. In women, the non hormonal bisphoshonate drugs, alendronate and rise dronate prevent and treat post menopausal osteoporosis. Raloxifene is approved for preventing and treating osteoporosis. A class of drugs called estrogen agonists antagonists; commonly referred to as Selective Estrogen Receptor Modulators-SERMS are approved for the prevention and treatment of postmenopausal osteoporosis. They help to slow the rate of bone loss.

Calcitonin: Calcitonin is a naturally occurring hormone that Can help slow the rate of bone loss.

Menopausal Hormone Therapy (M H T):- These drugs which are used to prevent bone loss.
Parathyroid Hormone or Triparatide:- Triparatide is an injectable from of human parathyroid hormone. It helps the body build up new bone faster the broken old bone.

Prevention
Building strong bones during childhood and teen years is one of the best ways to keep from getting osteoporosis later. As the person gets older, the bones don't make new bone fast enough to keep up with the bone loss. And after menopause, bone loss happens more quickly. But there are steps that can be taken to natural bone loss with aging and to prevent the bones from becoming weak and brittle.

1. Get enough calcium each day
Bones contain a lot of calcium. It is important to get enough calcium in the diet. The person, can get calcium through foods and calcium pills. For age group 9-18, the requirement of calcium is 1300mg./day, for 19-50, requirement is 1000 mg./day, and for 51- and above age group the requirement is 1200 mg./day.

2. Get enough vitamin 'D' each day
It is also important to get enough vitamin - D, which helps the body absorb calcium from the food taken. Vitamin "D" is produced in the skin when it is exposed to sunlight. The person needs 10 to 15 minutes of sunlight to the hands, arms and face, two to three times a weak to make enough vitamin D. The amount of time depends on how sensitive the skin is to light. It also depends on the use of sunscreen, the skin colour, and the amount of pollution in the air. The person can also get vitamin D through foods or by taking vitamin pills. The daily Vitamin D requirement for age group 19-50 is 200IU per day, for 51-70 age group, the requirement is 400 IU per day.

3. Eat a healthy diet
Other nutrients (like vitamin K, vitamin C, magnesium, and Zinc, as well as protein) help build strong bones too. Fish, green leafy vegetables, oranges, and milk contain many of the nutrients.

4. Exercise
Exercise is very important for slowing the progression of osteoporosis.

5. Don't smoke
Smoking raises the chances of getting osteoporosis. It harms the bones and lowers the amount of estrogen in the body.

6. Drink alcohol moderately
Alcohol makes it harder for the body to use the calcium taken in.

7. Make your home safe
Reduces the chances of falling by making the home safer. Use a rubber bath mat in the shower or tub. Keep the floors free from clutter. Make sure that have grab bars in the both or shower.

8. Lactose intolerance
If the person is lactose intolerant, it can be hard to get enough calcium. Lactose is the sugar that is found in dairy products like milk. Lactose intolerance means the body has a hard time digesting foods that contain lactose. The symptoms like gas, bloating, stomach cramps, diarrhea and nausea. Lactose intolerance can start at any age but often starts in older age. Lactose- reduced and lactose-free products are sold in food stores.

METHODOLOGY
A survey was conducted to collect the required information from patients suffering from osteoporosis. The data was collected from one orthopedic hospitals for a period of one month in Eluru. The data was collected from 50 patients of different age groups by questionnaire method and the results are tabulated.

RESULTS AND DISCUSSION
Table 1: Percentage of the samples.

S.No	Sex	Percentage of the samples
1	Female	90%
2	Male	10%

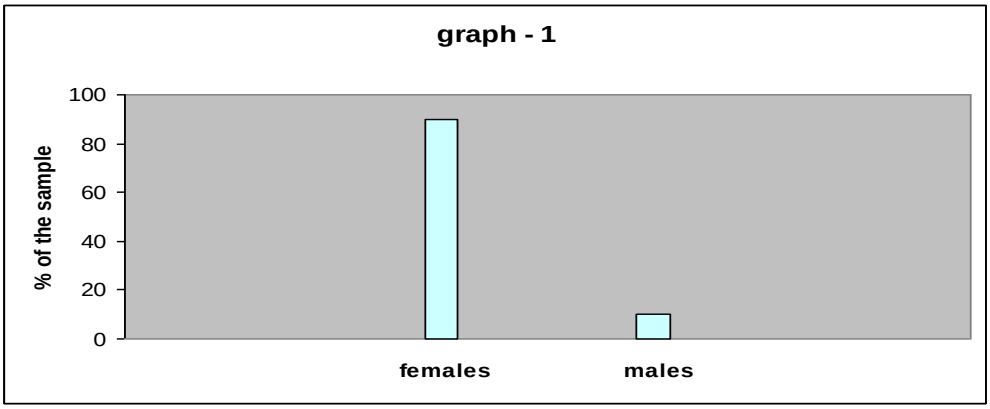


Table 2: Percentage of different age groups suffering.

S.No	Age – group	Percentage effected
1	40 -45	4%
2	46 -50	28%
3	51 -55	30%
4	56 -60	20%
5	61 -65	12%
6	66 – 70	6%

GRAPH - 2

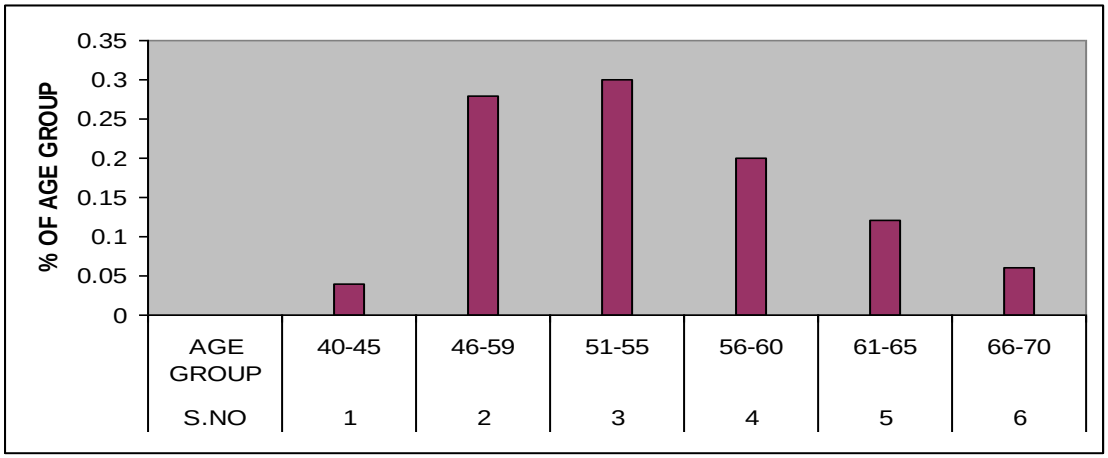


Table – 3: Percentage of the subjects with or without family history.

S.No	Family history	Percentage
1	With family history	20%
2	With out family history	80%

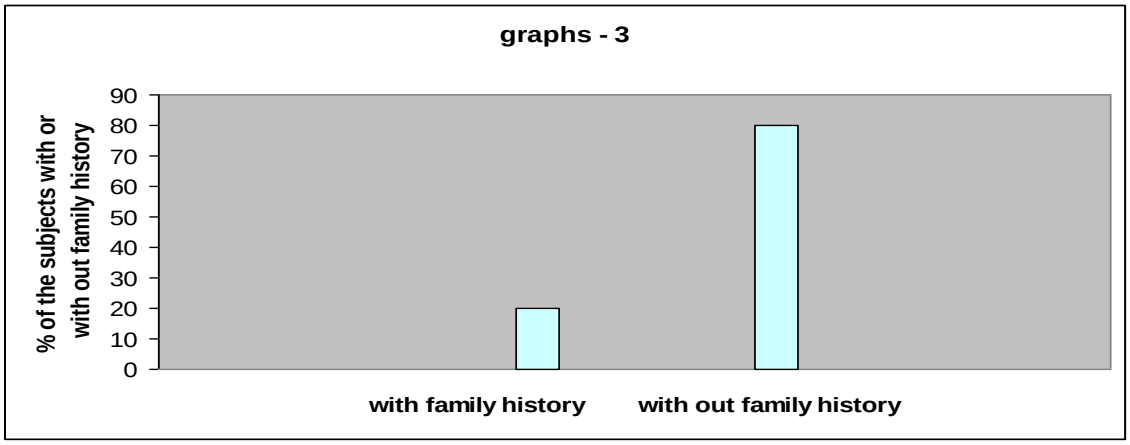
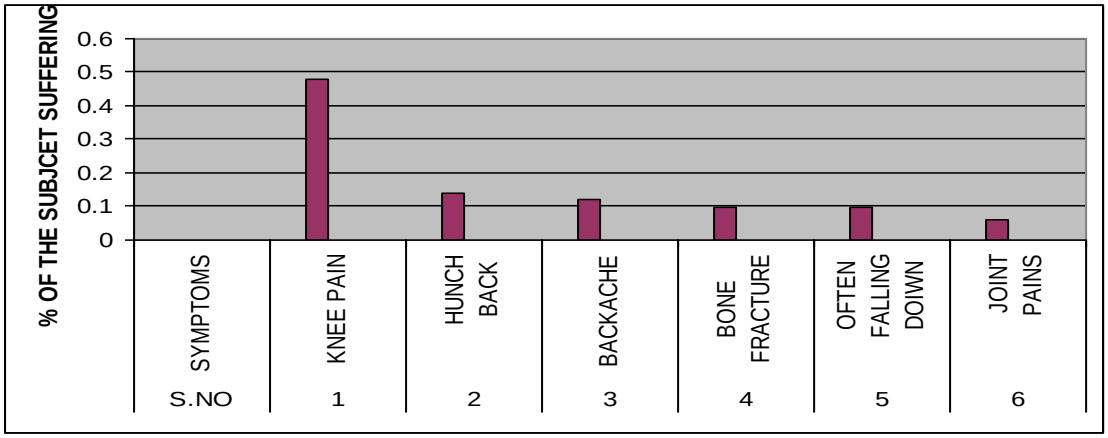


Table 4: Symptoms of Osteoporosis.

S.No	Symptoms	% of the subject suffering
1	Knee pain	48
2	Hunch back	14
3	Backache	12
4	Bone fracture	10
5	Often falling down	10
6	Joint pains	6

Graph – 4



DISCUSSION

- From the survey, it is observed that out of 50 subjects, males are 10% and females are 90% . So the females are more prone to this disease. Prevalence of osteoporosis increases with age in women and not in men. It is reported that 42.5% women and 24.6% men above the age of 50 years suffer from osteoporosis in India(6)
- Among 40 – 45 age group, 4 % are effected, 46 – 50 age group, 28% are effected, 51 – 55 age group, 30% are effected, 56 – 60 age group, 20 % are effected, 61 - 65 age group, 12% are effected, 66 – 70 age group, 6% are affected. These results reveal that the incidence of osteoporosis peaks in the age group of 51-55 followed by the age group 46-50 and it was proved in earlier studies. This condition is related to menopausal stage of women.
- 20% of the subjects are with family history and 80% are without family history. So to some extent osteoporosis may be hereditary.
- 48% of the subjects are suffering from Knee pain, 14% are suffering from Hunch back, 12% are suffering from Backache, 10% are suffering from Bone fracture, 10% are falling down frequently, 6% are suffering from severe joint pains. The main constraints to optimal treatment for osteoporosis, according to the physicians who participated in the current study, are lack of consistent compliance on the part of patients and lack of knowledge. Recently published studies have shown suboptimal adherence to osteoporosis treatment in a number of countries.[4,5]

CONCLUSION

Because it is hard to replace bone that is lost, prevention is the key. Beginning a life long commitment to exercise and nutritious, food in young age reduces the risk of developing this condition later in life. Act now to build strong bones to last a lifetime.

"**Best Bones Forever**" is a national education effort to encourage girls aged 9-14 to eat more foods with calcium and vitamin D and get more physical activity. There is also a website for the parents, which gives them the tools and information they need to help their daughters build strong bones, during the critical window period of bone growth that is between 9-18 years to make them empowered. Recent publications have attributed deficiencies in osteoporosis management to inadequate communication and cooperation among the physicians involved: general practitioners, orthopedic surgeons, endocrinologists and rheumatologists.[1,3] Empowerment of menopausal women will guarantee their health during the last third of their life. The results of the present study can pave the way for future research to promote women's empowerment for better health outcome of community.

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Category III

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"MATHEMATICAL APPLICATIONS IN BIOLOGY"

S. Pratima Kumari[1], M.Rama Satyavathi[2], K.Swarnalatha[3], V. Sandhya[4]
Dept. of Zoology[1'2], Dept. of Chemistry[3],Dept. of Zoology[4]
Ch.Sd.St Theresa's College for Women[1'2' 3], S.CH.V.P.M.R Govt. Degree College, Ganapavaram[4], Eluru, India.
1spratima67@yahoo.com.

ABSTRACT

Nowadays experimental techniques used to investigate biological systems are generating more amounts of data. This is the reason for which researchers are turning to mathematical and computational models to understand and make quantitative predictions of data as to how biological systems will behave in different conditions. The advancement of mathematical modeling, computer equipment, and computational methods has made it possible to describe in detail systems consisting of many billion atoms, while the achievements of molecular biology have helped to acquire large amounts of data from experiments. These prerequisites laid the foundation for new scientific disciplines, such as mathematical biology, bioinformatics etc., which study the structure, operation of living systems and proceeding. The main applied tasks of these disciplines are computer-aided design of medications, nanobioelectronics, and analysis of individual genetic information. Heavy metals with its high metallic weight and density are accumulated depending on the period of exposure causing notable changes in physiology and anatomy. Jointly with toxicology, human genome mass sequencing and mathematical biology form the basis for the national development.

KEYWORDS: Mathematical biology, Computational methods, Bioaccumulation, Statistics Toxicology.

INTRODUCTION

What is biomaths or bio-math·e·mat·ics?. The definition biomathematics is the application of math to the field of biology or using mathematical principles and applications to understand biology better. Mathematical biology aims at the mathematical representation and modeling of biological processes, using techniques and tools of applied mathematics. Mathematical and Theoretical biology is a branch f biology which employs theoretical analysis, mathematical models and abstractions of the living organisms to investigate the principles that govern the structure, development and behavior of the systems, as opposed to experimental biology which deals with the facts on experimental basis. Mathematical biology is a broad topic that can cover a large range of length scales, from the submicron lengths of DNA polymers to the kilometer length scales of migration patterns of animal herds. Where Math is used: Biologists use math as they plot graphs to help them understand equations, run small "trial and error" tests with some sample numbers, developing algorithms, and use the R project (Reverse phase analysis) for analyzing protein sequences and structures Yates .A, et al. (2004) Is there math in Biology? One key role of math in biology is the creation of mathematical models. These are equations, formulas, graphs, models, tables, methods that can predict or describe natural occurrences, such as organism behavior, patterns, population changes or bioaccumulation over time. The Malthusian growth model is the grand daddy of all population

models where statistics are used to count the number of individuals A.Friedman and F. Reitch (2001). Biofluid mechanics is a new branch applying fundamental ideas from fluid mechanics to understand better the biology of living systems where maths is used to measure the amounts of fluid and for preparation of fluid mixtures Avner Friedman, (2010). Biomathematics has both theoretical and practical applications in biological, biomedical and biotechnology research. Describing any systems in a quantitative manner means their behavior can be better simulated and hence properties can be predicted that might not be evident to the experimentation. This requires precise mathematical models. Mathematical biology employs many components of mathematics and has contributed to the development of new techniques Gyllenberg and M. Lewis (2018). Fast bioanalysis requires the use of short columns packed with high efficiency particles in HPLC, the use of ultra-high performance liquid chromatography (UHPLC) comes at a price of much higher pressure when sub-2 μm particles are employed for separation. In developmental biology genomics groups in ESAM are using tools from statistics, machine learning, and statistical physics to build data-driven mathematical models to address it A. Friedman and F. Reitch (2001). With advances in both chromatography and mass spectrometry, sensitivity and accuracy of a technique called LC-MS has further increased, allowing detection and identification of low-level analysis of analytics in complex sample matrices. This analytical technique has helped in quantization and identification of unknown from a variety of complex samples like human health nutritional requirements, minerals which include light and heavy metals such as copper, chromium, iron and zinc. They are non-toxic unless taken in large amounts. Other heavy metals such as mercury, arsenic, lead are toxic even at low levels. Heavy metals if accumulated in vital organs of human body such as in heart, brain, kidney, intestine and liver may create disturbances in the cell to cell communication occurring between inflammatory mediators, nerve cells or hormones. So it is pertinent to calculate the amount of heavy metals accumulated in the tissue which requires the aid of mathematics. .

CASE STUDY

Organism's growth in size is not a static matter before reproductive phase. It changes with time, food availability, toxicity and environmental resistance. Growth shows a predictable pattern represented in two growth graphs 'J' (Exponential growth) when the resources like food, space is available in plenty and 'S' type growth showing lag phase, acceleration, deceleration and finally asymptote phase which are also seen in experimental fish *Pangasianodon hypophthalamus* fish fry exposed to copper concentration of 0.25, 0.5, 1.0, 2.0, 4.0 for 96 hours shows LC50 value of 33.33, 53.63, 71.76, 80.45, 89.44 Pratima K.S (2014). The control fish showed no death and there was study growth in the fish population hence J shaped growth graph was seen. Never a population of any species in nature has at its disposal unlimited resources due to limit in resources, toxicity, different anthropological activities and competition there by maintaining a particular carrying capacity in a habitat. A sigmoid curve is seen. Using the principles of calculus, statistics and an integral form of the exponential growth an equation derived is

$$N_{t=No}\, e^{rt} \quad \text{Where}$$

N_t = Species density after time t;

No = Species density at time zero;

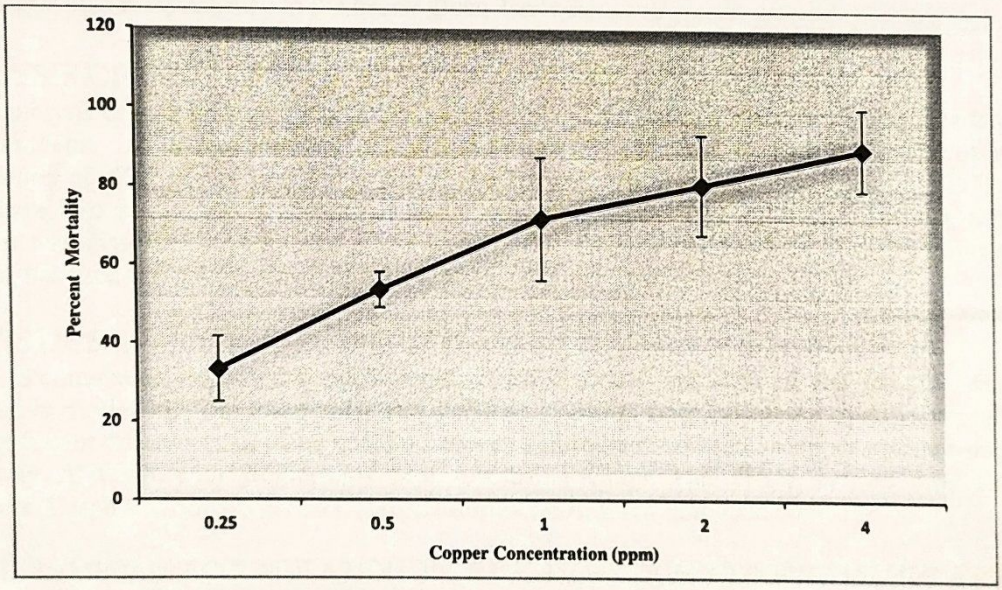
r = Intrinsic rate of natural increase

e = The base of natural logarithms

TABLE 1: TOLERANCE OF *PANGASIANODON HYPOPHTHALMUS* FRY EXPOSED TO DIFFERENT CONCENTRATIONS OF COPPER. EACH VALUE OF PERCENT MORTALITY REPRESENTS THE MEAN ± STANDARD DEVIATION OF FIVE EXPERIMENTS.

Concentration of copper (ppm)	No. of animals exposed in each experiment	Percent mortality ± Standard Deviation
0.25	20	33.33 ± 8.36
0.5	20	53.63 ± 4.52
1.0	20	71.76 ± 15.66
2.0	20	80.45 ± 12.73
4.0	20	89.44 ± 10.44

Graph: 1 THE MEAN PERCENT MORTALITY RATES OF THE FRY AFTER 96 HRS OF EXPOSURE TO DIFFERENT CONCENTRATIONS OF COPPER SHOWING A SIGMOID GROWTH.



The mean percent mortality rates of the fry after 96 hrs of exposure to different concentrations of copper are presented in Table 1. The linear regression equation obtained for log concentration of exposure and probit values of percent mortality was Y = 2.7227 + 1.3712X with correlation

coefficient (r) of 0.9947 as seen in Table 2. All these calculations require different applications formulas and procedure to ultimately note the effect of copper on the fish even in minor amounts. This will help ultimately to study its effect on fish ponds and tanks where Malachit Green a copper containing chemical is used as disinfectant by local farmers in a un calculated amounts which are showing its adverse effects on fish growth, physiology and biochemical reactions reflecting on its total productivity.

TABLE 2: LC_{50} VALUE, SAFE CONCENTRATION, REGRESSION EQUATION, CORRELATION CO-EFFICIENT FOR THE FRY OF *PANGASIANODON HYPOPHTHALMUS* FRY EXPOSED TO COPPER.

Parameters	*Pangasianodon hypophthalmus*
LC_{50} (ppm)	0.4578 ± 0.03167
Safe concentration (µg/L)	4.578
Regression equation	Y = 2.7227 + 1.3712X
Correlation co-efficient	0.9947

When the fish fry were exposed to a sublethal concentration (0.0915 ppm) i.e. $1/5^{th}$ of 96 hrs LC_{50} for a period of 30 days and the experiment repeated thrice for a batch of 50 fishes, it was seen that metal accumulation increased with increase in exposure period. Graph Pad Prism combines powerful biostatistics, curve-fitting, and scientific-graphing tools in a comprehensive program. Prism meets practically the majority of the data handling necessities of lab specialists, particularly researcher and scientific experts. It doesn't just reduce project risks but also provides one source of truth throughout the entire project. So ONE WAY ANOVA was done taking the above data which is represented in the below given Table 3.

ANALYSIS OF COPPER

The analysis of metal content was carried out with the dried tissue powder of *Pangasianodon hypophthalmus*. A known quantity of the tissue powder was kept in muffle furnace at a temperature of 600^0 C for about 4-5 hrs to make into ash (George and Kureishy, 1979; Prabhakara Rao *et al.*, 1986; Uma Devi and Prabhakara Rao, 1989b, 1989c). The dry ash obtained was dissolved in a known amount of 0.01N HNO_3. The final clean and colorless solution was used for metal estimati n with ICPMH (Agilent Technologies).

STATISTICS

The accumulation experiments were repeated for 3 times and each of the samples was analyzed in triplicates. The mean value and standard deviation were calculated at each interval. The significant differences in metal content between control and exposed group was made using "One-way ANOVA with Bonferronis post test using Graph Pad Prism version 5.00 for Windows, Graph Pad Software, San Diego California USA, www.graphpad.com".

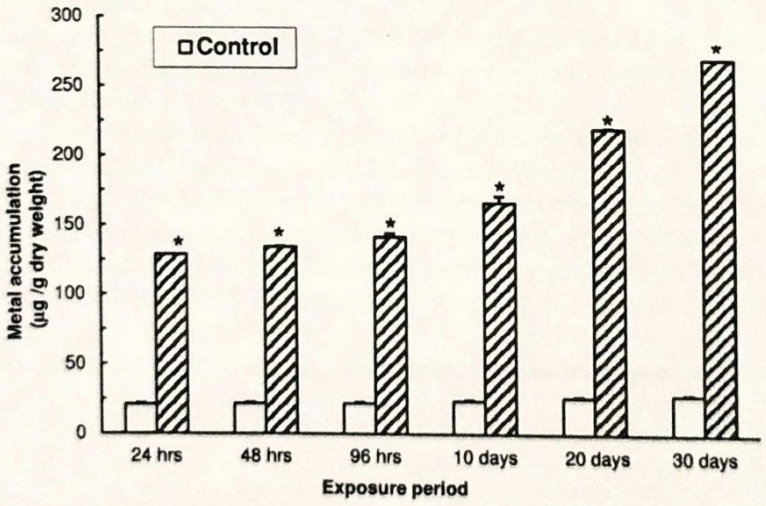
TABLE 3: METAL ACCUMULATION IN *PANGASIANODON HYPOPHTHALMUS* FRY EXPOSED TO 0.0915 PPM OF COPPER. EACH VALUE REPRESENTS THE MEAN ± STANDARD DEVIATION. THE VALUES IN THE PARENTHESES REPRESENT PERCENT DECREASE OVER THEIR RESPECTIVE CONTROLS. *SIGNIFICANTLY DIFFERENT FROM THEIR RESPECTIVE CONTROLS AT $P < 0.05$.

Groups	Exposure period					
	24 hrs	48 hrs	96 hrs	10 days	20 days	30 days
Control (µg/gm dry Wt.)	22.09 ± 2.51	22.79 ± 2.731	17.94 ± 4.19	21.33 ± 1.144	20.01 ± 2.651	20.33 ± 4.73
Exposed (µg/gm dry Wt.)	28.31 ± 2.731 (21.97)	36.56 ± 3.719* (37.66)	40.92 ± 2.316* (56.15)	43.87 ± 2.302* (51.37)	66.59 ± 5.155* (69.96)	111.2 ± 2.267* (86.76)

ONE WAY ANOVA

Source of Variation	Degrees of freedom	Sum of squares	Mean Square	F Value
Treatments (between columns)	11	24360	2215	221.9
Residuals (with in Columns)	24	239.5	9.979	
Total	35	24600		

Metal accumulation in P. hypophthalmus fry exposed to sublethal copper. Vertical lines represent standard deviation. * Signifies different from their respective controls at P< 0.05..



CONCLUSION

Mathematics has evolved by the urge of science and technology. Some of the science branches have developed due to advancements in mathematics. By using mathematics and computational model, biochemical and physiological changes can be understood better in the fish body. Without various tabloid formulations employed in the experiment it would be impossible to precisely explain what was the effect of copper on the fishes. The data obtained by experiments was very well analyzed by ONE WAY ANOVA which fully involves mathematics and graph respectively. The graphic representation helps even a lay man to understand easily the effect of copper. So it is easy to educate our literate and illiterate farmers which will help them to use calculated amounts of disinfectants in the fish ponds which reflect on our countries over all blue revolution output. By seeing the present trend in mathematical biology globally, I believe that the coming decades will demonstrate very clearly that mathematics and biology are frontiers of each other.

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Alternative Sources of Engine Fuel-Bio Diesel With Reference To Vegetable Oils

K.Ravi[1], V.Sandhya[2], R.Indira[3],K.S.V.Madhavi Rani[3], Ch.V.Mahalakshmi[4]
1. Dept of Telugu, Sir C.R.Reddy (A) College – Eluru, W.G.Dt
2. Dept of Zoology, S.CH.V.P.M.R Govt DegreeR college – Ganapavaram, West Godavari Dist
3. Dept of Zoology, St Theresa's(A) College For Women – Eluru,W.G.Dt
4. Dept of Hindi, St Theresa's(A) College For Women – Eluru,W.G.Dt
Corresponding Author: K.Ravi

Abstract: *Vegetable oil can be used as an alternative fuel in diesel engines and in heating oil burners. When vegetable oil is used directly as a fuel, it is referred to as straight vegetable oil (SVO) or pure plant oil (PPO). Conventional diesel engines can be modified to help ensure that the viscosity of the vegetable oil is low enough to allow proper atomization of the fuel. This prevents incomplete combustion, which would damage the engine by causing a build-up of carbon. Straight vegetable oil can also be blended with conventional diesel or processed into biodiesel or bio liquids for use under a wider range of conditions.Transportation industry is part and parcel of every nations economic growth. Motor fuel or diesel is the main ingredient which decides the transportation cost. Small Arab countries are able resources. Petroleum is a liquid gold for any country. But it is a non-renewable source, which takes hundred years to be replenished. Nation's like India do not have enough petroleum resources and have to spend a major part of its foreign exchange to import oil. The position is same for many other developing countries also. So search for renewable motor fuels gained importance.*

Keywords: *Preparation, Methods to reduce viscosity, Benefits, Physical properties.*

I. Introduction

Research for alternative renewable motor fuels like Bio-diesel started in scientific community way back in 1895. Doctor Rodolf diesel engine to run on vegetable oil (peanut oil). In 1911 he stated that "The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it." This statement is very much true and apt in case of India whose economy is dependent mainly on agriculture. Preparation of Bio-diesel is a simple process. It can be produced in backyard of the house itself using cooked vegetable oil with some safety measures. The following are some of the methods of preparation of Bio-diesel. Vegetable oils are chosen for chosen for production of Bio-diesel because of their better lubricity, but its viscosity is higher than petrol-diesel. Hence following methods are adopted to reduce its viscosity.

Method 1: Esters of vegetable oils formed by trans-esterification process of vegetable oil with alcohol in the presence of a catalyst gives Bio-diesel. The vegetable oil may be fresh or used vegetable oil (WVO). The other processes are pyrolysis, micro-emulsion, and blending and thermal, polymerization. These processes decrease the high viscosity of vegetable oil to be used as diesel fuels. The viscosity of the Bio-diesel now matches the European standard EN 14214, American ASTM standards.

Method 2: SVO or straight vegetable oil can also be used as diesel fuel. SVO can be used in vehicles by fitting two fuel tanks, the first containing petro-based diesel and the second, vegetable oil. The engine starts on petro-oil and runs for a short time while the vegetable oil in the second tank is warmed up by hot fluid form the engines cooling system. When oil reaches a specific temperature, the engine switches from petro-oil to vegetable oil.

Method 3: In another system, there will be only one fuel tank and the vegetable oil is heated up to appropriate temperature by an electric coil so that its viscosity decreases before it enters the high pressure pump.

Method 4: In this method blends of bio-diesel and petro-diesel or SVO & petro-diesel in proportions of B-20, B-30 etc are used in the fuel tanks. It facilitates improvement in performance of the engine, enhanced lubricity and reduction in toxic emissions.

Benefits:

- The main benefit derived is reduction in emissions generated when using this Biodegradable low toxic fuel.
- It is fully renewable source manufactured with in the country.
- It reduces carbon-dioxide emission by 80% and sulphur dioxide by 100%, which is the cause of acid rains.
- It reduces exhaust smoke by 75% cause for black cloud associated with a diesel engine.
- Its exhaust is far more pleasant than petro-diesel and does't harm the mechanic's hands while handling and also protect their skin from cracking or redness.
- It is less dangerous to fill in vehicle fuel tank since its flash point is 150 degree centigrade as opposed to petroleum diesel which is 70 degree centigrade.
- During spillage, Bio-diesel degrades four times faster than petroleum diesel.
- It has significant lubricity than petroleum diesel enhancing the lifetime of engines and performance. ULSD (ultra low sulphur diesel) needs additives to improve its lubricity. But ULSD mandated by EPA (environmental protection agency) makes injector pumps to wear-out soon.
- Bio-diesel reduces classic diesel engine knocking noise.
- Bio-diesel doesn't require any changes to the existing storage infrastructure.

Use of Bio-diesel in conventional diesel engine results in substantial reduction in unburnt hydrocarbons, carbon monoxide and particulate matter. The carbon fraction of particulate matter is decreased due to the increased amount of oxygen present in Bio-diesel, which enables a more complete combustion process.

Bio-diesel exhaust has a less harmful impact on human health and reduces the levels of all largest polycyclic aromatic hydrocarbons (PAH) and nitrated PAH compounds to 75-85%.

Using Bio-diesel with some additives Non emissions can be reduced by 24000 tons per year from air, which is the main contributor of ozone pollution.

Bio-diesel will clear injectors and fuel lines extremely well, as it is an excellent solvent. It will not create sludge as in the case of petro-based diesel engines. We need to reduce the amount of fossil fuel we burn, if we have any hope of cleaning up the air. Bio-diesel allows us to do this today without stopping the trucks running that keeps our economy moving.

II. Problems with Bio-diesel

compounds mainly aromatics, sulphur, oxygen, nitrogen where as vegetable oils are mixtures of tri glycerides of fatty acids It will soften and degrade certain types of elastomers and natural rubber compounds used in older fuel hoses and pump seal systems. But new vehicles (after 1994) are fitted with synthetic fuel lines and seals which suffer no problem with Bio-diesel.

Need of a physicist in bio-diesel scene: When SVO or Bio-diesel is to be used as alternative fuel, it is the work of a physicist to study the physical properties and standards prescribed for petro-diesel as motor fuels. These are basically homogenous mixtures of paraffin, naphthenes and unsaturated cyclic.

The physical properties of SVO's and Bio-diesel to be studied are:

API gravity: Inverse of specific gravity.

Pour point: It is the lowest temperature at which the lubricant will flow under specified conditions and is related to viscosity-temperature phenomena.

Flash point: Indication of combustibility of vapours of oil. It is the lowest temperature at which the vapor of oil can be ignited under specific conditions.

Specific heat: It is the function of fluid structure and density. It is used in the calculation of heat transfer and other thermal factors in oil filling.

Heat of combustion: It is measured in terms of Wobble number.

Latent heat of vaporization & Latent heat of fusion: Quantities related to molecular weight, API and boiling point.

Thermal expansion coefficient: It is required to find out the volume of the container (fuel tank) which is exposed to frequent changes of temperature.

Viscosity & Viscosity index: It is an important property of lube oils in removing the frictional forces between two moving bodies or engine parts.

Thermal conductivity: It is the controlling factor for overheating when oil is transferred from hot spot to a cooler area in a bearing.

Compressibility: It express the resistance of a fluid to a decrease in volume due to compression.

Electrical conductivity: This property is important for insulating oils. It is important in lubricated components subjected to stray or self-generated electric currents.

Surface tension: It is the ability of oil to wet a surface.

Interfacial tension: It exists between two liquid layers.
By studying above properties for vegetable oils we can predict which type of oils can be used as SVO or Bio-diesel. Bio-diesel is also utilized in generators for electric power production and as insulators in transfolrmer coils.

Advantages of biodiesel fuel:

- Biodiesel fuel is a renewable energy source unlike petroleum-based diesel**.**
- An excessive production of soy beans in the world makes it an economic way to utilize this surplus for manufacturing the biodiesel fuel.
- One of the main biodiesel fuel advantage is that it is less polluting than petroleum diesel.
- The lack of sulfur in 100% biodiesel extends the life of catalytic converters.
- Another advantage of biodiesel is that it can also be blended with other energy resources and oil.
- Biodiesel fuel can also be used in existing oil heating systems and diesel engines without making any alterations.
- It can also be distributed through existing diesel fuel pumps, which is another biodiesel fuel advantage over other alternative fuels.
- The lubricating property of the biodiesel may lengthen the lifetime of engines.

Disadvantages of biodiesel fuel:

- At present, biodiesel fuel is about one and a half times more expensive than petroleum diesel.
- It requires energy to produce biodiesel fuel from soy crops, plaus there is the energy of sowing, fertilizing and harvesting.
- As biodiesel cleans the dirt from the engine, this dirt can then get collected in the fuel filter, thus clogging it. So, filters have to be changed after the first several hours of biodiesel use.
- Biodiesel fuel distribution infrastructure needs improvement, which is another of the biodiesel fuel disadvantage.

In India, jatropha oil is used as main ingredient in production of Bio-diesel and Indian government subsidizes farming of Jatropha. In A.P, Palmolein oil is the cheapest oil produced. So we as researchers can study about the cheapest bio-diesel possible in our conditions.

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