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Taxonomic diversity of understorey vegetation in Kumaun Himalayan forests

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Abstract: Taxonomic diversity of understorey vegetation (herb species) was studied in two evergreen forests, *viz*. oak and pine in the Kumaun Himalaya. In terms of taxonomic diversity, Asteraceae and Lamiaceae were the two dominant families in the sampling forest types. Maximum number of species was found at hill base and minimum at hill top in both the forests. The number of families, genera and species ratio observed for pine forest was of course higher with compared to the oak forest showed about the higher taxonomic diversity. Perennials form had higher contribution as compared to annuals forms indicated better ability to store up soil. Very few species (9 species) were found to be common indicates higher dissimilarity in both type of forests. Species richness (per m^2) was higher in the pine forest than the oak forest. A high value of beta-diversity in the oak forest point out that the species composition varied from one stand to another. However, low concentration of dominance value in the pine forest with compare to the oak forest point towards the dominance, which is shared by many species. [Journal of American Science 2009;5(6):1-5]. (ISSN: 1545-1003).

Key words: Species richness, beta-diversity, taxonomic diversity, forest

1. Introduction

The pattern and relationships between species diversity and ecosystem functioning are the current areas of great ecological interest throughout the world. Species diversity incorporates two components (Stirling and Wilsey, 2001); evenness (how evenly abundance or biomass is distributed among species) and richness (number of species per unit area). High evenness can increase invasion resistance, below-ground productivity and reduce total extinction rates (Smith et al., 2004). The spatial variations in biodiversity generally include species diversity in relation to size of the area, relationship between local and regional species diversity and diversity along gradients across space, and environmental factors such as latitude, altitude, depth, isolation, moisture and productivity (Gaston, 2000). In addition, species richness of a taxon is not only sufficient to express diversity but the equitability is also a important factor because communities however vary in properties of the total importance of the species and share their functional contribution (Tilman, 2000).

A fundamental characteristic of mountain ecosystems is to the drastic change in vegetation as well as in climatic conditions from the base to the summit of the mountain. Elevation gradients create varied climates, along with resultant soil differentiation; promote the diversification of plant species (Brown, 2001). Many studies have investigated on species richness along elevation gradient across habit and taxa (Sanders et al., 2003), as part efforts to understand ecosystem effects on biodiversity and maintenance of biodiversity (Gytnes and Vetaas, 2002). Furthermore, the observation relations between species distribution and elevation bands may also help to understand the possible effects of climate change, e.g. by providing baseline information to measure the effect of climate change and anthropogenic changes on vegetation.

The forest herbs, which play important role for rural communities for example, the livestock totally dependent on them for fodder and as traditional medicines, have been hardly studied from diversity standpoint (Singh and Singh 1987). Quantitative information on the forest floor species of the Central Himalaya region is generally lacking except for studies done by Rawat and Singh (1989), and Singh and Singh (1992). Interestingly, most of the recent major field experiments addressed questions relating to species diversity which has been carried out in grasslands. But forest herbs of the Himalayan region remain poorly studied.

In the present study we investigate herb species richness (spermatophyte) in terms of taxonomical diversity and species composition in relation to oak and pine forests in Central Himalayan forests.

2. Material and Methods

The study area is located between 29°21′ and 29°24′ N latitudes, and between 79°25′ and 79°29′E longitudes, in the elevational belt of 1600-1950 m asl around Nainital town in Kumaun region of Central Himalaya. The two major forest types, *viz*., *Quercus leucotrichophora* (oak) and *Pinus roxburghii* (pine)

were selected for this study. The climate is monsoon temperate. The mean monthly temperature ranged from 11.5ºC (January) to 18.4ºC (June). The rocks of study area belongs to krol series which is a sequence of limestone, grey and greenish grey and purple slates, siltstones (Valdia, 1980). Soil texture is sandy clay and it is acidic in nature. The sites having minimal biotic disturbances in terms of grazing or herbage removal were selected. The site variations due to the canopy changes are presented in Table 1. For detailed studies of plant biodiversity and other vegetational parameters, selected sites were divided into three stands, *viz.*, hill base, hill slop and hill top (HB, HS and HT, respectively).

Table 1. Certain characteristic of study sites

Characters	Forest	
	Close	Open
Elevation (m)	1950	1600
Mean annual temperature (°C)	16	15.8
Total rainfall (cm)	216	200
pH	6.8	5.6
Nitrogen (%)	33	26
Organic carbon (%)	3.5	3.7
C: N ratio	10.6	14.2
Moisture content (%)	42	35

Phytosociological analysis of the herb species in each forest site was carried out by randomly placed 20, 1×1 m^2 quadrats during the peak growth month (September). Diversity was calculated by using Shannon-Wiener index (1963) as:

$$H' = -\sum_{n=1}^{i} \square Ni/N \square \log 2 \ \square Ni/N \square$$

where, Ni is the total number of species i and N is the number of individuals of all species in that site. Concentration of dominance was measured by Simpson's Index (1949) as: $C = \Sigma (Ni/N)^2$ where Ni and N are the same as for the Shannon-Weiner information function. Beta-diversity was calculated following Whittaker (1975) as: $\beta = Sc/s$ where, Sc is the total number of species encountered in all quadrats and s is the average number of species per quadrat. Equitability or Evenness was calculated to represent the distribution of individuals among the species (Whittaker, 1972) as: E = S / (log Ni - log Ns) where, S is the total number of species, Ni is the number of individuals of most important species, Ns is the number of individuals of least important species and E is the evenness index.

3. Results

The forest herbs species in the oak and pine forests belongs to 21 families. The total number of species present in the oak forest and pine forest was 32 and 41, respectively.

Table 2. Taxonomic distribution of species (G, Genus; S, Species)

Family	Oak		Pine	
	G	S	G	S
Asteraceae	4	4	9	9
Acanthaceae	1	1	1	1
Apiaceae	2	2	2	2
Amaranthaceae	1	1	-	-
Borngingaceae	-	-	1	1
Brassicaceae	-	-	1	1
Commelinaceae	1	1	1	1
Companulaceae	-	-	1	1
Cyperaceae	1	1	2	2
Fabaceae	2	2	2	2
Geraniaceae	1	2	-	-
Gentiaceae	1	1	1	1
Liliaceae	1	1	-	-
Lamiaceae	3	3	7	7
Orchidaceae	2	2	1	1
Oxalidaceae	1	1	-	-
Poaceae	1	1	2	2
Polygonaceae	1	1	1	1
Ranunculaceae	1	1	1	1
Rosaceae	1	1	1	1
Rubiaceae	1	1	2	3
Violaceae	1	1	-	-
Utricaceae	2	2	1	1
Zingiberaceae	2	2	1	1
Caryophyllaceae	-	-	1	1
Crassulaceae	-	-	1	1

Table 2 depicts diversity of the Angiosperm family in both forest sites. In the oak forest, Asteraceae was represented by four species, followed by Lamiaceae (3 spp.), Fabaceae, Orchidaceae, Utricaceae, Zingiberaceae, Apiaceae and Geraniaceae (2 spp. each) and remaining 13 families were represented by one species each. Taxonomically, Asteraceae was the dominant family (with 4 genera), followed by Lamiaceae (with 3 genera), Apiaceae, Fabaceae, Orchidaceae, Utricaceae and Zingiberaceae (with 2 genera each) and remaining 14 families were represented by single genus only.

In the pine forest, Asteraceae was represented by nine species followed by Lamiaceae (7 spp.), Rubiaceae, (3 spp.), Fabaceae, Poaceae, Apiaceae, and Cyperaceae (2 spp. each) and remaining 14 families were represented by single species. Taxonomically, Asteraceae (with 9 genera) was the most diverse family followed by Lamiaceae, (with 7 genera), Apiaceae,

Poaceae, Rubiaceae and Cyperaceae (with 2 genera each) and remaining 13 families were each represented by a single genus (Table 2).

The number of species varied spatially in both forests. In oak forest it varied from 15 (HT) to 30 (HB) and in pine forest from 12 (HT) to 23 (HB). Across the forests, maximum species were present in oak forest (at HB, 30) as compared to pine forest (at HB, 23). Species richness was higher (7.4) at HB and lower at HT (5.0) in oak forest. Similar pattern was found in pine forest, i.e., maximum species richness was at HB (10.5) and minimum at HT (4.7).

Table 3. Comparison of diversity indices (Sp, species number; Sr, speceis richness; Bd, beta-diversity; H', diversity; Cd, concentration of dominance; E, evenness/equitability)

Indices	Oak forest			Pine forest		
	HB	HS	HT	HB	HS	HT
Sp	30	23	15	23	17	12
Sr	7.4	6.9	5.0	10.5	6.5	4.7
Bd	4.5	4.6	4.6	2.8	2.9	2.8
H'	4.2	4.2	3.5	4.4	4.0	3.4
Cd	1.4	0.1	0.1	0.1	0.2	0.1
E	31.7	27.1	17	27.3	27.4	31.4

Among the both forest site, species richness value was maximum in pine forest at HB (10.5) and minimum in oak forest at HB (7.4). Beta diversity showed pronounced effect at both sites. The value for oak forest varied marginally from 4.5 (HB) to 4.6 (HS), respectively. While for pine forest, it remained approximately same at all sub-sites. Between the forests, the value was higher in oak forest than pine forest. The lowest value of beta-diversity in oak forest was observed at HB (4.5) and for pine forest at HS (2.8). Equitability/evenness value ranged from 17.0 (HT) to 31.7 (HB) in the oak forest. A reverse pattern was observed in the pine forest (31.4 at HT and 27.3 at HB).

Table 4. Forest wise ratio of species, genera and family (F, Family; G, Genus; S, Species)

Forest	F:G	F: S	G: S
Oak	1.2	1.3	1.0
Pine	1.4	1.5	1.1

The concentration of dominance fluctuated from 0.1 to 1.4 in oak and from 0.1 to 0.2 in pine forest (Table 3). It was comparatively higher in the oak forest. The low value of concentration of dominance indicates that the dominance is shared by many species. The ratio of family to species, family to genera and genera to species for the both forests indicated higher taxonomic diversity in pine forest than that in the oak forest (Table 4). Percent contribution of perennial herbs is maximum in oak forest than the pine forest (Figure 1).

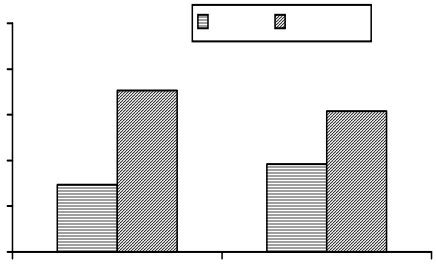

Figure 1. Percent contribution by life forms in oak and pine forests

4. Discussions

The changes in topography, altitude, precipitation, temperature and soil conditions contribute to the diverse bioclimate that results in a mosaic of biotic communities at various spatial and organizational levels. Diversity represents the number of species, their relative abundance, composition, interaction among species and temporal and spatial variation in their properties. Where richness and evenness coincide, i.e., a high proportion of plant species in the vegetation are restricted, community of that area is supposed to have evolved through a long period of environmental stability.

The observation in the present study showed that the oak forest was typically moister than the pine forest which is consistent with the study of Saxena and Singh (1982). Pine forest was about 25% more diverse (40 spp.) in comparison to the oak forest (32 spp.).

Asteraceae was the dominant family in pine forest because most of the species of the family are primary successionals and have different types of growth forms. This family showed basal as well as erect forms in which basal forms emerged near the ground-level with well-developed petioles and formed a short-umbrella (Mehrotra, 1998). They can tolerate cool temperatures to high irradiances with low density of herb cover. However, erect forms are less able to capitalize on the spring window of light than any other form. This showed that the different growth forms reflect a mixed type of forest response (harsh dry to mesic). Moreover, basal forms of Violaceae showed affinity to mesic and cold conditions under the oak forest. Few species are able to tolerate the entire spectrum of environment and range throughout the gradient (Brown, 2001).

Our study showed that perennials gained dominance over annuals in oak forest as well as pine forest (Figure 1). Perennial have ability to conserve soil and with their extensive root systems of perennial grasses they also add more organic matter to the soil than annuals which can be more favourable for plant growth. Singh and Singh (1987) observed that annuals colonize and dominate the early stages of succession. Annuals to perennials species ratio are higher at primary successional site than climax stage. Species richness generally increases during secondary succession when environmental and edaphic conditions are favourable with low fluctuations.

The above results indicate that the oak forest makes climax stage for succession. The evenness and β-diversity showed similar values in sub-sites of oak as well as pine forests. The high values of beta-diversity indicate that the species composition varied from one stand to another.

Equitability/evenness varied in pine forest with respect to sub-site from 27.3 (HB) to 31.4 (HT) (Table 3). This was because of the conditional presence or absence of functional relationship of species. Comparatively higher value of equitability in pine forest with respect to oak forest indicated that the individual herb species distribution is higher. This may perhaps due to intermediate level of disturbance.

The allocation of species in the Kumaun Central Himalaya is mainly governed by moisture and temperature gradients that incorporate the effect of many physical factors. Moustafa (1990) found that the association of community types is the result of the performance of the species in response to the environmental conditions that prevail in a particular forest type. Tewari (1982) assumed that the temperature gradient is the net product of elevation and aspect; while moisture gradient is a function of slope degree, soil texture and nature of soil surface.

In addition to that, hierarchical diversity concerns taxonomic differences at other than the species level. Pielou (1975) and Magurran (1998) suggested that hierarchical (taxonomic) diversity would be higher in an area in which the species are divided amongst many genera as opposed to one in which most species belong to the same genus, and still higher as these genera are divided amongst many families as opposed to few. The families, genera and species ratio was observed maximum in the pine forest as compared to the oak forest in the present study (Table 4), indicating diverse taxonomic vegetation in the pine forest.

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Nano structural characteristics of Zirconium Sulphide thin films

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Abstract: Spray deposition and characterization of zirconium sulphide (ZrS_2) thin films deposited onto a glass plates at 430^0C from an aqueous solution containing zirconium oxy chloride ($ZrO_2Cl_2.8H_2O$) and thiourea (CH_4N_2S) is discussed in this manuscript. Two different films were prepared by varying the molarity of zirconium oxy chloride and thiourea. The prepared films were characterized by X-ray diffraction analysis (XRD), scanning electron microscopy (SEM) and optical absorption techniques. Systematic XRD analysis of the film clearly indicates the polycrystalline hexagonal phase of the film with (110) orientation. The average grain size of the film is calculated using Scherrer's relation and it is found to be 18 nm. SEM study shows that the total substrate surface is well covered with densely packed nanotubes. The spectral absorption coefficient of the film at the fundamental absorption region (400nm-900nm) was determined using the spectral data of absorbance. The energy band gap (Eg) was determined from Tauc's plot and it is found to be 2.55eV.

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Key words: thin films; spray pyrolysis; nano structures

1. Introduction

Recently, considerable progress has been made in the synthesis of metal chalcogenide semiconductor nanostructures due to their important physical properties and their great potential applications [Murray, et al 1995; Spanhel,et al 1987; Bawendi, et al 1990; Brus,1999; Weller,et al 1993] These fascinating systems are expected to exhibit remarkable optical, electrical, and structural properties that are quite different from those of their corresponding bulk materials [Huang,et al 2001;. Wang, et al .2002; Liao, et al 2002]. Transition-metal sulfides have wide utility in catalytic and electronic applications because of their high sulfur bond energies, their oxophilicity, as well as their intrinsic electronic and structural properties [Ilona Kretzschmar et al 2006]. ZrS_2 belongs to the group 4B transition metal dichalcogenides which are semiconductors with layered structures. In the past many experiments on the optical properties of the group 4B transition metal dichalcogenides including ZrS_2 and HfS_2 have been reported. Greenaway and Nitsche [Greenaway, et al 1965] found the indirect transition in the absorption edge of ZrS_2 and HfS_2. The DICHALCOGENIDES of transition metals steadily attract a great attention of researchers due to the variety of their properties that are of both fundamental and practical interest [Hughes, et al 1977]. Thin films of zirconium based material can be prepared by number of technique which includes Plasma enhanced CVD method [Maskell,2000] Chemical vapor deposition [Bertrand,et al 1997; Cameron, et al 1999], and spray method [Brusaco, 1989]. Among the various thin film deposition technique available home built spray pyrolysis [Wuttiphan, et al 1997] technique is particularly attractive because of its low cost commercially scalable route for uniform deposition of zirconium sulphide thin films over large area substrate [Thiagarajan, et al 2001; Chen, et al 1995; Malik et al 1998]. To the best of our knowledge, no report is available for ZrS_2 thin film. On account of the numerous applications of zirconium sulphide thin film, an attempt has been made to prepare zirconium sulphide film using the spray method. In the present manuscript, we report, for the first time, the synthesis of ZrS_2 thin films by spray technique.

2. Experiment

2.1. Preparation of Thin Films

Two different Zirconium sulphide thin films were prepared by varying the molarity of zirconium oxy chloride and thiourea and were deposited on an optically flat well cleaned glass substrate by using a home made double nozzle sprayer. The 50 ml of the spray solution was prepared from aqueous 0.01 M of zirconium oxy chloride ($ZrOCl_2.8H_2O$); 0.01 M of thiourea ($CS(NH_2)_2$). The chemicals used in this deposition process were of analytical grade. The atomized chemical solution is

sprayed on to the preheated substrate maintained at 430^0C with the help of compressed air as carrier gas. The carrier gas flow rate was maintained at 3ml/min at a pressure of 2kg/cm^2. The distance between the spray nozzle and the substrate is 35 cm. To avoid excessive cooling of the substrate, spraying was done with time gap of 30 seconds between successive spray. Details of this setup have been published elsewhere [Thiagarajan, et al 2001]. If the substrate temperature is too high(>500^0C) the spray gets vaporized before reaching the substrate and the film becomes almost powdery, whereas at optimum substrate temperature (i.e.) in the range of 230^0C - 450^0C, the spray reaches the substrate surface in the semi vapour state and complete oxidation will takes place to give clear thin film as a final product which is observed in our experiment. By increasing the molarity ratio of Zirconium oxy chloride and thiourea to 0.02M: 0.02M in the precursor solution another set of Zirconium Sulphide thin films were deposited without changing the other process parameter. For each molarity the reproducibility of the films were verified by repeating the experiments several times. Basically, film thickness is very sensitive function to various preparative parameters such as deposition time, temperature, spray rate, spray interval and molar concentrations. In our studies, all other parameters (except molarity) were kept at their optimum values. The terminal thickness of the film was measured by loss of weight method and it is found to be in the order of micrometer. The thickness of ZrS_2 thin film prepared with 0.01M and 0.02M are found to be 1.2 micrometer and 1.4 micrometer respectively. This was consequently verified by the cross sectional studies of the film using Scanning Electron Microscope (SEM). Here, the film is mounted vertically to measure the thickness directly [Chen, et al 1995]. An increase in film thickness with increasing molarity has been observed. It is clear that, as the solution molarity increases, the amount of material that participates in forming the deposited film increases with subsequent increase in the film thickness.

3. Result and Discussion

3.1 XRD Studies

XRD pattern of the Zirconium Sulphide films were studied at room temperature by using RIGAKU diffractometer (model RAD II A) with CuKα radiation (1.5418 Å) where other radiations are suppressed using Ni filter. The data were recorded at a scan rate of 0.2^0/min and in the range of $20^0<2\theta<80^0$. The crystallinity pattern of as deposited films (0.01M and 0.02M of Zirconium Sulphide) on clean glass substrate prepared by spray pyrolysis technique at 430^0C is shown in figure (1). Observation of the film shows smooth surface and well adhesive nature of the film with substrate. The peaks observed in all the diffractograms confirm the nanocrystalline nature of the ZrS_2 film. The pattern also reveals that the film is polycrystalline with hexagonal crystal structure having preferential orientation along (110) plane. No other impurities peaks are observed. Also the intense peak oriented along (110) lattice plane indicates that the growth of the grains is parallel to the substrate. The other strong peaks observed correspond to (101) and (201) orientations. The diffraction peaks appears in the spectrum have been identified as 31.94^0, 49.48^0 and 60.46^0 which are verified with the known patterns of standard X-Ray diffraction data file (JCPDS file No:03-1099), While comparing the X-ray diffraction pattern of 0.01M and 0.02M ZrS_2 it is obvious that, Bragg peaks became more intense for higher concentration indicating a clear improvement in crystallinity. X-Ray diffraction line broadening (XDLB) was used to estimate the grain size of the film by utilizing Scherer's formula [Berry, 1967; Bragg, 1912],

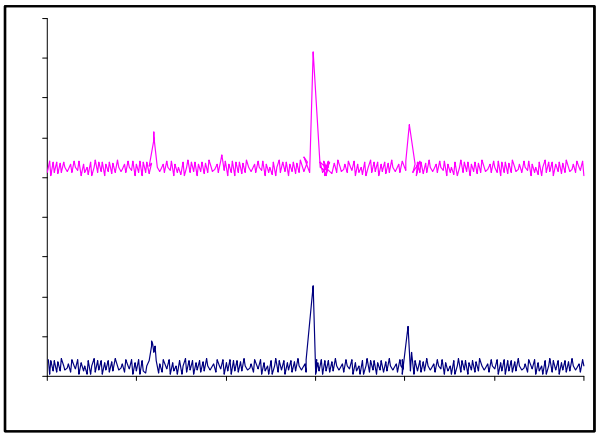

Figure 1. XRD pattern of ZrS_2 thin film

$$D = \left(\frac{K \lambda}{\beta \cos\theta} \right) \quad (1)$$

Where k is the shape factor constant (0.89), λ is the wavelength of CuKα line, θ the Bragg's angle, β is the full width half maximum (FWHM) of intense peak. The mean crystallite size of ZrS_2 calculated using Scherer's equation is 28nm for both 0.01M and 0.02M. Here, the grain size calculated by Scherer's formula is less than 50 nm. This small grain size is due to the evaporation of individual fine droplets during the spray process [Ma, et al 1977].

3.2. Optical Studies

A computer controlled ELICO make (SL 159 UV-VIS) single beam spectrophotometer was used to obtain absorbance (A) of undoped Zirconium Sulphide thin films over wide wavelength range of 420nm - 900nm at room temperature with unpolarized radiation. The experimental accuracy of the absorbance is ± 0.005 and the wavelength is ±0.05nm. The observed absorbance data were corrected relatively to optically identical uncoated glass substrate. The absorption spectra of the undoped Zirconium Sulphide with molarity of 0.01M and 0.02M prepared at 430^0C were recorded as a function of wavelength range 420nm - 900nm with glass as the reference is shown in figure (2). It shows the representatives of optical absorbance which reveals that the absorbance of the film decreases gradually with increase in wavelength. It is clear from the graph that, in the visible region there is no significant change in band edge by increasing the molarity of the solution from 0.01M - 0.02M. This implies that the basic crystal structure is not changed [Agarwal,et al 2006]. It also shows that as the molarities of the film increases from 0.01M - 0.02M there is a drastic increase in absorbance. The overall increase in absorbance with increase in molarity may be associated with the increase in film thickness. This is because in the thicker films more atoms are present in the film so more states will be available for the photons to be absorbed [Nadeem et al 2000]. Transmittance spectra recorded for as deposited film as a function of wavelength is shown in figure (3). The plot shows a sharp rise in transmittance near the band edge attributed to the good crystallinity of the film [Al-Sabayleh,et al 2008]. Transmittance spectra of as deposited films show a narrow range of variation with the increase in molarity of the precursor solution. Here the film deposited with lower molarity (0.01M of ZrS_2) shows higher transmittance (>85%). This property of high transmittance makes it a good material for optical coatings. The decrease in the transmittance with increase in molarity may be due to increasing absorption. It can be seen from the transmittance spectra that the films are transparent even in the shorter wavelength region of the visible spectrum. Hence the films are considered as almost absorption free in the higher wavelength region of the visible spectrum. Typical spectral variation in reflectance and absorbance is nearly similar in all cases. The variation in the reflectance with wavelength of the film shows low value in all the region of the visible spectrum as in figure (4). But, the films prepared from higher molarity shows higher reflectance value. This is consistence with the visual appearance of the films surfaces particularly for larger thickness. Therefore, the film thickness is another cause added to the effect of surface roughness, which participates in the drastic enhancement of film transmission for films prepared with lowest solution concentration.

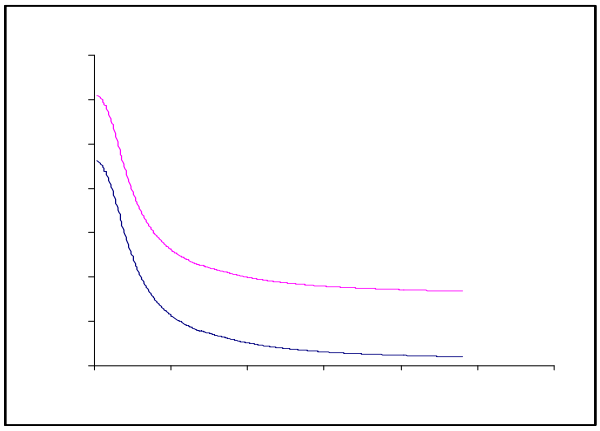

Figure 2. Absorbance spectra of ZrS_2 thin film

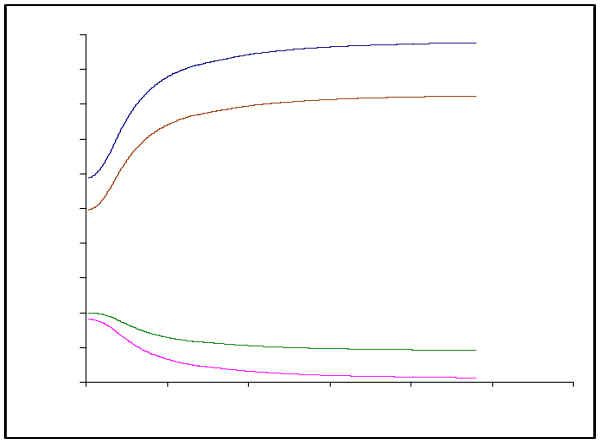

Figure 3. Transmittance & Reflectance of ZrS_2 films

The absorption co-efficient (α) is calculated using Lambert's law [Hoffmann, et al 1997]:

$$\alpha = \left(\frac{2.303 \quad A}{t} \right) \qquad (2)$$

Where 'A' is the absorbance, 't' is the thickness of the film, neglecting the reflection co-efficient which is negligible and insignificant near the absorption edge. The absorption co-efficient (α) calculated is found to be in the order of $10^5 cm^{-1}$. The high α value ($>10^4$) confirms the existence of direct band gap [Tarsame,et al 2004]. According to Tauc [Tauc,1974] it is possible to separate three distinct regions in the absorption edge spectrum of amorphous semiconductors. The first is the weak absorption tail, which originates from defects and impurities, the second is the exponential edge region, which is strongly related to the structural randomness of the system and the third is the high absorption region that determines the optical energy gap. The optical band gap Eg was calculated using Tauc's plot $(\alpha h\nu)^2$ Vs hν.

The photon energy at the point where $(\alpha h\nu)^2$ is zero represents Eg, which is determined by extrapolation of the linear portion of the curve. The typical plots of $(\alpha h\nu)^2$ versus hν for undoped Zirconium Sulphide thin films with 0.01M and 0.02M molarities deposited on glass substrate is shown in figure (4).

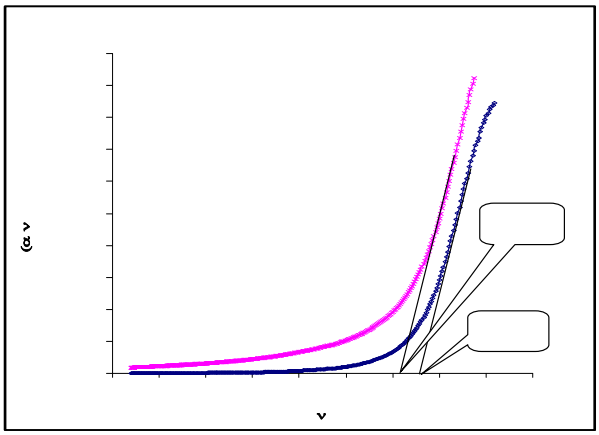

Figure 4. Tauc's plot for ZrS_2 Thin Films

It is observed that increase in molarity of Zirconium Sulphide precursor solution yields a slight shrinkage in optical band gap from 2.62eV to 2.54eV [Ezema, 2003]. This shrinkage was generally attributed to Moss-Burstein shift [Brustien, 1954;Moss,1954]. This may be due to the presence of allowed states near the conduction band in the forbidden region. In case of thick films these allowed states could well merge with the conduction band resulting in the reduction of the band gap [Hoffmann, et al 1997]. For semiconductor and insulator thin films there exists a relation between the reflectance (R) and refractive index (n), given by [Ndukwe, 1995; Ezema, et al 2002; Ezema et al 2003].

$$R = \left(\frac{(n-1)^2 + k^2}{(n+1)^2 + k^2} \right) \quad (3)$$

Refractive index of undoped Zirconium Sulphide with molarity of 0.01M and 0.02M was calculated using the above relation and it is plotted against the wavelength of the incident radiation is shown in figure (5). This plot reveals that refractive index of the film increases with increase in molarity. It is also observed that refractive index of both the films decreases with the wavelength and attains almost constant value towards higher wavelength. The over all increase in the refractive index is the results of increase in the film reflectance and which is attributed to the over all increase in film thickness. This variation is quite common in spray deposited films attributed to the substrate temperature, which favours the denser films as well as higher refractive index. The optical conductivity (σ) and absorption co-efficient (α) are related by [Ndukwe, 1995; Ezema, et al 2002; Ezema, et al 2003],

$$\alpha = \left(\frac{4\pi\sigma}{nc} \right) \quad (4)$$

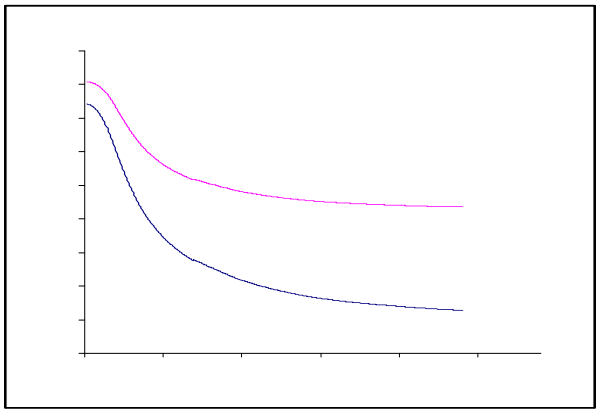

Figure 5. Refractive index of ZrS_2 films

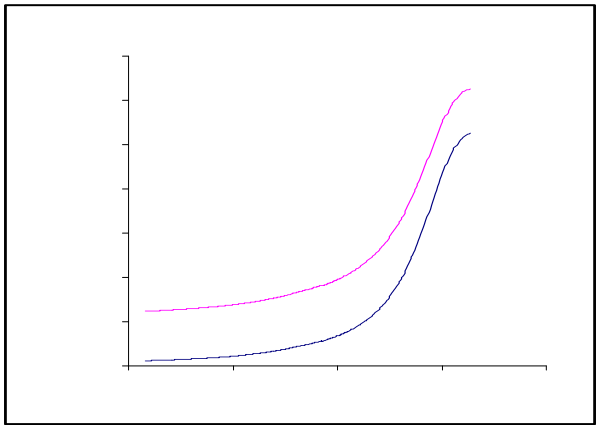

Figure 6. Optical Conductivity of ZrS_2 Films

Thus the Optical conductivity [Ndukwe I.C 1995; Ezema.F.I et al 2002; Ezema.F.I et al 2003], σ is

$$\sigma = \left(\frac{\alpha\, nc}{4\,\pi} \right) \quad (5)$$

Optical conductivity of the undoped Zirconium Sulphide films prepared from molarity 0.01M and 0.02M is calculated using the above equation and it is plotted against photon energy and it is shown in figure 6. It is obvious that optical conductivity reaches the maximum value at high photon energies is due to high absorbance of thin films in that region. The optical conductivity is found to increase with increase in the

molarity of the precursor in the as deposited film.

3.3. SEM Studies

The SEM picture of the undoped Zirconium Sulphide thin film deposited on a clean glass slide at 430^0C using Zirconium Sulphide precursor in the molar ratio of 0.01M and 0.02M, is taken using cold field emission of SEM (JEOL, JSM 6701F, Japan) to support the XRD observations.

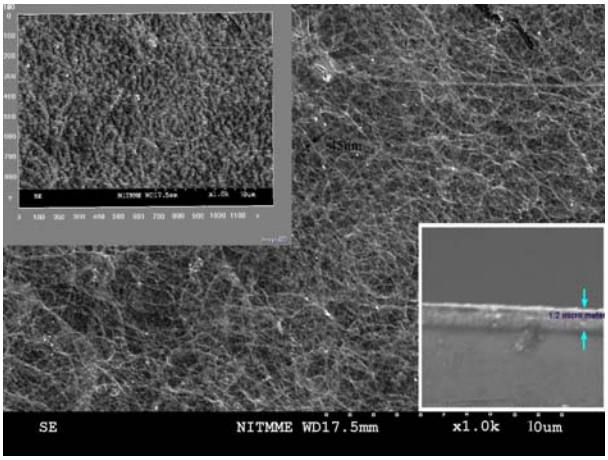

Figure 7. SEM picture of ZrS_2 (0.01 M) thin film

Prior to the observation, using an auto sputter fine coater (JFC 1600, JEOL Japan) about 50Å gold was sputtered on the thin film surface for better contrast and to avoid charge accumulation. Figure (7 & 8) is the SEM picture showing the undoped Zirconium Sulphide thin films with morphology of nanotubes very similar to the other nanotubes reported earlier [Manashi Nath et al 2002; Li-Dong Gao Yuan Le et al ; Jiangtao Hu et al 1999; Yakobson, et al 1996;]. The SEM image in figure (7 & 8) reveals that a good yield of the nanostructures is obtained. Interestingly, a large proportion of these nanostructures are nanotubes. The Zirconium Sulphide nanotube structures could be created reproducibly and they were randomly oriented as a porous membrane and found to cover the entire substrate. Although, Zirconium Sulphide nanotube (figure 7 & 8) are not as well defined as other non carbon nanotubes reported [Manashi Nath et al 2002; Li-Dong Gao Yuan Le et al ; Jiangtao Hu et al 1999; Yakobson, et al 1996;]. The nanotubes as can be seen from the SEM image in figure (7 & 8) are quite lengthy, some being more than a micron long with a smooth surface. The 3D magnification of SEM picture (left top) shows that the growth of the nano tube is along the surface of the substrate. The cross sectional view of the film to measure the thickness is shown at the right bottom of the figure (7 & 8). Their outer diameters are found using image identifier which is found to be 45nanometer. However, the inner diameters of the Zirconium Sulphide nanotubes are smaller. Breaks in nanotubes were rarely observed which implies that nanotubes have very high strength [Yakobson, et al 1996;].

On close inspection; layer fringes are visible along the tube walls. Interrupted layer growth is observed in the inner edge of the tube wall, causing terminated layers and thus non uniformity in the wall thickness. Also visible in figure (7 & 8) is the nanoscale sub-structure of undoped Zirconium Sulphide nanotubes, demonstrating their polycrystalline nature.

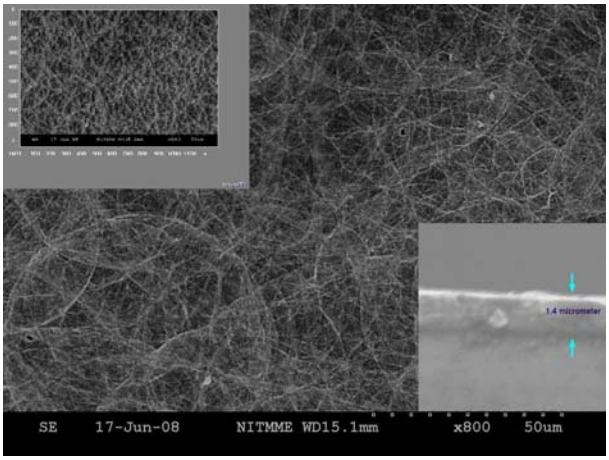

Figure 8. SEM picture of ZrS_2 (0.02 M) thin film

4. Conclusion

Spray deposited Zirconium sulphide film with two different molarities were deposited on glass substrate at 430^0C are polycrystalline having HCP structure. Deposited film shows preferential orientations along (110) plane in addition to other prominent planes (101) and (201). The grain size of the deposited film found using Scherer‘s relation is 18nm. Sem picture confirms the good yield of nanotubes. Our results do show that the growth of nano tubes of Zirconium sulphide can be achieved by simple and economical spray technique. Large quantities of nanotubes can be synthesized by this method; advances in growth processes are making NTs more commercially viable.

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Toxicity of Crude *Balanites aegyptiaca* Seed Oil in Rats

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Abstract: *Balanites aegyptiaca* seed oil has been used in Nigeria as ingredient and substitute to groundnut oil in the preparation of local foods. A four week repeated dose toxicity study of crude *B.aegyptiaca* seed oil was performed on male Wister strain rats. The rats were divided into four groups consisting of five animals each and fed diet containing 0, 0.5, 1 and 5% crude *B. aegyptiaca* seed oil. Result showed no significant ($p > 0.05$) changes in AST and ALT, except in the 5% group where ALT activity was elevated. No significant ($p>0.05$) changes in serum total protein, albumin, A/G ratio, serum urea, creatinine, mean final body weight, food consumption and relative liver and kidney weight were observed. The results showed that dietary exposure of crude *B. aegyptiaca* seed oil in rats did not result in marked changes in the toxicological parameters been assayed. Thus, consumption of the crude oil at the present level of exposure may be of no serious safety concern, especially on liver and kidney injury [The Journal of American Science 2009;5(6):13-16].(ISSN:1545-1003).

KEYWORDS: *Balanites aegyptiaca* ;seed oil; toxicity; rat

1.0 Introduction

*Balanites aegyptiaca (L.)*Del., is a perennial tropical plant used in food preparations and herbal medicine, especially in Africa and some developing countries. It is also called desert date (English), adua (Hausa, Nigeria), tanni (Fulfulde, Nigeria) and heglig (Arabic).*B.aegyptiaca* belongs to the family *Balanitecea*. The plant attains a height of more than 6 meters. It has a multiplicity of uses and almost every part of the plant is useful including, leaves, thorns, back of root and fruit. *B.aegyptiaca* is used to treat so many illnesses including, laxative, diarrhoea, hermorrhoid, stomach aches, jaundice, yellow fever, syphilis and epilepsy (Ojo *et al.*, 2006). For instance, the fruit is used to treat liver disease and as a purgative and sucked by schools children as a confectionary in some countries (Barley, 1962 and Croach, 1962). The bark is used in the treatment of syphilis, round worm infections and as a fish poison. The aqueous leaf extract and saponins isolated from its kernel cakes have anti bacterial activity (Bashir *et al.*, 1984 and Doughari *et al.*, 2007) and potent larvicidal activity (Zarroug *et al.*, 1988), repectively.

Studies conducted elsewhere on some parts of the plant indicated the presence of many flavanoids, saponins and other important phytochemicals (Maksoud and Al-Hadidi, 1988).The alcoholic extract of the pulp and kernel contained sterols, terpenes and saponins as predominant compounds where as tannins, alkaloids and resins where found in slightly small amount (Abdel-Rahi *et al.*, 1986).

In Nigeria, the seed oil obtained from *B. aegyptiaca* has been used especially in the Northern part, as substitute to groundnut oil which is usually relatively expensive. The oil is used for frying food and adding flavor to the food. It is also used to add flavor to tea. This is in addition to medicinal uses such as treatment of skin disease and rheumatism. Despite such wide spread use, there is limited literature on the possible effects of long term consumption of the oil. This study attempts to evaluate the toxicity of the oil after dietary exposure in rats for four weeks.

2.0 Materials and Methods

2.1 Chemicals

The kits for the determination of serum alanine aminotransferase(ALT) and Aspartate aminotransferase(AST) were products of Randox laboratories Co.(Atrium, UK). The rest of the chemicals and reagents utilized were of analytical grade and were obtained from local firms (Nigeria).

2.2 Collection of *Balanites aegyptiaca* seeds and extraction of the oil

Balanites aegyptiaca seeds were collected from around Yola-Numan road, Adamawa state, Nigeria and were air dried in shade. The crude *B.aegyptiaca* seed oil was extracted using the traditional method for extraction of vegetable oils (Balami *et al.*, 2004) with little modifications. Briefly, the dried seeds were shelled to obtain the kernel and grilled with intermittent stirring for five minutes. The kernels were allowed to cool and pounded to paste using mortar and pestle. Some little amount of boiling water was added and stirred

until oil separates from the cake. The crude oil was decanted and heated to reduce the moisture.

The percentage yield of the crude oil from the seeds was 29.6%. Refractive index was determined using Abbe refractometer and found to be 1.457. The specific gravity of the oil was determined (Oladele and Oshodi, 2008) using density bottle at 28ºC and found to be 0.918.The oil was stored in glass bottles and refrigerated until use.

2.3 Animals

Male Wister strain rats weighing 150±10g were obtained from the animal house unit of the National Veterinary Research Institute (NVRI) Vom, Jos, Nigeria. They were allowed to acclimatize for one week prior to the experiment. The animals were housed in plastic cages, in a well ventilated room at room temperature and have free access to water throughout the period of the experimentation. A commercial pelleted diet (Grand cereals Ltd., Jos, Nigeria) was used in the entire study.

2.4 Experimental design

From a total of 34 rats, 20 animals were selected and divided into four groups of five animals each, so that the weight distribution within each group was similar and initial mean body weights were approximately equal. The remaining animals were excluded from the study.

The rats were fed crude B. *aegyptiaca* seed oil mixed in the diet at concentrations of 0, 0.5, 1, or 5% daily for four weeks. The diet containing the oil was prepared daily. Food intake was recorded weekly and body weights of animals were measured once a week. Rats were fasted overnight at the completion of the treatment period and blood collected by heart puncture under diethyl ether anesthesia for serum chemistry. Serum alanine aminotranferase (ALT) and aspartate aminotransferase(AST) activity were determined by the method of Reitman and Frankel (1957) using commercial kits(Randox laboratories Co.Atrium, UK). Serum creatinine, urea, total protein, albumin, and globulins and albumin/globulin ratio (A/G) were also determined (Chawla, 1999).

2.5 Statistical analysis

Results were presented as Mean and Standard error (Mean ± S.E), n=5. The significance between the control and each of the oil treated group was determined by Dunnett's test (Dunnett, 1955) after one-way ANOVA. The level of significance was set at $p<0.05$.

Table 1: Final body weight and food consumption of rats treated with crude *B.aegyptiaca* seed oil for four weeks

Dose group(%)	Final body weight(g)	Food consumption(g/rat/day)
0 (control)	275.31 ± 8.34	24.16± 2.93
0.5	275.75 ± 7.92	23.85± 3.35
1	277.25 ± 10.14	23.41± 2.58
5	276.75 ± 8.94	23.61± 3.13

Values are mean ± S.E., n=5

Table 2: Serum biochemical parameters in rats treated with crude *B.aegyptiaca* seed oil for four weeks

Dose group (%)	ALT (U/L)	AST (U/L)	UREA (mg/dl)	CREATININE (mg/dl)	TOTAL PROTEIN (g/dl)	ALBUMIN (g/dl)	ALBUMIN/ GLOBULIN (A/G)
0 (control)	75.01±8.49	55.51±5.80	38.49±5.17	0.26±0.016	8.95± 0.7	5.76±0.5	1.8±0.2
0.5	78.75±9.29	56.12±6.37	37.09±6.78	0.27±0.018	9.12± 0.3	5.87±0.4	1.8±0.1
1	82.11±8.53	58.52±7.19	39.31±6.77	0.28±0.020	9.03± 0.3	5.85±0.6	1.7±0.1
5	91.12±9.61*	61.07±6.05	44.53±5.64	0.29±0.017	8.81±0.4	5.55±0.4	1.6±0.2

Values are Mean ± S.E., n=5

*Significantly different from control ($p<0.05$)

Table 3: Relative organ weights of rats treated with crude *B.aegyptiaca* seed oil for four weeks.

Dose group (%)	Relative organ weight (g/100g body weight)	
	Liver	Kidney
0 (control)	3.92 ± 0.19	0.76 ± 0.04
0.5	3.92 ± 0.14	0.75 ± 0.05
1	3.94 ± 0.16	0.74 ± 0.06
5	3.95 ± 0.21	0.78 ± 0.05

Values are Mean ± S.E., n=5

3.0 RESULTS AND DISCUSSION

3.1 Final body weight and food consumption

The results of changes in final body weight and food consumption of rats treated with crude *B. aegyptiaca* seed oil are presented in ***Table 1***. There were no significant ($p>0.05$) changes in final body weight and food consumption between control and treated groups. The effect of food consumption on body weight gain have already been studied (Coleman *et al.*, 1997, Hubert *et al.*, 2000 and Moriyama *et al.*, 2006)**.** In the present study, no treatment related changes were observed in food consumption and final body weight of the animals, which may imply that consumption of the diet mixed with the oil, had no effect on rat appetite and cell injury.

3.2 Serum biochemical parameters

Table 2, shows the result of serum biochemical parameters in rats treated with crude *B. aegyptiaca* seed oil for four weeks. The result showed a dose dependent increase in serum ALT activity. Compared to rats fed with normal diet, serum ALT increased significantly ($p< 0.05$) in the 5% treated group. No significant ($p>0.05$) changes in serum AST activities, total protein, albumin and A/G ratio were observed between the control and treated groups. Although, the elevated levels of ALT activity in the 5% treated group may indicate hepatotoxicity in rats, the absence of significant changes in other related indicators such as AST, total protein, albumin and A/G ratio may suggest that the hepatotoxic effect of the oil was mild. High levels of AST and ALT are usually present within hepatocytes and plasma levels rise as hepatocytes membrane integrity is disturbed during hepatocellular cell injury (Kew, 2000 and Dobbs, 2003). Rise in the level of ALT is generally accompanied by significant elevation in the levels of AST which is not observed in the present work. This could partly explain the fact that the liver is not seriously affected by the crude oil. Both enzymes play important role in the conversion of amino acids to ketoacids and they are major markers of liver damage caused by exposure to toxic substances (Chawla, 1999). The changes in serum urea and creatinine were statistically insignificant ($p> 0.05$). These parameters are indicators of kidney injury and are elevated in renal toxicity (Chawla, 1999). Renal disease which deminishes glomerular filteration leads to urea and creatinine retention. The insignificant rise in serum urea and creatinine is suggestive of normal functional kidney.

3.3 Relative liver and kidney weights

The effect of administration of crude *B. aegyptiaca* seed oil on relative liver and kidney weights of rats are presented in ***Table 3***. No statistical difference ($P> 0.05$) was observed in relative liver weights of the groups treated with the crude seed oil when compared with control animals. Also, treatments had no effect on relative kidney weights of the experimental rats. These further substantiate lack of serious toxic effect of the crude oil.

Conclusion

In conclusion, dietary exposure of crude *Balanites aegyptiaca* seed oil to rats did not show any toxicological concern but should be used with caution having indicated subtle hepatotoxic effects in the 5% treated group.

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Wind Energy Conversion System: The Past, The Present And The Prospect

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Abstract: Wind energy has matured to a level of development where it is ready to become a generally accepted utility generation technology. Wind turbine technology has undergone a dramatic transformation in the last decades, developing from a fringe science in the 1970's to the wind turbines of the 1990's, utilizing the latest in power electronics, aerodynamics and mechanical drive train design. The developmental stages of wind energy conversion and utilization over the years was reviewed and given the advanced state of wind turbine technology, availability of wind resources, the modularity of wind electric generators and an expected increase in demand for environmentally friendly energy sources, it is expected that wind energy will become a significant component of energy supply portfolio in the near future. [The Journal of American Science 2009;5(6):17-22].(ISSN:1545-1003).

Keywords: Wind energy, Wind turbine, power electronics, aerodynamics, drive train, energy portfolio.

1. Introduction

The precise date when man first used a machine to assist him in his daily work would be virtually impossible to determine. However, it seems clear that the earliest machines were based on the principle of rotation as a means of providing continuous motion for routine tasks such as grinding corn or pumping water. Thus, there were the mills, driven by animal or man-power, in which the rotating shaft was vertical and driven by a long horizontal beam, fixed to it, and pulled or pushed around by the animal walking round in a circular path (Golding, 1976).

Wind energy has been used for a long time. The first field of application was to propel boats along the river Nile around 5000B.C. By comparison wind turbines technology is a fairly recent invention. The first simple windmills were used in Persia as early as the 7th century for irrigation purposes and for milling grains.

In Europe, it has been claimed that the crusaders introduced the windmills around the 11th century. Their constructions were based on wood. In order to bring the sails into the wind, they were manually rotated around a central post. In 1745, the fantail was invented and soon became one of the most important improvements in the history of the windmill.

The modern concept of windmills began around the industrial revolution. Millions of windmills were built in the United States during the 19th century. While the industrial revolution proceeded, the industrialization sparked the development of large windmills to generate electricity. Pour La Cour developed the first electricity generating wind turbine (Anders, 2005).

The earliest horizontal-axis windmill to use the principles of aerodynamic lift instead of drag may have been introduced in the 12th century. These horizontal-axis sail turbines were allowed to run at varying speeds, limited only by braking or furling to control their speed during storms. In the over seven hundred years since the first sail-wing turbine, designers discovered many of the key principles of aerodynamic without understanding the physics behind them. It was not until the 19th century that these principles began to be clearly understood (Carlin et. al, 2001).

In the early 19th century, the classic American water pump was introduced. The need for this machine was driven by the phenomenal growth of agriculture in the American Midwest, beginning with the opening of the Northwestern Prairie States in the early 1800's. More than a million of these machines dotted the Midwest and West starting in the early 1850's. Even now, these multi-bladed farm windmills can be seen throughout the western United States and Canada, where the energy and storage requirements for providing drinking water for cattle are well matched to the wind powered water pump, the storage capacity of the associated stock tank, and the wind statistics of the Great Plains.

These machines use the most rudimentary airfoils and are allowed to rotate proportionally to wind velocity. For the purpose of direct mechanical water pumping, this variable-speed operation works effectively. Even though the American water-pumping design gives up something by its

dependence on a flat-plate airfoil, its simplicity, ease of construction and reliability still make it ideal for its intended purpose.

In 1925 Marcelleus and Joseph Jacobs began work on the first truly high-speed, small-size, affordable battery charging turbine. Thousands of their 32-volts and 110-volts direct current machines were manufactured. This machine was followed by others such as wind charger. They could be set up easily and require little maintenance, if any. All of these machines were allowed to run at variable speed. Even after alternating current utility power had begun to spread through cities and towns, Sears Roeback Company and other manufacturers distributed a wide range of products designed to run on direct current to satisfy the needs of remote farms and ranches using batteries and variable-speed direct current turbines (Carlin et. al, 2001).

In the late 30's and then in 1941, Americans started planning a megawatt-scale wind turbine generator using the latest technology. The result of this work was the 1.25MW Smith-Putnam wind turbine. This was the largest wind turbine ever built then and it kept its leading position for forty (40) years thereafter.

With the introduction of the steam engine in the 18th century, the world gradually changes its demand for power to techniques and machines based on thermodynamic processes. Especially with the introduction of fossil fuel (coal, oil and gas) the advantages of these machines became obvious.

Firstly, steam engines, gas turbines, and oil and gas based engines are much more compact and can provide power at a much larger scale than necessary for water pumping and grinding. Secondly, they can be located independent of the streaming water or good wind sites. Finally, these machines provided a more reliable source of power than wind turbines (Andersen).

Therefore, the importance of wind energy as a power source decreased during the 19th century and especially during the present century. Though, in some parts of the world wind energy prolonged its utility. In countries with populations scattered over large areas, such as the Americas, Australia, and Russia, wind power continued to contribute to the power needed, for example in farming. With the electrification of the industrialized world the role of wind power decreased. Fossil fuels showed to be more competitive in providing electrical power on large scales.

Meanwhile, the traditional wind rose (the multi bladed wind turbine) used in the farmland all over the world was still further developed and refined. The wood used in most parts of these machines was replaced by iron and steel. Lattice steel towers as well as steel blades were introduced. This transformation from wood to steel did not appear over night but went on for some decades, and contributed to the optimization of the wind turbines. In the 1920's and 1930's the French F.M Darrieus and the Finnish S.J Savonius designed and tested new concepts for vertical-axis wind turbines.

In the 1920's the German professor Albert Betz of the German Aerodynamic Research Centre in Gottingen made some path-breaking theoretical studies on wind turbines in the light of modern research by determining the coefficient of performance of a wind turbine to be 0.593 and known as the Betz limit. Also in the 1920's H. Glauert contributed with an aerodynamic theory for wind turbines. Both of these theoretical contributions are still the foundation of today's rotor theory.

2. Wind Power in Denmark

The early dissemination of information on windmills all over Europe also involved Denmark. Here the first windmill was mentioned in 1259 and it was placed in the village of Flong between Roskilde and Copenhagen [4]. With the fossil fuels and the electrification, the development followed the same pattern as in the rest of Europe, but in countries without any domestic fossil resources such as Demark, wind energy continue to contribute to the supply of energy. First of all with the classical purposes in the farm land as pumping water and grinding grain.

In 1916 alone, one thousand, three hundred (1300) new ones were built to provide power to threshing machines, grinding mills, and for water pumping. With no other realized natural energy sources (no water falls for hydropower, no coal, etc) it may seem natural that Denmark became the first country in which scientists and engineers began a dedicated effort to implement wind technology as a basis for electrification. This started in 1891, when Poul La Cour and a team of scientists built a test windmill, funded by the Danish government at Askov Folk High school.

La Cour was drawing on the results of two contemporary Danish engineers and scientists H.C Vogt and J. Irminger, who together with the American P.S Langley participated in formulating modern theory on aerodynamic lift and drag which will be discussed in later chapter.

By 1918, as a result of La Cour's work, a fourth (about 120 in number) of all Danish rural power stations used wind turbines for power generation. Most machines had a rated capacity of 20-35kW.

After World War I, with a sufficient supply of fossil fuel, these machines were rapidly outdated, and in 1920 only seventy-five turbines were left. But immediately after World War II, J. Juul, a Danish engineer at a power utility, SEAS, started a Research and Development programme on wind energy utilization. This research and development (R&D) effort formed the basis for Juul's design of modern electricity producing wind turbine-the well-known 200kW Gedser machine. The Gedser machine was installed in 1959 and was in operation until 1967.

In 1977, when data for large wind turbine were badly needed, the refurbished Gedser machine was used for a measurement programme, which was co-funded by the U.S Department of Energy. This programme was carried out by Risϕ National Laboratory and formed Risϕ's entrance to wind turbine research and development. Besides, a tradition in wind turbine R& D, Risϕ also draw on a tradition on boundary layer meteorology and wind climate studies.

The studies of aerodynamic and wind tunnel experiments performed by Irminger by the turn of the century was continued at the Technical University of Denmark by Professor Nϕkketved, Martin Jensen and Niels Franck. Their path-breaking research on wind climate, model laws, terrain roughness, and shelter effects formed the scientific platform for European wind Atlas used for wind resource estimation. This work was initiated in the late 1970's. The Awakening green movement in the western societies and especially the oil embargoes of 1973 and 1979 set the stage for the present era of wind power.

3. Wind Power in United States

Charles F. Brush was the first to use a large wind turbine to generate electricity (Robert et. al, 2004). The system was built in Cleveland, Ohio in 1888. The Brush machine was the first wind turbine to incorporate a step-up gearbox in order to turn a direct current generator at its required operational speed. Despite its relative success in operating for over 20 years, the Brush wind turbine demonstrates the limitations of the low-speed, high-solidity rotor for electricity applications.

During the 1920's, the two dominant rotor configurations (fan-type and sail) had both been tried and found to be inadequate for generating significant amount of electricity. A shift was therefore undertaken and the further development of wind generator electrical systems in the United States was inspired by the design of airplane propellers.

The first small electrical-output wind turbines simply use modified propellers to drive direct current generators. By the mid-1920's, 1 to 3 kilowatts wind generators developed by companies like Parris-Dunn and Jacobs wind-electric found widespread use in the rural areas of the Midwestern Great Plains of USA. They had two or three thin blades which rotated at high speeds to drive electrical generators. These wind turbines were installed to provide electricity to farms beyond the reach of power lines and were typically used to charge storage batteries, operate radio receivers and power a light bulb or two.

Wind turbine generator hence achieved a measure of technical and economic practicality in rural and remote areas of the United States during the 1920's and 1930's. In the 1940's hundred of thousands of electricity producing wind turbines were built in the United States. The wind turbine industry in North America remained very active into the 1930's. During this decade, however, the combination of demand of farmsteads for ever large amounts of power and a major economic depression spurred the United States to stimulate the depressed rural economics by extending the electrical grid throughout those areas.

The lower cost of electricity produced by a central utility plus the greater reliability led to the rapid demise of the home wind electric generator and therefore began a slow decline from which the wind industry never fully recovered.

The largest wind turbine built before the late 1970's was a 1250kW machine built on Grandpa's Knob, near Rutland, Vermont, in 1941. The concept for this turbine started in 1934 when an engineer, Palmer C. Putnam, began to look at wind electric generator to reduce the cost of electricity to his Cape Cod home. In 1939, Putnam presented his ideas and the results of his preliminary work to the S. Morgan Smith Company of York, Pennsylvania. Agreement was reached to fund a wind-energy project and the Smith-Putnam wind turbine experiment was born, involving a team of scientists who designed, built and operated the world's first megawatt-size wind power plant (Dodge).

Between 1941 and 1945 the Smith-Putnam machine, which was connected into the central Vermont public service corporation's network, accumulated about 1100 hours of operation. More would have been accumulated except for the problem of getting critical repair parts during the World War

II. In 1945 one of the blades broke off near the hub, apparently as a result of metal fatigue and hence due to inadequate design than technological limitations. The project was reviewed and was determined to be a technical success.

The economics, however, did not justify building more machines at that time. The project, however, advanced the field of wind power engineering from small direct current generators and water pumps to large alternating current units capable of integration into electrical supply systems.

The gradual extension of electrical utility networks and the availability of low cost fossil fuels led to the abandonment of wind turbines by the 1940's. By the early 1950's the extension of the central power grid to nearly every American household, via the Rural Electrification Administration, had almost eliminated the market for wind turbines.

The technical results of the Smith-Putnam wind turbine had nevertheless caused Percy H. Thomas, an engineer with the Federal Power Commission, to spend approximately 10 years in a detailed analysis of wind power electric generation. Thomas used economic data from the Smith-Putnam machine and concluded that even larger machines were necessary for economic viability. He designed two large machines in the size range of 6500kW and 7500kW.

While the market for new small wind machines of any type had been largely eroded in the United States by late 1950's, the use of mechanical and electrical system continued throughout Europe. The development of bulk-power, utility-scale wind energy conversions systems was undertaken in several countries and although research showed that large-scale wind turbine actually would work, it failed to result in a practical large electrical wind turbine.

4. Wind Power in Nigeria

Nigeria is blessed with abundant fossil fuel (oil and gas) and the Government investment in power generation had been mainly restricted to thermal coal plants, gas plants and hydro power stations. Adegoke and Anjorin (1996) investigated the prospects of wind energy utilization in Nigeria by analyzing available wind data for Akure, Bauchi and Port Harcourt and observed that the average wind speed measured at 10metres height above the ground for Bauchi is 4.78m/s, Port Harcourt is 2.56m/s and that for Akure is 0.76m/s. It was concluded that Bauchi favours the installation of wind turbines more than Port Harcourt and Akure and that the variation of annual mean wind speed is much lower for Port Harcourt than it is for Bauchi implying that wind turbines installed in Port Harcourt would function more regularly over several years.

Wind speeds of not less than 2.22m/s have been found to be favourable for uses of windmills in northern Nigeria although this may strictly apply to the type of windmill tested. It has also been reported that most windmills would not start at wind speeds less than 3m/s (Ejieji, 2006).

The National Energy Commission of Nigeria (NECN) is presently leading Research and Development (R&D) efforts in developing indigenous technology in wind energy conversion systems.

5. Wind Power utilization today

The expected global shortage of oil and coal after World War II did not happen. Instead the prices of oil fell in the 1960's. Energy consumption was increasing drastically as was the general growth and wealth in the industrialized countries. It therefore took a serious energy crisis before wind power once again was put back on the agenda.

This turn around came in October 1973, when Egyptian troops crossed the Suez Canal entering Sinai, which Israel had occupied during the 6-day war in 1967. A war in the Middle East had started and this time oil was used as a weapon in the conflict. Throughout the 1950's and 1960's Organization of Petroleum Exporting Countries (OPEC) had gradually gained more and more control of oil and it subsequently decided to raise oil prices and introduced an oil embargo on countries supporting Israel.

The resulting supply problems and rising prices not only caused downward market conditions in the Western world but also proved just how vulnerable and dependent these countries had become on the import of oil. Wind power was therefore soon back to reckoning.

Table 1: World Grid-Connected Wind Capacity (MW) Data (Adapted from IEA, Wind Power Monthly, April, 2001)

Cumulative(MW)	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
United States	10	1,039	1,525	1,770	1,794	1,741	1,890	2,455	2,554	4,240	4,685	6,374
Germany	2	3	60	1,137	1,576	2,082	2,874	4,445	6,095	8,100	11,994	14,609
Spain	0	0	9	126	216	421	834	1,539	2,334	3,175	4,825	6,202
Denmark	3	50	310	630	785	1,100	1,400	1,752	2,338	2,417	2,889	3,110
Netherlands	0	0	49	255	305	325	364	416	447	483	693	912
Italy			3	22	70	103	180	282	427	682	788	904
United Kingdom	0	0	6	193	264	324	331	344	391	477	552	649
Europe	5	58	450	2,494	3,384	4,644	6,420	9,399	12,961	16,362	23,308	28,706
India	0	0	20	550	820	933	968	1,095	1,220	1,426	1,702	2110
Japan	0	0	1	10	14	7	32	75	121	250	415	686
Rest of the World	0	0	6	63	106	254	315	574	797	992	1,270	1,418
World Total	15	1,097	2,002	4,887	6,118	7,579	9,625	13,598	17,653	23,270	31,128	39,294

From an experimental stage of turning wind energy into electricity in the early 1970's, a new industry for producing standardized wind turbines gained foothold in the beginning of the 1980's and since then the industry has developed rapidly throughout the 1980's and the 1990's.By the end of 1996 a total of 6200MW grid connected wind turbine capacity was installed around the world.

Today, wind energy is the fastest growing energy technology in the world. The world wind energy capacity installations have surged from under 2000MW in 1990 to the present level of approximately 39,500MW. It is expected that the wind turbine capacity will rise to 230GW by the year 2020 judging from the current attention been given to it.

There has been a concerted effort over the last decade to raise the level of technology in small wind turbines led by groups such as the American Wind Energy Association (AWEA), and the National Wind Technology Centre (NWTC) in Colorado which is part of the U.S Department of Energy's National Renewable Energy laboratory (NREL) among others (Andrew, 2005).

6. The future of wind energy system

In the years to come, the prime resource for generation of wind power will not be wind but windy sites. With only limited sites suitable for wind power generation available, it makes better sense to develop technologies, which will increase the efficiency of wind electric generators.

The developments in turbine technology coupled with optimization techniques will lead to higher energy densities. Also it is expected that in future the power quality issues in grid interfacing wind electric generators will be addressed and power quality devices will be inbuilt into the turbines.

The global wind energy installed capacity has increased exponentially over a 25-year period, and in the process the cost of energy (COE) from wind power plants has been reduced by an order of magnitude. Wind energy installations in the United States have grown during the past decade from about 1800 MW in 1990 to more than 6,000 MW at the end of 2003(Musial et. al, 2004).

Offshore wind turbines have a number of advantages over onshore ones. The size of onshore turbines is constrained by capacity limitations of the available transportation and erection equipment. Transportation and erection problems are mitigated offshore where the size and lifting capacities of marine shipping and handling equipment still exceed the installation requirements for multi-megawatt wind turbines.

The visual appearance of massive turbines in populated areas may be undesirable. At a sufficient distance from the coast, visual intrusion is minimized and wind turbines can be larger, thus increasing the overall installed capacity per unit area. Similarly, less attention needs to be devoted to reduce turbine noise emissions offshore, which adds significant costs to onshore wind turbines. Also, the wind tends to blow faster and more uniformly at sea than on land. A higher, steadier wind means less wear on the turbine components and more electricity generated per square meter of swept rotor area can be integrated to the national grid.

Onshore turbines are often located in remote areas, where the electricity must be transmitted by relatively long power lines to densely populated regions, but offshore turbines can be located close to high-value urban load centers, simplifying transmission issues.

On the negative side of offshore development, investment costs are higher and accessibility is more difficult, resulting in higher capital and maintenance costs. Also, environmental conditions at sea are more severe: more corrosion

from salt water and additional loads from waves and ice.

And obviously, offshore construction is more complicated. Despite the difficulties of offshore development, it holds great promise for expanding wind generation capacity.

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Conservation of *Ringal* (a dwarf bamboo) through economic development in Rudraprayag district Garhwal (Uttarakhand), India

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ABSTRACT The Himalaya is one of the richest sources with respect to the occurrence of *ringal* in oak forests. *Ringal* is a widely distributed shrub found in the temperate regions of Garhwal Himalaya. This shrub contributes to biodiversity and is important as fodder, basket materials and for household uses. But in future if efforts for *ringal* conservation will not be done it will affect the livelihood of the *ringal* weavers. Out of three blocks, stakeholders of Jakholi (Khod) and Agustamuni (Bhanaj) block are found highly dependent on *ringal* based activities to conduct their livelihood. [The Journal of American Science. 2009; 5(6):23-26]. (ISSN 1545-1003).

Keywords: *Ringal, oak forests, livelihood activities, Rudraprayag*

INTRODUCTION

India greatly depends on the Himalayan region for its forest reserves. In most parts of the Central Himalayas, oak forests are known for their superior ecosystem services. Occurrence of dwarf bamboo *Drepanostachyum falcatum* (Nees) or *Golu ringal* is a common feature in the Himalayas. *Ringal* shrubs are found generally in patches of varying size in tropical evergreen, moist deciduous and in wet subtropical and moist temperate forests. *Ringal* is a non-timber forest produce (NTFP) harvested directly from the oak forest of Garhwal Himalaya without any conservation effort. *Ringal* harvesting is a common practice among the villagers in the temperate belts of Garhwal Himalaya. In the study area (district Rudraprayag) *Drepanostachyum falcatum* and *Thamnocalamus pathiflorus* species of *ringal* are the most harvested species for making baskets, mats, flowerpots etc and other commercial purposes.

Ringal is one of the oldest weaving materials used by mankind and in the district Rudraprayag *ringal* weavers are known as *Rudhiya*. It has been a main source of livelihood for local inhabitants due to its multifaceted use. Lack of foresightedness in utilizing the multifaceted *ringal* has resulted in local inhabitants concentrating on agricultural based activities.

In the present paper author has described the *ringal* conservation strategies and economic development followed by the *Rudhiya's* of Rudraprayag district Uttarakhand. In this connection the unscientific extraction of *ringal* would reduce its diversity as well as biomass.

METERIALS AND METHODS

Study area: District Rudraprayag (Garhwal) of Uttarakhand state is the remote area in terms of lifestyle and is also rich in botanical resources like *ringal* resource. All three blocks (Ukhimath, Jakholi & Agustamuni) of the district has been covered in the present study. From three blocks total seven villages were selected for conducting the *ringal* study on the basis of availability of *ringal* resource, weavers and remoteness. All the selected areas were similar in *ringal* diversity and its biomass, but different in its harvesting system.

A. Reconnaissance Survey: The reconnaissance survey was conducted for knowing the traditional method of *ringal* harvesting and involvement of *ringal* stakeholders (called *ringal bunkers*) of different rivals of the area. In Rudraprayag district, *ringal* is traditionally harvested by the *ringal weavers* of Mansuna, Khod, Karandhar, Bhanaj, Sari, Makhanda and Makku villages. These areas come under the Kedarnath forest division. These areas falls within the Garhwal Himalaya region and the forests are dominated with *Quercus semecarpifolia* (brown oak), *Q. floribunda* (green oak) and *Q. leucotrichophora* (white oak) and lies between 1300m to 3000m altitudes of Mandakini valley of district Rudraprayag. Oak forests of the area are rich in *ringal* diversity and biomass.

The traditional weavers harvest *ringal* from the oak forests and prepare the *ringal* products like Kanda, Solta, Changra for collecting fodder and manure. Weavers also sell the *ringal* products at local market like Ukhimath, Agustamuni and Rudraprayag. Some small villagers also sell the products at Rishikesh market of the state. Similarly some weavers also sell the *ringal* products in neighbouring villages of the area.

During the field visit author have interviewed with some *ringal* harvesters and weavers to assess the information on traditional method of *ringal* harvesting, conservation and socioeconomic status of *ringal* in the area.

B. Questionnaire Design: The questionnaire was designed keeping in mind some tasks related to socio-economic and ecological impacts of *ringal*, which is always ignored by various workers.

C. Questionnaire Sampling and Selection of the Respondent: The survey was carried out during August 2007. The questionnaire was used to gather information on conservation efforts and assessment of annual income from *ringal* sector at different level of stakeholders. The respondents from the area were selected randomly on the basis of their involvement in the *ringal* activity as traditional harvester; trackers (transpiring *ringal* from forest to weaving point/store house), local traders etc. and they were the respondents of the ideal questionnaire.

D. *Process of Questionnaire Filling:* All questionnaires were filled throughout a long discussion along with the respondent.
E. *Data Analysis:* The data has been analyzed by using the SPSS software.

RESULTS

Total five species of *ringal* viz. *Drepanostachyum falcatum* (Golu/ Garh/ Garila) *Thamnocalamus pathiflorus* (Dev ringal), *T. jonsarensis* (Tham ringal), *Arundineria falcate* (Sararu ringal) and Bhatputra (locally identified) has been recorded from the study area.

Table 2 shows that Schedule Caste families are highly involved in the *ringal* based livelihood activity. Bhanaj village of the Agustamuni block was found maximum (90%) and Maikhanda & Sari villages of the Ukhimath block was found minimum (23%) dependent on *ringal* activity. 100% Generals of Khod and 90% SC of the Bhanaj villages are actively engaged in the *ringal* sector. No any kind of involvement in the ringal activity of SC families of Khod village (Jakholi block) has been found. Table 3 shows about 78% annual income of the stakeholders generated from the *ringal* activity and near about 14% and 8% income comes from labour and agricultural activity. Table 4 shows the maximum part of the earned money from *ringal* is used for providing food (53%) and clothes (27%), and remaining about 20% money is used in medicines and marriage & recreations.

Table 1. List of investigated villages according to availability of ringal species

Sl. No.	Name of Village	Altitudes (m) a.m.s.l.	*Ringal* species used
1.	Mansuna	1000-2000	*Drepanostachyum falcatum*
2.	Karandhar	1000-2000	
3.	Maikhanda	1000-2000	(Golu ringal)
4.	Makku	2000- >	*Thamnocalamus pathiflorus*
5.	Sari	2000- >	
6.	Bhanaj	2000- >	(Dev ringal)
7.	Khod	2000- >	

Table 2. Caste wise percentage involvement of the villagers in ringal activity

Sl. No.	Name of Village	Name of Block	Total No. of HH in the village	Percentage of HH engaged in *ringal* activity	
				SC	General
1.	Mansuna	Ukhimath	148	46	0
2.	Karandhar	Ukhimath	70	56	0
3.	Maikhanda	Ukhimath	68	23	25
4.	Makku	Ukhimath	438	38	0
5.	Sari	Ukhimath	163	23	0
6.	Bhanaj	Agustamuni	286	90	0
7.	Khod	Jakholi	89	0	100

Table 3. Calculation of annual income of ringal stakeholders from different sources

Sl. No.	Name of Village	Annual income of ringal stakeholder from different sources (Rupees/ stakeholder/year)			
		Ringal	Agriculture	Labour	Total
1.	Mansuna	17000	9375	2638	29013
2.	Karandhar	6333	0	2833	9166
3.	Maikhanda	5800	0	1000	6800
4.	Makku	9667	0	167	9834
5.	Sari	7000	0	0	7000
6.	Bhanaj	4667	111	2222	7000
7.	Khod	9886	2286	5714	17886

Table 4. Percentage wise use of earned money from ringal

Sl. No.	Name of Village	Percentage wise use of earn money from ringal			
		Food	Cloths	Medicine	Marriage & recreation
1.	Mansuna	51.25	28.75	10	10
2.	Karandhar	55	26.67	10	8.33
3.	Maikhanda	56	24	24	12
4.	Makku	54.52	26.43	26.43	9.64

5.	Sari	50	30	10	10
6.	Bhanaj	57.78	23.33	23.33	9.44
7.	Khod	51.43	28.57	28.57	10

DISCUSSION

In the study area (Rudraprayag) it is found that r*ingal* is the primary livelihood activity particularly within the socially backward caste. They are totally dependent on this natural resource and have no other source of income. In all the three blocks *ringal* sector contributes highest to generate income as compared to other sources. *Ringal* is low input cost and high-income generating activity for its weavers.

To increase *Ringal* production, scientific techniques about nursery development through seeds, cuttings and information about time of flowering and seed maturing should be given to the weavers through trainings and meetings. To reduce dependency on forests weavers should be provided the plantation of extensively used *ringal* species in their wastelands. *Ringal* conservation can be improved through livelihood improvement of the weavers and not by direct ban on *Ringal* harvesting. Training and awareness programs should be conducted for *Ringal* weavers for making fancy and modern products of *Ringal* like flowerpots, small baskets, pen stands, file covers, fancy bags etc. and production of traditional products like Kanda, Solta, Changra etc. should be stopped. Since too much quantity of *Ringal* (20-40 sticks) is used to prepare traditional products (Kanda, Solta, Changra etc.) that too at low cost and through long time taking process therefore the *Ringal* weavers should prepare modern products in which less quantity of *Ringal* (about 2-3 sticks) is used and they can earn too much money in very short time.

Traditional products should be prepared for self-use only and modern products should be prepared for commercial purposes. If the *ringal* based livelihood activity would be started properly, the migration of some unemployed youth of the area to plains can be reduced, because they can get the job opportunity in *Ringal* sector.

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The Effects of Different Dietary Fibre Levels in the Diet of Growing Snails (*Archachatina marginata)* on Performance Characeristics

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Abstract: Fiber is very important factor in feed formulation for livestock because high level of fiber in the diet has been reported to affect digestibility and nutrient utilization hence this study assessed the effect of different levels of fibre in the diet of growing snails. Four diets were formulated to contain fibre level of at 6% (F_1) Control, 8% (F_2), 10% (F_3) and 12% (F_4). Each treatment was replicated thrice with 8 growing snails per replicate in a Completely randomized design. The snails were reared in a cage of 12 compartments. Feed intake, weight gain, shell length and width were measured. Feed conversion ratio, nutrients digestibility and dressing percentage were calculated. The results showed that no significant difference was observed in snails fed diet containing F_1, F_2 and F_3 ($P>0.05$) while the lowest weight gain was recorded in diet containing 12% crude fibre. The mean monthly feed intake followed the same trend with the monthly weight gain ($P<0.05$). The feed was efficiently utilized in F_1, F_2 and F_3. The highest dressing percentage were recorded in diet containing 6 and 10% crude fibre levels. The highest dry matter, crude protein digestibility were observed in diet containing 6% crude fibre level which was similar to F_2 and F_3. The results established that snail could tolerate up to 10% crude fibre in the diet. [Journal of American Science 2009;5(6):27-31]. (ISSN: 1545-1003).

Keywords: Digestibility, dietary fibre, feed conversion ratio, Nigeria, weight gain, snails.

Introduction

Snail meat is a good source of protein, rich in iron and calcium but low in fat and cholesterol level compared to other protein sources like poultry and pigs (Radrizzani, 1992; Gbadamosi, 1998 ;Oji, 2000 ; Omole *et al.*,2000).The cost of production or the cost of setting up the business is relatively low compared with other conventional livestock (Imevbore,1990 ; NRC, 1991; Malik, 2009) hence there need to increase the production through appropriate research into all aspect involve in production and most especially feeding management feed quality, quantity and cost of feed are very important factor for efficient and profitable livestock production. Nutrient such as carbohydrate, fat and oil, protein minerals and vitamin are essential for better performance of livestock. Fiber is a polysaccharide or complex carbohydrate. The dietary fiber includes the cellulose, hemi cellulose, protein, gum, lignin and mucilage. Fiber requirement determination is very important because high level of fiber in the diet has been reported to affect digestibility and nutrient utilization (Arthur, 1975). Crude fiber has the function of maintaining micro-ecological balances of gut, promoting digestive system development, low level of fiber in the diet will lead to diarrhea (Fraga, 1990; Gidenne, 1992). The sources of fiber in the diet include brewer dry grain, rice bran, wheat offal, etc. Snail farming is new and there is no information on the Fiber requirement of snail in the tropic hence the study was designed to determine the effect different levels of fibre in the diet of growing snails weight gain, feed conversion ratio, dressing percentage and nutrient's digestibility.

Materials and Method

The experiment was carried out at the Snailery Unit of the Institute of Agricultural Research and Training (I.A.R.& T.), Moor Plantation, Ibadan which is located on Longitude 03°51E, Latitude 07°23N and Altitude 650" lies in the humid zone of the rainforest belt 0703.25 of Southwestern Nigeria with mean annual rainfall of 1220 mm and mean temperature of 26°C. A total of ninety six growing snails of mean weight 91.23±2.4g were used for the feeding trial. The snails were acclimatized for one week before the commencement of the feeding trial. Four diets were formulated to contain fibre level of at 6% (T_1) Control, 8% (T_2), 10% (T_3) and 12% (T_4). The diets were formulated to contain about 24% crude protein and energy of 2400 – 2500 kcal/kgME (Table 1). Feed intake and weight gain were measured on daily and weekly basis with the use of sensitive weighing balance. Feed intake was calculated by subtracting the left-over feed from the feed given while the weight gain was

calculated by deducting the initial weight from the final weight. Shell length, width and aperture were measured on weekly basis with Venier calliper. Feed conversion ratio were calculated as the ratio of feed intake to weight gain. Feed cost and cost per weight gain were also calculated. Two snails from each replicate were randomly selected for the digestibility trial for seven days according to the method of Omole, 2003. Carcass analysis was carried out at the end of the feeding trial by randomly selecting eight snails from each treatment and weighed separately. Each snail was killed by striking the shell with a club. The shell, foot and viscerals were separated and weighed separately. The chemical composition of the experimental diets and the foot were done according to the method of A.O.A.C. (1990). All data were subjected to statistical analysis using analysis of variance and the means were separated using Duncan Multiple Range Test [SAS 1999].

Table 1 . Gross Composition Of Experimental Diet.

Ingredient (%)	F_1 (6%)	F_2 8%)	F_3 (10%)	F_4 (12%)
Maize	26.00	22.45	21.45	22
GNC	10.00	16	14	12.65
Soyabean meal	24.2	18	15	13
Brewer dry grain	15	18.7	22	27.3
Rice bran	14.60	15.00	16.5	20
Fish meal	4.00	4.00	5	5
Bone meal	2.15	2.00	2.00	2.00
Oyster shell	3.5	3.3	3.5	3.5
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Salt	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25
Total	**100.0**	**100.0**	**100.0**	**100.0**
Crude protein (%)	24.55	24.62	24.70	24.88
Fibre content (%)	6.19	8.24	10.30	12.02
Energy (Kcal/kgME)	2544.43	2512.68	2499.02	2485.04

Results and Discussion

There were no significant differences (P>0.05)in the mean initial weight of the snails as shown in Table 3. The values varied between 85.8 and 88.3g. The mean monthly weight gain was significantly influenced by different level of fibre in the diet (Table 2). No significant difference was observed mean monthly weight gain of snails fed diet containing 6% (F_1), 8% (F_2) and 10% (F_3) crude fibre level while the lowest weight gain was recorded in diet containing 12% (F_4) crude fibre. The mean monthly feed intake followed the same trend with the monthly weight gain (P<0.05). The highest mean monthly feed intake was recorded in F_1 which was relatively similar to F_2 and F_3 (Table 3). The lowest feed intake and weight gain recorded in F_4 could be due to increase in fibre content of the diet. It has been observed that feed intake tends to reduce when the fibre content in the diet of livestock increase (Fraga, 1990; Wilfart *et al.,* 2007). High fibre content in the feed reduces the movement of ingested feed in the gut (Gidenne,1992). The lowest weight gain recorded in F_4 could also be due to lowest feed intake reported. The mean feed conversion ratio which is the ratio of feed intake to weight gain was influenced by different level of fibre in the diet (P<0.05). The feed was efficiently utilized in F_1, F_2 and F_3 as observed in Table 3. There were no significant differences in the mean monthly shell length, width and thickness increment as shown in Table 3. It has been confirmed that high fibre level above tolerant level has adverse effect on absorption of calcium and phosphorus etc. (Fraga, 1990). From the result observed, it could be inferred that the level of fibre content in the diets was still within the range of level of tolerance because the shell growth in all the treatments was not significantly influenced by different level of fibre in the diet. There were significant

differences (P<0.05) in the mean dry matter, crude protein, crude fibre and ash digestibility as shown in Table 4. The highest dry matter, crude protein and crude fibre digestibility were observed in diet containing 6% crude fibre level which was similar to F_2 and F_3. The better nutrients digestibility observed in F_1 could be due to low fibre content in the diet which result into highest feed intake recorded. The results were relatively similar to the report of (Gidenne,1992) who recorded low digestibility of nutrients as the fibre level of the diet increase in rabbit. The low digestibility of nutrients observed n F_4 was due to high fibre content of the feed. The results of carcass analysis showed that the foot weight (edible portion) of the snails was significantly (P<0.05) influenced by the levels of fibre in the diets as shown in Table 5. The dressing percentage was also significantly influenced (P<0.05) by different levels of fibre in the diet. The highest dressing percentage was recorded in diet containing 6% which was relatively similar to F_2 and F_3. The dressing percentage observed in F_1, F_2 and F_3 were 41.3% and 41.1% was relatively similar to the report of Omole, 2003. It could be concluded that mean feed intake and weight gain were relatively similar in diet containing 6, 8 and 10% level of fibre. The lowest feed intake and weight gain were recorded in diet containing highest fibre content (12% CF). The efficiency of feed utilization was best in the diet containing 6% crude fibre level (CFL) but relatively similar to diet with 8 and 10% crude fibre level. The feed was poorly utilized in diet containing 12% crude fibre level. The dressing percentage of the snails was relatively the same in F_1 , F_2 and F_3. Snails could tolerate up to 10% on crude fibre in the diet.

Table 2: Chemical Composition Of The Experimental Diets.

%	F_1 (6%CF)	F_2 8%CF)	F_3 (10%CF)	F_4 (12%CF)
Dry matter	87.15	86.47	87.01	86.65
Crude protein	24.03	24.18	24.21	24.30
Crude fibre	6.01	7.92	10.05	12.11
Ash	8.14	8.10	7.92	7.86
Ether extract	4.86	4.81	4.74	4.70
Nitrogen free extract	56.96	54.99	53.08	51.03

Table 3 Performance Of Snail Fed Different Levels Of Fibre.

	F_1 (6%CF)	F_2 8%CF)	F_3 (10%CF)	F_4 (12%CF)	± SEM
Initial weight (g)	86.2	88.3	85.8	86.9	4.5
Final weight (g)	235.64 [a]	236.4 [a]	230.08 [a]	214.46 [b]	12.9
Total weight gain g	149.44 [a]	148.12 [a]	144.28 [a]	126.36 [b]	10.6
Monthly weight gain (g)	37.36 [a]	37.03 [a]	36.09 [a]	31.59 [b]	4.7
Total feed intake (g)	866.88 [a]	862.0 [a]	841.2 [a]	749.2 [b]	23.7
Monthly feed intake (g)	216.7 [a]	215.5 [a]	210.3 [a]	187.3 [b]	8.5
Feed conversion ratio	5.8 [a]	5.82 [a]	5.83 [a]	5.93 [b]	0.05
Mortality/snail	0	1	1	0	
Shell length increment (mm)	11.84	11.82	11.80	11.74	0.08
Shell width increment. (mm)	9.76	9.75	9.75	9.66	0.06
Shell thickness increment. (mm)	0.15	0.15	0.14	0.14	0.02

a & b = means with different superscripts along the same row are significantly different (P<0.05).

SEM =standard error of means.

Table 4. Digestibility Of Nutrients By Snail Fed Different Level Of Fibre In The Diet.

Parameters	F_1 (6%CF)	F_2 8%CF)	F_3 (10%CF)	F_4 (12%CF)	± SEM
Dry matter digestibility %	77.91 [a]	77.8 [a]	76.38 [a]	71.42 [b]	4.6
Crude protein dig. %	70.28 [a]	69.95 [a]	69.01 [a]	62.12 [a]	4.1
Crude fibre dig. %	67.80 [a]	67.10 [a]	66.81 [ab]	62.1 [b]	3.7
Ether extract dig. %	78.21 [a]	77.9 [a]	76.35 [a]	71.4 [a]	5.3
Ash digestibility %	70.45 [a]	70.15 [a]	69.3 [a]	64.5 [b]	4.8
Nit. Free extract dig%	69.4 [a]	69.1 [a]	68.2 [a]	62.7 [b]	4.6

a & b = means with different superscripts along the same row are significantly different ($P<0.05$).

Table 5. Carcass Analysis Of Snail Fed Different Level Of Fibre In The Diet

	F_1 (6%CF)	F_2 8%CF)	F_3 (10%CF)	F_4 (12%CF)	± SEM
Live weight (g)	234.3 [a]	232.3 [a]	230.2 [a]	213.5 [b]	12.8
Shell weight (g)	49.91 [a]	49.25 [a]	46.7 [ab]	41.42 [b]	4.4
Offal weight (g)	45.22 [a]	43.44 [a]	42.12 [a]	36.7 [b]	3.8
Foot weight (g)	96.7 [a]	95.47 [a]	91.53 [a]	82.65 [b]	5.8
Dressing percent %	41.3 [a]	41.1 [a]	39.76 [a]	38.71 [b]	3.1
Offal/live weight%	19.3	18.7	18.3	17.2	2.8
Shell/live weight%	21.3	21.2	20.3	19.4	2.9

a & b = means with different superscripts along the same row are significantly different ($P<0.05$).

SEM =standard error of means.

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A Shortest Adaptive Learning Path in eLearning Systems: Mathematical View

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Abstract: The main challenge of e-learning systems is to provide courses tailored to different students with different learning rate and knowledge degree. Such systems must be also efficient, as well as adaptive. However, the most recent researches can be classified in to two major groups. The first group emphasizes the need for E-learning to be adaptive. While the second group, emphasizes the efficiency of such systems. In this research we set an objective to achieve both efficiency and adaptivity. This can be accomplished by selecting a representative algorithm for the first group and a representative algorithm for the second one, and attempting to combine them. This is justified by the fact that the first one aimed at improving the ability to select dynamically an appropriate learning object for a specific learner, while the second one aimed at selecting a learning path that costs least time and effort. In order to decide how these two approaches can be combined, the representative approaches were further analyzed, implemented and then experimented. As a result, a formalization and some modifications to these algorithms were suggested and a new approach is proposed. [Journal of American Science 2009;5(6):32-42]. (ISSN: 1545-1003).

Keywords: eLearning; Learning Object; optimized selection; shortest learning path.

1. Introduction

The term e-learning refers to online learning delivered over the World Wide Web via public internet or private intranet (Yu et. al., 2006). It is concerned with the computer based implementation of an educational system, thus it is a result of a computer oriented analysis and design of such system. Furthermore, web based education and training is a hot research area. Most of the progress made in this field has been influenced by the evolving technological infrastructure. However, the main challenge of the most recent research is to provide efficient and adaptive e-learning systems. To achieve efficiency, the e-learning systems are modeled as a directed graph where each node represents a Learning Object (LO) (Viet and Si, 2006). Each LO may contain one concept, one object, an image, or an audio session. Two nodes are connected if there exist a dependency relation, such that one node is a prerequisite to the other. Given a target node, the resulting graph can be used to determine the shortest path leading to such node. One of the most important features which has not been fully explored in this approach is the ability of the learning system to adapt to the learner's profile (Yanwen and Zhonghong, 2004).

The e-learning systems act as an adaptive system if they select the path of learning that meet the student's requirements and needs and discard those paths, which are not in accordance with these needs. Furthermore, such an adaptive learning must be as efficient as possible (Andreev and Troyanova, 2006). To achieve such adaptivity and efficiency, two groups of solutions do exist. The first group emphasizes the need for e-learning to be adaptive (Atif et al., 2003; Karampiperis and Sampson, 2004; Liu and Greer, 2004; Viet and Si, 2006). The other group emphasizes the efficiency by selecting learning path which costs the least time and effort (Zhao and Wan, 2006) .

Based on these solutions the aim of our research is to select a representative algorithm from each group and combine these algorithms, in order to create a shortest path that is tailored for the learner's needs. Hence, the benefits of both groups are to be obtained.

This research is organized as follows; section 2 is a discussion of related work. Section 3 constitutes a formalization of the Eliminating and Optimized Selection (EOS) (Liu and Greer, 2004) and section 4 introduces a new approach that combines this algorithm with the shortest learning path algorithm with a respective modification of their different phases (elimination, selection and optimization). Experiment and results are given in section 5 and conclusion and discussion are given in section 6.

2. Related Work

Carchiolo et al.(2002) proposed an adaptive system for e-learning, which provides students with all paths from an initial knowledge to a desired one. The paths are retrieved and optimized based on student profile and teacher profile. Thus discarding those paths, which are not in accordance with the student's needs; the remaining paths are presented to the student to select one path and learn its course units.

Based on this system Zhao and Wan (2006) proposed an algorithm to select the shortest learning paths to learn the target knowledge. They assumed that a course is modeled as a graph, in which each node represents a knowledge unit (KU), and two nodes in the graph are connected if the first node is a perquisite to the later node. In addition, they considered the weight of the course graph to be managed by teachers. Then they defined the best learning path as the learning process that will cost the least time and effort. Thus, they introduced the shortest learning paths algorithm.

Atif et al. (2003) represented the content structure of the course by learning object graph (LOG), and classified the peaks of LOG into two categories: Mandatory learning object, and secondary learning object. Based on this structure, Viet and Si (2006) built an adaptive course generation (ACG) system to create adaptive courses for each learner based on evaluating demand, ability, background and learning style of them. In the course content there is a test in each section, an algorithm is proposed to select the learning objects (LO) from the learning object graph, which are suitable for the requirements of learner.

Karampiperis and Sampson (2004) addressed the learning object selection problem in intelligent learning systems and they introduced a decision model that mimics the way the instructional designer decides. They proposed a function that estimates the suitability of a learning object for a specific learner. The same methodology they proposed in educational hypermedia systems (Karampiperis and Sampson, 2004).

Karampiperis and Sampson (2005) suggested some changes on the previous methodology, such that they construct a similar function with several assumptions; the first one is that the elements of the user model defined by the designer and remain the same during the life cycle of the system. The second assumption is the learners characteristics and preferences stored in user model and the structure of the educational resource description model have been defined by the instructional designer. Then they used this suitability function for weighting the connections of the learning paths graph in adaptive educational hypermedia systems (AEHS). They assumed that using this function make the most suitable path is the shortest between two nodes, and they used simulation to compare the learning paths generated by the proposed methodology with ideal ones produced by a simulated perfect rule-based AEHS.

Liu and Greer (2004) proposed a framework for individualized learning object selection. This framework gives a suggestion to select a group of suitable learning objects for the learner, also it evaluates the suitability of a learning object using information about the learning object, information about learner, and historical information about the learner and the learning context. This framework was divided into three steps: eliminating irrelevant learning objects depending on some features of the learning object, the second step was to select learning object depending mainly on educational information and pedagogical principles, finally optimization for the selected learning objects had to be performed.

The analysis of the above-mentioned work reveals the fact that they can be classified in two major groups; the first group emphasizes the need for E-learning to be adaptive (Atif et al., 2003; Viet and Si, 2006; Karampiperis and Sampson, 2004; Liu and Greer, 2004). While the second group, emphasizes the efficiency (Zhao and Wan, 2006; Pythagoras and Demetrios, 2004)

As a representative for the first group we select the work suggested by Liu and Greer (2004); while a representative for the second one is the work suggested by Zhao and Wan (2006). This is justified by the fact that Eliminating and Optimized Selection (EOS) suggested by Liu and Greer (2004) aimed at improving the ability to select dynamically an appropriate learning object for a specific learner, while the shortest learning path suggested by Zhao and Wan (2006) aimed at selecting a learning path that costs least time and effort.

Our research aims at obtaining the benefits of both groups this can be achieved by an attempt to combine the above-mentioned representative algorithms. In order to decide how these two approaches can be combined, the above mentioned representative approaches were further analyzed, implemented and then experimented. As a result a formalization and some modifications to the above algorithms were suggested. Finally, a new approach is proposed to combine these representative algorithms.

3. Formalization of EOS

The key features of the EOS approach were to evaluate the suitability of a learning object in its situated context and to optimize the evaluation by using historical information about the learner, the learning object, and the learning context. The suitability of a learning object requires an evaluation based on its features. Whether a learning object is suitable depends on its own features and the context where it is used (Liu and Greer, 2004).

The analysis of this framework reveals the fact that the attributes of a learning object can be classified into two groups: eliminating attributes and selecting attributes, these attributes are used in different phases of EOS. The eliminating attributes are used in the filtering phase where certain Learning objects are eliminated if they do not match the learner's needs. The selecting attributes are used in the selection phase where each learning object assigned a value according to the comparison between the selecting attributes and learner's characteristics. The resulted set of learning objects will be candidate to enter the optimization phase, in which a value assigned to these learning objects according to the history of using learning objects by previous learners.

Table1: Learning Object attributes.

Attribute Name	Explanation
Learning Object ID	An Identifier of the learning object
Language ID	The language in which the content is presented
Environment ID	The technical requirements needed for presenting the learning object
Current learner ID	Current learner using the leaning object
Pedagogical Objective	The concept represented in the learning object
Cost	The price of the learning object
Expected Reading Level	The reading capability required by the learning object.
Prerequisite	The knowledge needed by the learning object
Typical Learning Time	Time needed for working with the learning object
Presentation Type	The way of presenting the content of the learning object

Table 2: Learner attributes.

Attribute Name	Explanation
Learner ID	An Identifier for the learner
Learner Name	First Name and last name of the learner
Learning objective	The subject or topic the current learner is going to learn
Learner Type	Learner's category
Background	Information about related knowledge or experiences of the learner
Knowledge in Related Area	Learner's level of domain related knowledge
Preferred Language	Language that the learner prefers
Reading Level	Learner's capability of understanding written materials
Listening Level	Learner's capability of understanding vocal materials
Reading Speed	Learner's speed of reading
Preferred Presentation Type	Learner's preference about the way in which the content is presented
Learning Style	Learner's way of learning new concepts or knowledge
General Academic Achievement	Information about the learner's academic performance
Environment ID	Computer environment (hardware, and software)
Financial Situation	Financial restriction
Time	Time the learner wishes to spend

Table 3: Learning Object History attributes.

Attribute Name	Explanation
Learner ID	Learner identifier
Learning Object ID	Learning object identifier
Accessing Time	The time when the learning object is accessed by the learner
Learner status	The learner status after using the learning object
Learning Style	Learner's way of learning new concepts or knowledge
Learner Type	Learner's category
General Academic Achievement	Information about the learner's academic performance
Interactions	Actions the learner makes while accessing the learning

	object
Evaluation	The learner's opinion about the learning object
Achievement	The assessment result of the learner after working with the object
Previous instructor ID	Teachers who have accessed the learning object
General Popularity	How often the learning object is selected for all type of learners
Specialized Popularity	How often the learning object is selected for certain type of learners

Table 4: Language attributes.

Attribute Name	Explanation
Language ID	The identifier of the language
Language Name	Human language name

Table 5: Environment attributes.

Attribute Name	Explanation
Environment ID	The identifier of the environment
Software	Operating system type in the environment
RAM	Memory exist in the environment
CPU	CPU type used in the environment

Based on learning object attributes a general framework to evaluate the suitability of a learning object is given in Figure 1. Where Eliminate (S) is a function that calculate the value $e_{eliminate}$ (0 or 1) for each LO_j in S, and then constructs the set S' as composing of learning objects with $e_{eliminate}$ equal (1). Select (S') is a function that assign a value e_{select} - considering selecting attributes- for each learning object in S', after that the function Optimize (S') is applied, in order to assign a value $e_{optimize}$ for each learning object in S'. Finally, the function Suitability (S') is applied to assign e_{final} for each LO in S', where e_{final} is the final evaluation result of the learning object and it is calculated as:

$$e_{final} = e_{eliminate} \times (e_{select} + e_{optimize}) \quad (1)$$

The learning object that has the highest e final value is the most suitable learning object. In the following subsections we will discuss how to calculate each value of $e_{eminate}$, e_{select} , and $e_{optimize}$.

Let $S = \{LO_1,\ldots,LO_j\}$ the set of the learning objects from which an E-learning system is composed

$S_{eliminate}$ = Eliminate (S)

Where: Eliminate (S) constructs the sets $S_{eliminate}$ and S' such that:

- $S_{eliminate} = \{ e_{eliminate1} , \ldots, e_{eliminate\ j} \}$
- $e_{eliminate}$ is a value assigned for each $LO_j \in S$ as :

$$e_{eliminate\ j} = \prod_i a_{eliminate\ i} \quad , a_{eliminate} \in \{0,1\}$$

- $S' = \{ LO_j \in S \mid e_{eliminate\ j} = 1 \}$

S_{select} = Select (S')

Where: Select (S') constructs the set S_{select} such that:

- $S_{select} = \{ e_{select\ 1} ,\ldots, e_{select\ j}\}$
- e_{select} is a value assigned for each $LO_j \in S'$ as :

$$e_{select\ j} = \sum_i W_i \times a_{select\ i} \quad ; \quad W, a_{select} \in [0,1]$$

- W_i is calculated by formula (4)

$S_{optimize}$ = Optimize(S')

Where: Optimize(S') constructs the set $S_{optimize}$ such that:

- $S_{optimize} = \{ e_{optimize\ 1},\ldots, e_{optimize\ j} \}$
- $e_{optimize}$ is a value assigned for each $LO_j \in S'$ as:

$$e_{optimize\ j} = \sum_i W_i \times a_{optimize\ i} ; \quad W, \quad a_{optimizei} \in [0,1]$$

- W_i integer values to be given

$S_{suitability}$ = Suitability(S')

Where: Suitability (S') constructs the set $S_{suitability}$

- $S_{suitability} = \{ e_{final\ 1} ,\ldots, e_{final\ j} \}$
- $e_{final\ j}$ is a value assigned for each For each $LO_j \in S'$ as:

$$e_{final\ j} = e_{select\ j} + e_{optimize\ j}$$

Figure 1: Evaluation of the suitability of Learning Objects

3.1. Eliminating irrelevant objects

The first phase in EOS approach is eliminating irrelevant objects, in other words, filtering process. This step depends on some attributes such as the following attributes:

- Pedagogical objective (Keyword
- language
- Environment condition (software, hardware)
- Financial cost

The eliminating attributes are constraints so they are binary variables (1 or 0). If any attribute of the eliminating attributes did not match the requirements of the learner, the learning object will be omitted. In this step if an attribute satisfies the requirements, it has a value (1), and if the attribute does not fit in the current context, it has a value (0). Hence, the eliminating phase is based on applying the following formula for each learning object:

$$e_{eliminate} = \prod_i a_{eliminatei} \text{ where } a_{eliminate} \in \{0,1\} \quad (2)$$

In Figure 2 we formalize a function that is used to calculate e eliminate for each learning object. This function is called Eliminate(S).

Let a_1, a_2, ……, a_8,be the following attributes respectively:
- Objective in Learner table
- Concept in Learning Object table.
- Financial Situation in Learner table
- Cost in Learning Object table
- Environment ID in Learner table
- Environment ID in Learning Object table
- Language ID in Learner table
- Language ID in Learning Object table

four eliminating criteria are computed as follows:

$a_{eliminate1} = (a_1 = a_2)$

$a_{eliminate2} = (a_3 \geq a_4)$

$a_{eliminate3} = (a_5 = a_6)$

$a_{eliminate4} = (a_7 = a_8)$

We define a function F1 that returns 1 or 0 as follows:

F1 ($a_{eliminate1}$, $a_{eliminate2}$, $a_{eliminate3}$, $a_{eliminate4}$)
If $a_{eliminate1} \cap a_{eliminate2} \cap a_{eliminate3} \cap a_{eliminate4}$ then
return 1
Else
return 0

Figure2: Calculating of eliminating criteria $e_{eliminate}$

3.2. Selecting candidate learning object

To select the candidate learning objects. A suitability evaluation for each learning object is performed. This proceeds as follows:
- An importance analysis of the features surrounding each LO or context is performed. This analysis is reflected by assigning weight (W) for each attribute (feature) of the learning objects in a given context.
- A degree of match between these attributes and the requirement is performed. This degree is represented by a value between 0 and 1, and it is denoted by a $_{select}$

Thus, the selecting criteria for each LO is based on the following formula:

$$e_{select} = \sum W_i \times a_{selecti} \text{ where } W, a_{select} \in [0,1] \qquad (3)$$

For the purpose of implementation, we will use time, presentation type, and reading level as selecting attributes for the learning object. We will use the learner style as a context to determine the importance of these selecting attributes. For example, if the learner style was visual then the most importance LO attribute will be the time then the presentation type, and finally the expected reading level, but if the learner style was auditory then the attributes will be arranged according to their importance as follows: presentation style, time, and finally expected reading level. If the learner style was tactile and kinesthetic (i.e. learn by doing) then the most importance feature of the LO will be expected reading level, time, finally presentation style.

Hence, the importance of each attribute is presented by a weight W_i. According to the context, since in different context a learning object attribute affects the suitability in various ways. For the purpose of our implementation, the weight is calculated as follows:

$$W_i = P_i / N \qquad (4)$$

Where:
P : the preference degree of the selecting attribute (i) according to the learner.
N : the number of selecting attributes.

For instance, if the learner style was auditory then the weight for presentation style =1, weight for time =2/3, and finally weight for expected reading level =1/3.

The degree of match for each attribute is a value in the interval [0, 1]. Figure 3 shows a formal definition for calculating the degree of match for each selecting attribute.

Let the properties of a Learning Object defined as $a_1 \ldots a_i$
Let the properties of a Learner defined as $a_1 \ldots a_j$
Where $a_1 \ldots a_i$, $a_1 \ldots a_j$ are integer values
Let n be the number of selecting attributes
Then
$a_{select\ i}$ is defined as the degree of match for each selecting attribute for a learning object, where:

$$a_{select\ i} = \begin{cases} 0, & \text{if } a_j < a_i \quad i,j=1 \ldots n \\ 1, & \text{if } a_j = a_i \quad i,j=1 \ldots n \\ (a_i / a_j), & \text{if } a_j > a_i \quad i,j=1 \ldots n \end{cases}$$

Figure3: Calculating the degree of match a_{select}

3.3. Optimization phase

In some situations a learning object which match a learner's preferences might not be the best for the learner, so the selection of the most suitable learning object can be optimized based on:
- Previous usage of the learning object.
- Expert's evaluation.
- Similar learner's experience.
- Popularities of the learning object.

In Our implementation of optimization phase, we consider the following:

- General popularity of the learning object.
- Specialized popularity of the learning object.
- Previous similar learner's evaluation for the learning object.

Furthermore, the similarity between learners is based on learner style, learner level (e.g. beginner, expert… etc), and learner academic achievement. In order to select the learning objects that are suited for individualized learner, optimization phase is based on optimization criteria $e_{optimize}$ that can be calculated using the following formula:

$$e_{optimize} = \sum W_i \times a_{optimize\ i} \quad (5)$$

Figure 4 shows the calculation of $e_{optimize}$ for each learning object.

Let $S' = \{ LO_1, LO_2, \ldots LO_i \}$ the set of selected learning objects
Let Av be the average of similar previous learners evaluation
Let L_{given} be the current learner using the system
Let L_{cls} be Learning Style for current learner
Let L_{pls} be Learning Style for previous learner
Let L_{ctl} be Learner Type for current learner
Let L_{ptl} be Learner Type for previous learner
Let L_{pev} be the previous learner evaluation for $LO_i \in S'$
Let G_p be General Popularity of $LO_i \in S'$
Let S_p be Specialized Popularity of $LO_i \in S'$
Let w_1, w_2, and w_3 be weights assigned for Av, G_p, and S_p, respectively.

For each $LO_i \in S'$

$a_{optimize1} = G_p$

$a_{optimize2} = S_p$

$a_{optimize3} = \text{average}(L_{pev})$

$$Av = \begin{cases} \text{average}(L_{pev}), \text{ if } (L_{cls} = L_{pls}) \cap (L_{ctl} = L_{ptl}) \\ 0, \text{ otherwise} \end{cases}$$

$$e_{optimize\ i} = (w_1 \times a_{optimize\ 1}) + (w_2 \times a_{optimize\ 2}) + (w_3 \times a_{optimize\ 3})$$

Figure 4: Calculating optimization criteria $e_{optimize}$

4. Discovering Suitable Learning Path

The result of merging the knowledge space(ontology plane) and the media space(content space) is a directed acyclic graph (DAG) of learning objects inheriting relations from both spaces, This graph contains all possible navigation paths that a learner can follow to reach his learning goal (Pythagoras and Demetrios, 2004). Thus, there is a need to optimize such navigation paths as well as to select the path that is most suitable for the learner. In order to achieve this, we suggest the following approach:

1. Given a DAG that represents all possible navigation paths, a sub graph that is relevant to a learner is constructed.
2. The sub graph is augmented with weights that represent the suitability of learning objects for the learner.
3. A shortest path algorithm is then applied to select an adaptive path that is as suitable and as shortest as possible for the learner.

The implementation of our approach is based on:

- EOS approach to calculate the suitability of learning object (Liu and Greer, 2004).
- A shortest path algorithm on weighted graph suggested by Zhao and Wan (2006)

However, since our approach is based on constructing a sub graph that is relative to the learner, the EOS approach has to be modified to take this into consideration. This is because the initial construction of the DAG will affect the subsequent phases and improve the overall optimization and adaptation.

4.1. Modifications on EOS approach

Our modification to the EOS approach is based on introducing relevance calculation. Such relevance calculation is needed to obtain the relevant sub graph. Thus the first phase of EOS is divided into two sub phases:

- Relevance calculation for the requested concept or objective. As a result, the most relevant learning objects will be candidate for the next sub phase.
- Eliminating irrelevant learning object according to the eliminating attributes (the language, the cost, and the environment condition)

Such a modification requires a corpus for the concepts and objectives that presented in the domain ontology. This facilitates the representation of the requested objectives, or concepts as terms of keywords within a domain.

For example, a specific concept in a specific domain, or an objective. Based on such terms a relevance value can be computed. For example, terms not frequent in the corpus have a low probability of being representative in the domain. Peñas et al. (2001) have define a formula that gives such a relevance value for the requested terms and we are going to use this formula with some adaptation.

Within the framework of our approach, the following information structures are added.

Two tables to represent corpus are needed; the first one consists of attributes that represent the concept and related information as shown in Table 6. While the other consists of the attributes that represent the concept objective corpus as shown in Table7.

Table 6: Concepts Domain Corpus attributes.

Attribute Name	Explanation
Concept ID	The identifier of the concept
Concept Name	Description of the concept
Domain	The domain in which the concept frequent
Frequency in Domain	Relative frequency of the concept in the specified domain

Table 7: Concept Objective Corpus attributes.

Attribute Name	Explanation
Concept ID	The identifier of the concept
Concept Name	Description of the concept
Objective	The objective in which the concept frequent
Frequency in Objective	Relative frequency of the concept in the specified objective.

Some attributes are added to the learning object table, such as Main Domain, Objective, and the attribute specialized popularity is separated into three attributes, Beginners Specialized Popularity, Trainers Specialized Popularity, and Experts Specialized Popularity as shown in Table 8.

Table 8: New Learning object attributes.

Attribute Name	Explanation
Learning Object ID	An Identifier of the learning object
Language ID	The language in which the content is presented
Environment ID	The technical requirements needed for presenting the learning object
Current learner ID	Current learner using the leaning object
Pedagogical Objective	The concept presented in the learning object
Cost	The price of the learning object
Expected Reading Level	The reading capability required by the learning object.
Prerequisite	The knowledge needed by the learning object
Typical Learning Time	Time needed for working with the learning object
Presentation Type	The way of representing the content of the learning object
Objective	The objective of the learning object
Main Domain	The domain to which the concept of this learning object belongs.
General Popularity	How often the learning object is selected for all types of learners
Beginners Specialized Popularity	How often the learning object is selected for beginners
Trainers Specialized Popularity	How often the learning object is selected for trainers
Experts Specialized Popularity	How often the learning object is selected for experts

- A relationship table is constructed to represents the relations between learning objects in the DAG as shown in Table 9.

Table 9: Relationship attributes.

Attribute Name	Explanation
Learning Object ID	An Identifier of the learning object
Related Learning Object ID	An Identifier of the related learning object
Relation Type	The relationship type between the connected learning objects

4.2. Constructing Relevant Sub Graph

Based on the DAG that represents all possible navigation paths and the above mentioned modifications as well as the newly introduced information (table 6, 7, 8, and 9), constructing the sub graph that is relevant to a learner proceeds as follows:

Firstly, a set of learning objects with relevance value denoted by $e_{relevane}$ for each learning object is constructed, where $0 \leq e_{relevane} \leq 1$. Then, the learning objects with zero value are eliminated. This can be formalized as follows:

Let $S = \{ LO_1,\ldots,LO_j\}$

$S' = Relevance (S)$

where: Relevance (S) is a function that constructs the sets $S_{relevance}$ and S', such that:

- $S_{relevance} = \{e_{relevance\ 1}, \ldots, e_{relevance\ j}\}$
- $S' = \{LO_j \in S \mid e_{relevane\ j} \neq 0\}$

where: $e_{relevance\ j}$ is a value assigned for each $LO_j \in S$

- $e_{relevance\ j} \in \{0, a_{relevance}\}$

where $a_{relevance}$ is calculated by the following formula:

$$a_{relevance}(c,dom,col) = 1 - \frac{1}{\log\left[\frac{2 + F_{c,dom} \times N}{F_{c,col}}\right]} \quad (6)$$

where:

$F_{c,dom}$: frequency of the requested concept in the specified domain or objective (dom)

$F_{c,col}$: frequency of the requested concept in the all collection .

N: the number of learning objects.

$e_{relevane}$ for a given LO is calculated by the function shown in Figure 5. This function is called by Relevance(S) for each LO∈ S.

Let $a_1, a_2, \ldots\ldots, a_{10}$ be the following attributes respectively:
- Concept in Learner table
- Concept in Learning Object table.
- requested Objective or Domain in learner table
- Objective or Domain in Learning Object table
- Financial Situation in Learner table
- Cost in Learning Object table
- Environment ID in Learner table
- Environment ID in Learning Object table
- Language ID in Learner table
- Language ID in Learning Object table

Let a_{11} be the frequency of the requested concept in the specified domain or objective.
Let a_{12} be the frequency of the requested concept in all collection.
Let a_{13} be the number of learning objects in the system.

Five eliminating criteria are computed as follows:

$a_{eliminate1} = (a_1 = a_2)$
$a_{eliminate2} = (a_1 = a_2)$
$a_{eliminate3} = (a_5 \geq a_6)$
$a_{eliminate4} = (a_7 = a_8)$
$a_{eliminate5} = (a_9 = a_{10})$

Let $a_{relevance}$ be a relevance value of the requested term calculated as:
$a_{relevance} = 1 - (1 / \log_2((2 + (a_{11} \times a_{13})) / a_{12}))$

If $a_{eliminate1} \cap a_{eliminate2} \cap a_{eliminate3} \cap a_{eliminate4} \cap a_{eliminate5}$ then
return $a_{relevance}$
Else
return 0

Figure 5: A function to calculate $e_{relevane}$.

4.3. Sub Graph Weighting

DAG weighting is need to find the shortest path by any shortest path algorithm. Hence, the result of applying the shortest path algorithm is the learning path that covers the desired concepts objects, and reaches the learning goal by providing all information about cognitive characteristics and preferences for the learner. Such a weighting for the DAG is calculated by the following formula:

$$W = 1 - e_{final\ j} \quad (7)$$

e_{finalj} is calculated by a suitability function as shown in Figure 6, where:

- Select (S') is a function that assigns a value e_{select} - considering selecting attributes- for each LO in S', where e_{select} is calculated by formula (3).
- Optimize (S') is a function to assign a value $e_{optimize}$ for each learning object in S', where $e_{optimize}$ is calculated by formula (5).
- Suitability(S') is a function to assign e_{final} for each LO in S', where e_{final} is the final evaluation result of the learning object.

S_{select} = Select (S')
where: Select (S')is a function that constructs the set S_{select}
- $S_{select} = \{ e_{select\ 1}, \ldots\ldots, e_{select\ j} \}$
- e_{select} is a value assigned for each $LO_j \in S'$ and calculated by the formula :

$$e_{select\ j} = \sum_i W_i \times a_{select\ i} \quad ; \quad W, a_{select} \in [0,1]$$

- W_i is calculated by formula (4)

$S_{optimize}$ = Optimize(S')
where: Optimize(S') constructs the set $S_{optimize}$, such that:
- $S_{optimize} = \{ e_{optimize\ 1}, \ldots\ldots, e_{optimize\ j} \}$
- $e_{optimize}$ is a value assigned for each $LO_j \in S'$ as:

$$e_{optimize\ j} = \sum_i W_i \times a_{optimize i} \; ; W, a_{optimize i} \in [0,1]$$

- W_i integer values to be given

Then $S_{suitability}$ = Suitability(S')
where Suitability (S') constructs the set $S_{suitability}$ such that:
$S_{suitability} = \{ e_{final\ 1}, \ldots\ldots, e_{final\ j} \}$
$e_{final\ j}$ is a value assigned for each $LO_j \in S'$ as:
$e_{final\ j} = e_{relevane\ j} \times (e_{select\ j} + e_{optimize\ j})$

Figure 6: A function calculates the suitability of a learning object

4.4. Selecting Adaptive path using shortest path algorithm

Based on the previous formalization and calculation of e_{final} as well as the fact that the learning object that has the highest e_{final} value is the most suitable learning object for a learner, The weights of the learning objects that are represented in the sub graph are calculated in away that is inversely proportional to their suitability value. Hence, the lower weight they have the more suitable they are.

5. Experiment and Results

Within the framework of this research, we have conducted several experiments as follows:

- Implementing EOS.
- Implementing the proposed approach.

Further experiments were conducted for testing and comparing EOS, and the proposed approach based on a number of created instances of learning object metadata, a number of learners, and simulated usage history of the learning objects.

The first experiment was conducted based on different learning objects that represent a concept that may appear in one domain or many domains.

The results of applying EOS and the proposed approach are given in Figure 7.

The obtained results show that the number of selected learning objects using the proposed approach is less than the number of selected learning objects using EOS. Also the number of selected learning objects using objective is not always greater than the number of the learning objects selected using main domain; this is because when a concept appears in one domain the objective will have less representative learning objects.

The second experiment was conducted based on concepts that appear in more than one domain and has more than one objective.

Table 10: The characteristics of the three LOs that were used for EOS experiment

Learning Object	Characteristics		
	Presentation Type	Time	Required reading Level
LO_1	Exercise	1 hour	Excellent
LO_2	Table	3 hours	Very Good
LO_3	Diagram	1 hour	Good

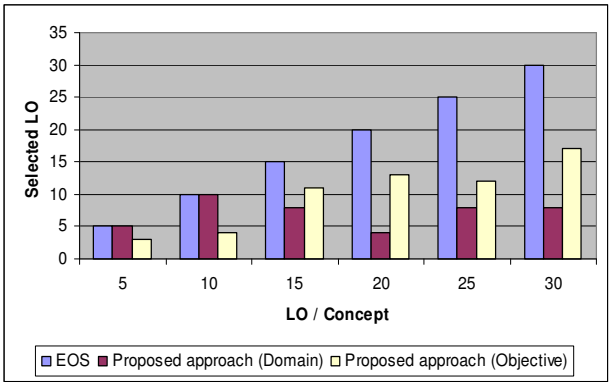

Figure 7: Selection results when a concept appears in one domain or more.

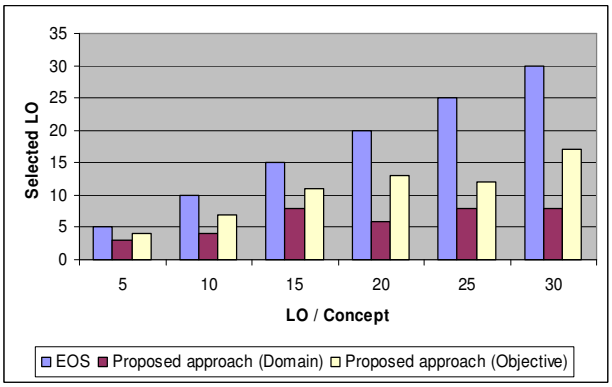

Figure 8: Selection results when concept appears in more than one domain.

The results are given in Figure8. These results show that the number of selected learning objects using objective always greater than the number of selected learning objects using a domain. This is because when a concept appears in more than one domain, each time it has the same objective but in different domains. Thus, when the selection depends on objective all learning objects that represents the specified objective for the requested concept will be retrieved, but in different domains.

The third experiment was conducted by applying the proposed approach to the same learners and learning objects that are used in the implementation of EOS, where EOS was experimented on three different learners and three learning objects (LO1, LO2, LO3), the characteristics of these learning objects are given in Table 10.

The first learner was a beginner with a very good reading level and had 12 hour for learning, his learning style was Visual and his preferred presentation type was videos. The second learner was a trainer with a good reading level, 5 hours to learn, his learning style is Auditory and his preferred presentation type was audios. Finally, the third learner was an expert with an excellent reading level, his learning style was Tactile & Kinesthetic (learn by doing), 20 hours for learning and he preferred slides as a presentation type.

The results are given in Figure 9. These results show how the suitability of the three learning objects varies from one learner to another.

The results show that the suitability variation using the proposed approach is more than in EOS approach, as shown in Figure10. This is because within the framework of the proposed approach the relevance calculation of a concept is added to the calculation of the suitability.

To evaluate the overall performance of the proposed approach, its selection results were compared to the selection results that obtained by experts. Such a selection was performed by both on the same simulated data set, which includes a number of created instances of learning object metadata, a number of learners, and simulated usage history of the learning objects. Such evaluation depends on the formula that was proposed by Karampiperis and Sampson (2005):

$$\text{Selection success}(\%) = 100 \times \frac{\text{Correct LO selected}}{m} \quad (8)$$

where m is the number of requested learning objects from the media space per concept node.

The evaluation depends on the comparison between resulting selection sequence of learning objects by the proposed approach and the selection sequence produced by three experts with different points of view for preferences. Figure 11 shows the selection success for the resulting learning objects sequence while Figure 12 shows the average success for the selection of learning objects.

Both Figures show that the efficiency is affected by the number of desired learning objects (m). Hence, representing a concept by small number of learning objects is more efficient than large numbers of learning objects. However, the selection results of the proposed approach are competitive to the results obtained by the three experts.

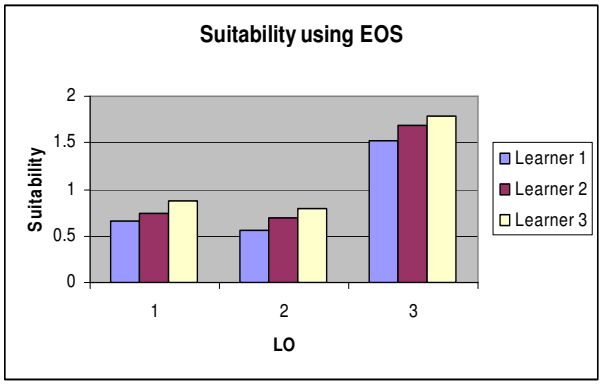

Figure 9: The suitability of three LO for three different learners

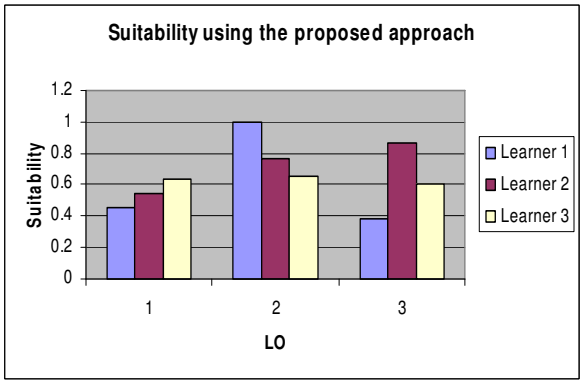

Figure 10: Suitability using the proposed approach.

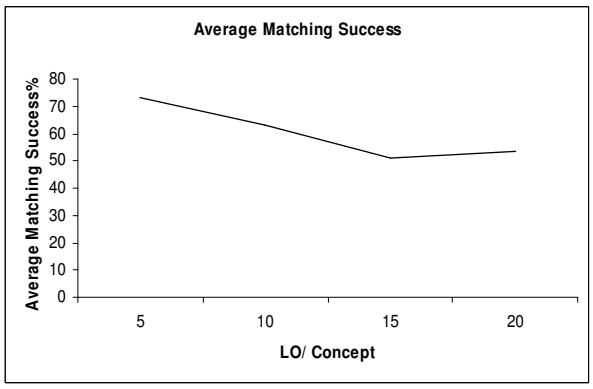

Figure 12: Average selection success using the proposed approach

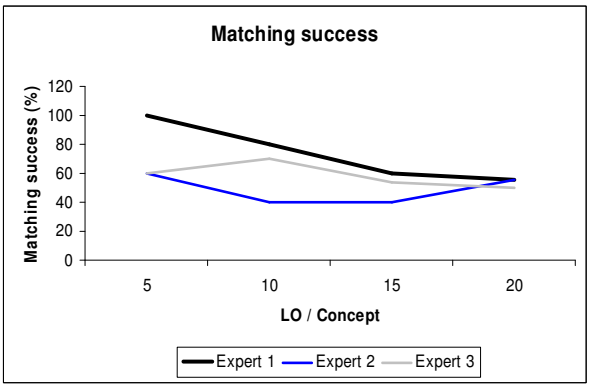

Figure 11: Selection success using the proposed approach

6. Conclusion

This research aims at improving the ability of selecting appropriate learning objects for a specific learner, as well as to select the shortest learning path for that learner. In order to achieve this we select two representative algorithms; Eliminating and Optimized Selection and the shortest learning path algorithm in order to obtain the benefits of both.

Based the DAG that represents all possible navigation paths between learning objects in an e-learning system, the first step of our approach is to construct a sub graph that is relevant to a learner. The second step is to augment the sub graph with weights that represent the suitability of learning objects for the learner. The third step is to apply a shortest path algorithm to select an adaptive path that is as suitable and as shortest as possible for the learner.

The augmented weights represent the suitability of learning objects. In order to calculate the suitability of a learning object, we have added some modifications to the EOS approach by a proposed framework that contains a suggestion on extending the learning object metadata specifications and selecting a short list of appropriate and relevant learning objects for the learner and the learning context. This selection is based on terms that represent objectives and concepts within a domain or more than one domain. This constitutes an improvements on EOS approach. This is because we have used an ontology based representation for LOs. This representation serves the learning objects selection and comparison much better. Furthermore the use of such terms instead of keywords ad full description is also a better approach. This motivated by the fact that the description is difficult to used for automatic learning objects comparison.

Our experiment showed that the improvement on EOS approach gives more specific and more optimized selection of learning objects that are suitable for the learner.

In addition, we have compared the produced LOs sequences selected by our proposed approach with that selected by different experts. Experiment results showed that the success in learning objects sequencing is affected by the number of learning objects that represents the desired concept and our approach is competitive with the results obtained by these experts. Finally, we have seen that the DAG construction affects the subsequent phases and improves the overall performance and adaptation.

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Morphology and Influence of Various Plant Growth Substances on Germination and Early Seedling Growth in *Macrotyloma uniflorum* (Lam.)

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Abstract

The paper presents the results of studies on morphological characters, seed germination and the influence of different concentrations of plant growth substances on *Macrotyloma uniflorum* including the comparative growth patterns of the seedlings. This is one of the lesser known beans mainly cultivated in hilly areas and commonly grown up at 1800m above MSL. Seeds pre-soaked for 24h in various concentrations (0.1, 1.0 and 10 ppm) of GA_3, IBA and NAA respectively putting a separate control set soaked only in distilled water. The mean value of germination percentage, growth of root, shoot and cotyledonary expansion and biomass of seedlings were computed. The maximum germination percentage (99%) was observed through GA_3 0.1ppm and NAA 1 ppm in comparison to control set (90%). Although highest elongation of shoot was observed under GA_3 10 ppm (11.29 cm) and lowest under GA_3 at 1 ppm (10.45 cm) in comparison to control (7.50 cm) but the highest elongation of root was favoured by GA_3 at 0.1 ppm (4.46 cm) whereas, the minimum was observed under NAA at 10 ppm (1.28 cm). The maximum Cotyledon expansion was gained in GA_3 at1ppm (5.36 cm) as compared to controlled set (2.94 cm). IBA 0.1 ppm resulted in highest dry weight of shoot (0.0183 g.) as compared to control (0.0172 g.) while dry weight of root was recorded highest under NAA at 10 ppm (0.0076 g). Lower concentrations of all the plant growth substances exhibited supportive response towards germination, growth of seedlings and development of cotyledons. The results of present findings show that applications of these plant growth substances if used at lower concentrations could enhance germinations and healthy seedling growth leading towards high production of *Macrotyloma uniflorum* to fulfill the demand of farming community. It is thus imperative that more identical studies be conducted on other legume species also generating data base so that the use of growth substances can be extended to produces healthy seedlings required to support large scale seed germination and plantations of those species. [Journal of American Science 2009;5(6):43-50]. (ISSN: 1545-1003).

Keyword: *Macrotyloma uniflorum*, Morphology, Plant Growth Substances, Seed Germination, Seedling Growth.

Introduction

Production of high quality seeds is primary source to the success of Indian agriculture. Every farmer is sensitive to need for the rapid uniform seedling emergence and establishment of an even and productive stand. Crop production relies heavily on high quality planting seeds. The latest ISTA rules (ISTA, 2008) contain seed testing protocols of a large number of species cultivated all over the world and it forms the basic reference book for all kinds of seed testing activities and also for the international seed trade. Seeds are fundamental input to agriculture and natural ecosystem. The production of high percentage of viable seeds with capacity to germinate quickly is necessary for the propagation. Seed quality is very essential for optimum stand establishment and maximum yield potential. As a result, it is necessary

to have different seed testing parameters that permit rapid, objective and accurate evaluation of seed quality (S.C. Joshi *et al* 2009).

Horse gram *(Macrotyloma uniflorum* Lam) is a popular pulse, locally known as Gaheth belongs to the family Fabaceae that still remain an under exploited legume crop. It is usually grown up to the area at1800msl. Horse gram seeds are rich in protein and consumed in majority by poorest section of the society. The fodder being rich in protein; it is widely used as a feed to animals and horses (B. G. Prakash *et al*. 2008). Dehusking, germination, cooking, and roasting have been shown to produce beneficial effects on nutritional quality of the legumes. Seeds and fruits of different species vary greatly in appearance, shape, size and ornamentation and structure of the embryo in relation to storage tissues. In some legumes seed coat colour is quite heterogeneous within a sample and such seeds often comprise a germplasm accession in a gene bank. Correlation of different seed coat colours with seed quality parameters may provide a non-destructive tool (especially useful in a gene bank) for sorting good quality seeds.

Germination represents a critical event in plant's life cycle and its timing largely predetermined the chances of survival of a seedling up to maturity (Thompson, 1973). Temperature is an important physical parameter of an environment, which determines the success or failure of a species in a particular locality, which in turns depends mostly on the germinability of the seed. It is well known that the different population of the same species varies in their temperature and light requirements for germination. Germination requirements of a particular species are a result of the interaction of its genetic makeup with the environment and dormancy pattern of seeds of various plant species, which enable them to survive during adverse conditions (Wittington, 1973; Nikolaeva, 1977). The germination of seed is affected by hormonal secretion and enzymatic activity with in the seeds. Gibberellins (GA_3) and Auxin- IBA (Indolebutyric acid), IAA (Indole acetic acid) control many behavioral functions in plants which act as chemical messengers influencing many patterns of plant development. These stimulate cell division and cell elongation and control enzyme secretions. Seed germination and seedling growth can be influenced by various concentrations of growth regulators i.e. GA_3 and IAA (Chauhan *et al*. 2009).

The present investigation is carried out to investigate the response of different concentrations of the Plant Growth Substances on seed germination, root, shoot and hypocotyls elongation and biomass production of seedlings. Some morphological features of seed of Horse gram have also been observed with germination processes.

Material and Methods

The seeds of *Macrotyloma Uniflorum* were collected from Jakh village of District Tehri of Uttarakhad, India. The observation recorded on various morphological features of the seed such as shape, size, colour, ornamentation, length and width, fresh and dry weight of seed, floral characters along with length and width of pod, pods per plant and seed per pod etc. After thorough mixing, the whole lot was sampled and dried in open air for ten days and stored at room temperature till the experimentation. The moisture content of seeds was determined by air oven method. Subsequently, the sample contained in glass and dried thermostatically at room temperature and weighed, then placed in hot air oven at 80^0 C for 48hrs to find out the average dry weight and calculated using the following formula (Anonymous, 1976).

$$\text{Moisture content (\%)} = \frac{\text{Fresh Weight - Dry weight}}{\text{Fresh weight}} \times 100$$

Seeds were pre-soaked for 24h under the different concentrations of Plant Growth Substances (0.1, 1.0 and 10 ppm) of GA_3, IBA and NAA. A control set was soaked only in distilled water. The seeds were placed on a wet filter paper in petridish and kept in Seed Germinator. The mean valve of germination percentage, growth of root, shoot and cotyledonary expansion and biomass of seedlings were computed on each alternate day till the final day of experimentation (Table 1).

Table 1. The effects of various concentrations of different plant growth substances on seed germination and seedling growth of *Macrotyloma uniflorum.*

Plant Growth Substances	Concentrations used		
GA_3	0.1ppm	1ppm	10ppm
IBA	0.1ppm	1ppm	10ppm
NAA	0.1ppm	1ppm	10ppm
Control	Only distilled water		

Results and Discussion

Macrotyloma Uniflorum is an erect, sub-erect or trailing, densely hairy annual herb. The tap root produces a branched root system with smooth, rounded nodules. Seed is small somewhat gray to brown with pale fawn in colour sometimes with faint mottles or with small scattered black spots or with both. Seed size ranges 6-8 mm long and 3-4mm broad smooth of which 100 seed weight is recorded 3.65gm. The flowers are short and only 6-12 mm long cream - yellow with purple spot in auxiliary racemes with 2 appendages at base. The pods are 4-6 cm long and about 6 mm broad with 18-23 pods per plant bearing 6-7seeds per pod. Flowering and fruiting takes place between August to October (Table-2).

Correlation of different seed coat colours with seed quality parameters may provide a non-destructive tool (especially useful in a gene bank) for sorting good quality seeds. Relationship between seed coat colour and quality parameters in horse gram (*Macrotyloma uniflorum*) was studied by Singh et al. (2009) in seeds separated in to pale brown, medium brown and blackish brown coloured fractions in 20 accessions of horse gram. Seed quality was assessed in terms of germination, seedling vigour and seed storability. The light coloured fractions consistently showed highest germination percentage and seedling vigor followed by medium and dark coloured fractions in all the accessions. Percentage seed moisture content and electrical conductivity were observed to be highest in the dark coloured seeds. Light coloured seeds showed better storability after three years of ambient storage whereas the medium and dark coloured seeds were poor in germination and showed significant decline. Colour of seeds can be used as a visual indicator of seed quality and storability in horse gram.

Table 2. The Morphological Features of *Macrotyloma uniflorum* Seeds

S. No.	Parameters studied	Range of Variation
1.	Shape of seed	Seeds are small and somewhat round
2.	Colour	Gray to brown with pale fawn in colour. Sometimes with faint mottles or with small scattered black spots or with both.
3.	Ornamentation	Smooth and ovoid
4.	Length of seed	6-8 mm
5.	Width of seed	3-4 mm broad
6	Seed fresh weight (100)	3.65 gm
	Seed dried weight	1.095 gm
7	Flowers	Short only 6-12 mm long. The flower is cream - yellow with purple spot in auxiliary racemes with 2 appendages at base.
8	Pod	Shortly stipitate, slightly curved and tomentose.
9	Length and width of pod	4-6 cm long and about 6 mm broad with a point about 6 mm long.
10	Pods per plant	18-23 pods
11	Seed per pod	Usually bear 6 or 7 seed per pod.
12	The sowing time of the seed	Last week of June to first week of July.
	Flowering and fruiting period	The plant attains flowers and fruits between Aug to Oct.

13	Harvesting	The crop is harvested, when the seeds turn to shining brown-grey color, generally during mid Oct to Nov.

The observations of the experiment showed that GA_3 0.1ppm and NAA 1ppm resulted in equal 99 percent germination which was followed by IBA10ppm (96%) while control set showed lowest germination (90%). GA_3 1, $GA_3$10, IBA 0.1, and IBA-1ppm resulted in equal percent germination (98). Within the concentrations, the NAA 10ppm responded only 96 percent germination which is less than the control. (Table 3 and Fig. 1).

In case of the seedling growth, GA_3 at 10ppm attained maximum (11.29cm) shoot length which was followed by GA_3 at 1ppm (10.45cm) and IBA at 0.1ppm (9.23cm). Minimum shoot length was observed under NAA 10ppm (7.02cm) that was slightly lower than the control set (7.50cm). As far as root growth is concerned, it was observed highest under GA_3 at 0.1ppm (4.46) followed by NAA at 1ppm (4.07). The lowest performance with regards to the root length was recorded under NAA at 10ppm (1.28) that was very less than control (3.68).The cotyledon expansion was observed highest under the influence of GA_3 1ppm (5.36 cm) that was followed by GA_3 10ppm(3.79, Fig-4). The control set exhibited (2.94 cm) a little higher than NAA-10 ppm (2.27).

The highest cotyledons development has enhanced under the GA_3 at 1ppm (5.36 ±0.5cm) concentration that was followed by GA3 at 100ppm (5.36 ±0.5cm) and GA3 0.1 ppm(3.65 ±0.3). The lowest growth was recoded under the influence of NAA 10ppm (2.27 ±0.2) which is less than the control set (2.94 ±0.2, Fig-2). Dry weight of root biomass in case of controlled set was observed to be 0.0047±0.004g. The maximum dry weight of root was found in NAA at 10 PPM (0.0076 ±0.006g) and minimum dry weight of root was observed under GA_3 at 10 PPM (0.0021±0.002). The maximum fresh weight of shoot (0.0183 ±0.5) was observed under IBA at 0.1 ppm whereas, the dry weight of shoot under the control set has recorded higher (0.0172±0.2) than some of other concentrations (Table-4 and Fig.3).

Table 3: Effect of Various Concentrations of Plant Growth Substances on the Seed Germination and Seedling Development of *Macrotyloma uniflorum*.

Treatments	Germination %	Shoot Length (cm)	Root Length (cm)	Cotyledon Expansion (cm)
GA_3 0.1 ppm.	99	9.53 ±0.7	4.46 ±0.3	3.65 ±0.3
GA_3 1 ppm.	98	10.45 ±0.5	3.57 ±0.2	5.36 ±0.5
GA_3 10ppm.	98	11.29 ±0.8	3.69 ±0.5	3.79 ±0.2
IBA-0.1 ppm.	98	9.23 ±0.7	3.86 ±0.3	3.05 ±0.3
IBA -1 ppm.	98	8.34 ±0.7	3.95 ±0.3	2.91 ±0.2
IBA -10 ppm.	96	9.50 ±0.7	3.55 ±0.3	2.94 ±0.2
NAA- 0.1 ppm.	97	8.54 ±0.8	1.93 ±0.5	3.12 ±0.5
NAA -1 ppm	99	8.84 ±0.8	4.07 ±0.5	2.8 ±0.2
NAA -10ppm.	96	7.02 ±0.8	1.28 ±0.5	2.27 ±0.2
CONTROL	95	7.50 ±0.8	3.68 ±0.5	2.94 ±0.2

Table 4: Effect of Various Concentrations of Plant Growth Substances on the Shoot and Root Dry Weight of *Macrotyloma uniflorum*.

Treatments	Shoot Dry Weight(gm)	Root Dry Weight(gm)	Shoot: root ratio	Epicotyls length((cm)	No. of Roots
GA_3 0.1 ppm	0.0143 ±0.5	0.0053 ±0.005	1: 13	2.92	7
GA_3 1 ppm	0.0174 ±0.2	0.0029 ±0.002	1:0.8	2.62	9
GA_3 10ppm	0.0162 ±0.2	0.0021 ±0.002	1:0.2	3.52	9
IBA- 0.1 ppm	0.0183 ±0.5	0.0043 ±0.003	1: 4.1	3.46	8
IBA -1 ppm	0.0152 ±0.5	0.0036 ±0.003	1:3.6	3.44	8
IBA -10 ppm	0.0137 ±0.2	0.0053 ±0.005	1:3.5	1.87	8
NAA -0.1 ppm	0.0140±0.2	0.0045 ±0.004	1:0.6	2.45	7
NAA- 1 ppm	0.0143 ±0.2	0.0055 ±0. 005	1:40	2.58	7

NAA- 10 ppm	0.0175 ±0.5	0.0076 ±0. 006	1:1.8	0.29	6
Control	0.0172 ±0.2	0.0047 ±0. 004	1: 6.7	2.85	7

Heavy seeds generally have shown superior germination, survivorship, and seedling mass as also have been mentioned by Aaron M. Ellison (2001). The findings of Douglass H (1985) have summarized that seed size and germination requirements can be determined to be useful characters for resolving systematic and phylogenetic problems. Archna and Shivana (1985) have studied the requirements for seed germination and seedling formation of a hemi-root parasite *Sopubia delphinifolia*.

Fig. 1: Effect of Various Concentrations of Plant Growth Substances on the Seed Germination of *Macrotyloma uniflorum*

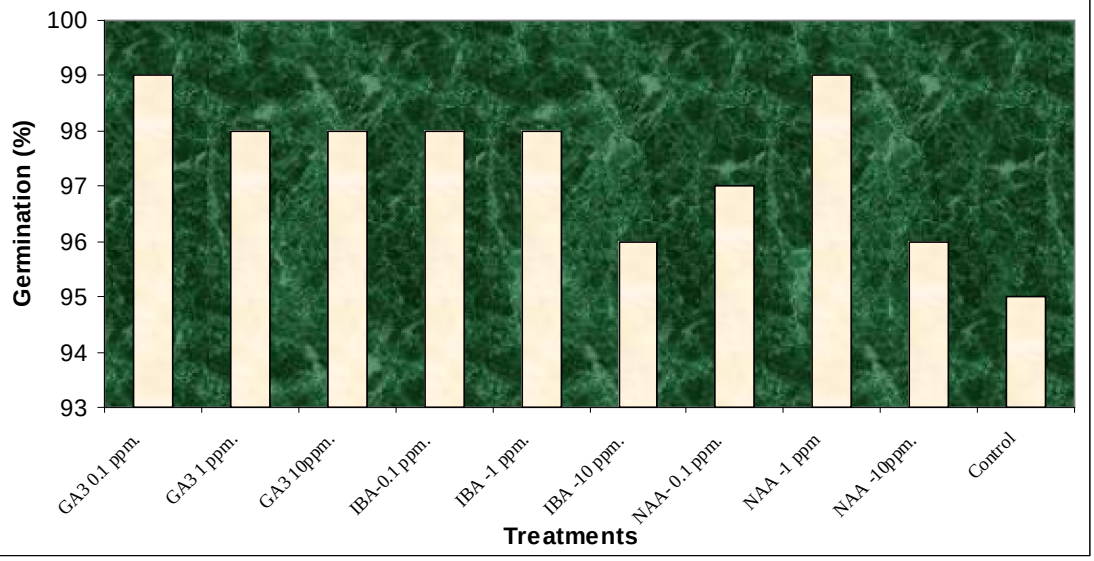
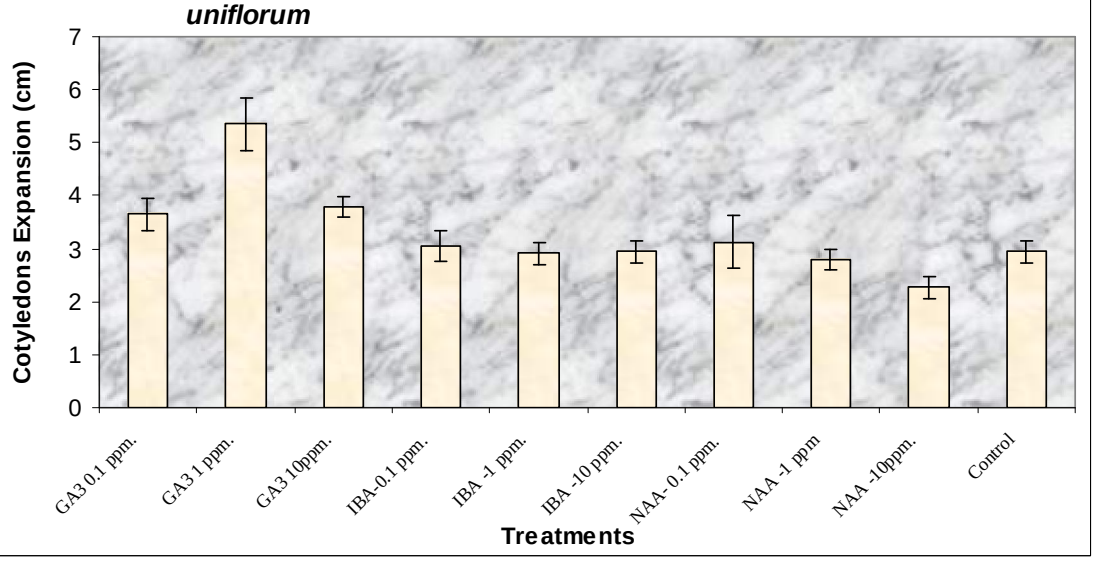


Fig. 2: Effect of Various Concentrations of Plant Growth Substances on the Cotyledons Expansion of *Macrotyloma uniflorum*



Light was found to be essential for germination; none of the growth substances could replace the light requirement. Seed must attain certain minimum specific moisture content, before they

germinate (Negbi *et.al*., 1966). GA_3 at 0.1ppm affected germination the most, leading 4% higher than the control. The more effective concentration has been proved to be GA_3 at 10 ppm with regards to shoot growth (11.29 ±0.8) at the cost of only 1% less germination. The same concentration resulted in almost equal growth of root (3.69 ±0.5) in comparison to control set. Response of lower and middle level of concentration such as GA_3 at 0.1ppm and NAA at 1ppm has shown remarkable germination and seedling growth in *Macrotyloma*. GA_3 resulted in maximum shoot growth (11.29±0.8) in comparison to Control (7.50±0.8). These concentrations have shown good response on cotyledons development (5.36±0.5). As far as dry weight of shoot and root is concerned, GA_3 at10 ppm resulted less responsive in comparison to IBA 0.1 (0.0183±0.5) and GA_3 1 ppm (0.0174±0.2).

Fig. 3: Effect of Various Concentrations of Plant Growth Substances on the Dry Weight of Shoots and Roots of *Macrotyloma uniflorum*

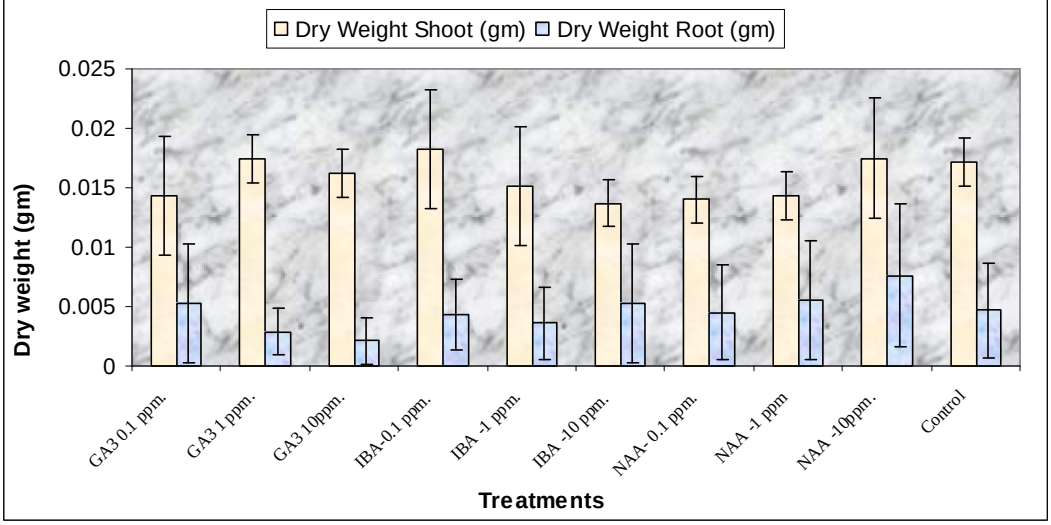
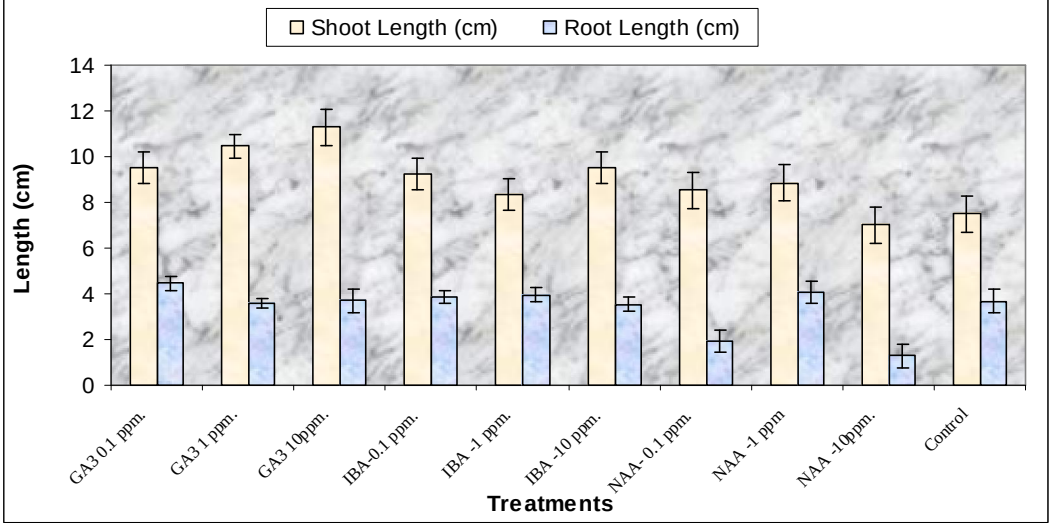


Fig. 4: Effect of Various Concentrations of Plant Growth Substances on the Length of Shoot and Root of *Macrotyloma uniflorum*



The effect of seed-soaking for 24 hours with different Plant Growth Substances has been examined by M. Grzesik. (2006) on the growth of seedlings of Lathyrus odoratus, Zinnia elegans, Matthiola incana and Antirrhinum majus. GA_3 improved the germination of the treated seeds. The seedlings of Zinnia, *Matthiola*

and *Antirrhinum* treated with NAA, GA_3 and GA_{4+7} where higher, better branched and of better quality than the non-treated plants. Singh and Dara (1971) have shown the results on Influence of presoaking of seeds with gibberellins and Auxin on growth and yield attributes of wheat under high salinity, sodium adsorption ratio and boron levels. Similar efforts have been made through another experiment by M. Farooq et al. (2006) to investigate the possibility of rice seed invigoration by pre-sowing ethanol seed treatment. They revealed that employing ethanol treatments at lower concentrations can invigorate fine rice seeds. High temperature both delayed and inhibited the germinations of barley and radish seeds (Cavusoglu K & Kabar K 2007). Irfan Afzal et al., (2005) have shown the effects of seed soaking with plant growth regulators (IAA, GA_3, and Kinetin) on wheat emergence and seedling growth under normal and saline conditions and found their usefulness in increasing relative salt-tolerance. Among the 14 pre-sowing treatments, KNO_3 (150 min) and $NaHClO_3$ (30 min) significantly stimulated seed germination of *Angelica glauca* and reduced mean germination time under both laboratory and nursery trials, as well as developed seedling vigour under nursery conditions (Jitendra S. Butola and Hemant K. Badola 2004). A similar experiment was carried out by Gao Huan Zhang et al. (2002) in which Walnuts cv. Jianshi were soaked in water (control), IBA at 80 mg/kg, IAA at 100 mg/kg, NAA at 80 mg/kg, ABT root-growing powder at 1 g/kg, or 6-BA at 5 mg/kg. In this experiment, different concentrations of GA_3, IBA and NAA, the maximum germination percentage (100%) was recorded in seed treated with IBA 0.1 ppm, which shows that the lower concentrations of growth hormone shows better performance than higher which was similar to the results of James Chukwuma Ogbonna and P.G. Abraham (1989).

The results of the present findings are parallel to the findings of Parameswari and Srimathi (2008) to evaluate the influence of plant growth substances on seed germination and seedling quality characteristics of tamarind seeds. They revealed that the concentration of 100 and 200 ppm GA3 were found to enhance both the seed germination and seedling vigour parameters, such as root length, shoot length, hypocotyl length, dry matter production and vigour index values. Seed fortification with GA3 100 ppm performed well even under nursery conditions recording a higher leaf number and stem circumference.

IBA proved good in seedlings biomass production. However, lower concentrations of all the plant growth substances exhibited supportive response towards germination, growth of seedlings and development of cotyledons. The results of present findings shows that applications of these plant growth substances if used at lower concentrations could enhance germinations and healthy seedling growth leading towards the production of Macrotyloma uniflorum to fulfill the demand of farming community. It is thus imperative that more identical studies be conducted on other legume species also generating data base so that the use of growth substances can be extended to produces healthy seedlings required to support large scale seed germination and plantations of those species.

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Mechanical Characterization of Spray Pyrolytic Cadmium Sulphide Thin Films by Indentation Technique

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Abstract: Thin films of Cadmium Sulphide have been successfully grown by Spray Pyrolysis technique at two different temperatures. The grown thin films are confirmed by X-ray diffraction (XRD) and it reveals that the films are nanocrystalline in nature with grain size in the order of nanometers. Scanning electron microscopy (SEM) was used to characterize the coating morphology and it indicate that the grains are uniformly distributed throughout the sample area. The mechanical behavior of Cadmium Sulphide thin films under point loading conditions was studied by Ultra low load micro indentation using Vicker's indenter with 100nm tip radius. The value of hardness and elastic modulus of the film reaches 4.89GPa and 51.01GPa at 250°C, 4.4GPa and 49.02GPa at 300°C respectively.
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Key words: thin films; structural properties; hardness; elastic modulus

1. Introduction

In recent years, thin film science has grown world wide into a major research area. The importance of coatings and the synthesis of new materials for industry have resulted in a tremendous increase of innovative thin film processing technologies. Currently, this development goes hand in hand with the explosion of scientific and technological break through in microelectronics, optics and nano technology [Siegel, et al, 1997]. Presently, rapidly changing needs for thin film materials and devices are creating new opportunities for the development of new processes, materials and technologies. The mechanical properties of bulk materials are quite different from those of metallic thin films [Hoffman, et al, 1964]. Mechanical properties are significantly influenced by the deposition conditions, and can be considerably different from those of their bulk material counterpart [Huan, et al, 2005]. In the past two decades, depth sensing indentation technique has attracted the attention of researchers as a simple, relatively non-invasive means of quantifying basics material properties, especially hardness and elastic modulus of thin films on substrates [Bhattacharya, et al, 1988, Olive, et al 2004]. Note that this technique provides a possibility to evaluate a mechanical property in 'real' values i.e. the influence of substrate material is eliminated since the minimum depth of indentations remains lower than 10-15% of the coating thickness [Fernandez et al., 2000]. Generally, several applications of Cadmium Sulphide thin films are known in electrical, optical and mechanical equipments [NASCAR et al 1997]. Since CdS materials are widely used in absorbing material in solar cell and MEMS based devices. Mechanical properties of CdS thin films like hardness, elastic modulus, adhesion etc., are not investigated in detail in literature, although they are very important for stable device performance. Hence the material life span depends on it mechanical properties like stiffness, hardness as well as elastic modulus. It is well known that material's mechanical property is one of the most important effect factors in the manufacturing of the optoelectronic devices because of the unavoidable extensive handling. In this work, pure CdS thin films were prepared by a Spray Pyrolysis technique on glass substrate at 250°C and 300°C and reported hardness and elastic modulus values are moderately higher than the bulk material.

2. Experimental

2.1 Preparation of Solution

The precursor solution used to form Cadmium Sulphide thin films was obtained by dissolving the salts of Cadmium acetate ($Cd(CH_3COO)_2.2H_2O$) and thiourea (CH_4N_2S) in the molar ratio (0.1M: 0.1M) in double distilled water along with the complexing agent Ethylene-Diamine-Tetra-Aceticacid(EDTA)($C_{10}H_{16}N_2O_8$) of 0.1M is chooses to stabilize the grain size. The amount of solution was made together as 50ml.The chemicals used this deposition were of analytical grade.

2.2 Spraying Process and Characterization

The Spray Pyrolysis setup consists of a substrate heater, spray gun, air compressor, solution reservoir and a gas exhaust unit. Details of this setup have been

published elsewhere [Bruneaux et al., 1991]. The heating of the substrate was performed using a ceramic heating plate with electrical heating wires. Optically plane cleaned glass plates was placed over the hot plate. The aqueous solution was then sprayed on the preheated glass substrate maintained at two different temperatures of 250°C and 300°C by conventional chemical spray pyrolysis technique to obtain homogeneous thin films. Compressed dry air at a pressure of 2 kg/cm^2 from an air compressor via an air filter cum regulator was used as the carrier gas and spray rate of the solution was maintained at 3ml/min. The distance between the spray nozzle and the substrate is 35cm. The spray time was maintained constant about one second throughout the deposition. An increase in spray time causes thermal shock of the substrate due to excessive cooling. A two minute waiting time is allowed between each spray to maintain the substrate temperature and enable to decompose the starting material completely. Total time is 45 minute for all deposition. Film obtained due to endothermic thermal decomposition that takes place at the hot surface of the substrate. For each temperature the reproducibility of the films were verified by repeating the experiments several times. The film thickness was measure using a JEOL, JSM 6701F, Japan, Scanning Electron Microscope (SEM). The film is mounted vertically to measure the thickness directly [Chen. 1995]. The measured thickness of the films is found to be in the range of 1-1.2 micrometer. The surface morphologies of the films were observed by using an SEM and the nanostructure was determined by X-ray diffractometry (XRD) [Rigaku Model RAD II A]. Indentation experiments were performed using an Ultra low load micro indenter unit (Shimadzu -DUH 211/211-S). The system was fitted with a Vicker's diamond indenter (four sided pyramid shape tip).

3. Result and Discussion

3.1 XRD Studies

XRD pattern of the Cadmium Sulphide films were studied at room temperature by using RIGAKU diffractometer (Model RAD II A) with CuKα radiation (1.5418Å) where other radiations are suppressed using Ni filter. The data were recorded at a scan rate of 0.2° /min and in the range of 20°<2θ<80°. The Crystallinity pattern of Cadmium Sulphide (0.1M) film prepared by spray pyrolysis technique at 250°C and 300°C is as shown in figure (1). Observation of film shows smooth surface and well adhesive with substrate. The narrow peaks in all the diffractograms confirm the nanocrystalline nature of the CdS film. The XRD pattern of the films also reveals that the CdS film is polycrystalline with cubic crystal structure and

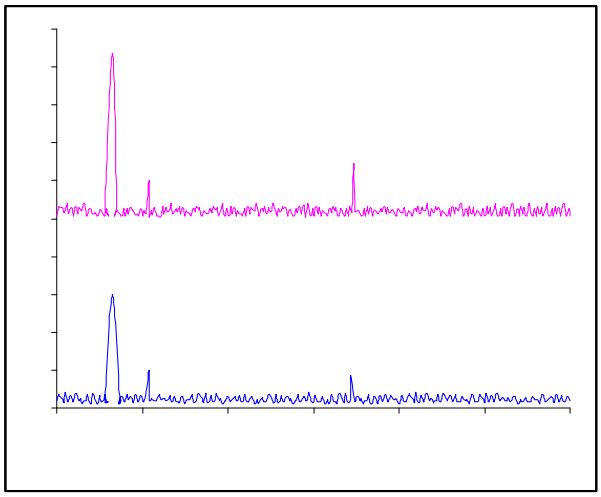

Figure 1. XRD pattern of CdS films

preferential orientation along (111) plane. No other impurity peaks are observed and this indicates the presence of single CdS phase the prepared film. Also the intense peak oriented along (111) lattice plane indicate the growth of the grains is parallel to the substrate. The other strong peaks observed correspond to the (200) and (222) orientations. The diffraction peaks appears in the spectrum have been identified at 26.54°, 30.74° and 54.67° are verified with the known patterns of standard X-Ray Diffraction data file (JCPDS file No: CdS 80-0019)) and can be indexed to (111), (200) and (222) reflections respectively. While comparing the X-ray diffraction pattern of 250°C and 300°C of 0.1 M CdS it is obvious that, Bragg peaks became more intense for higher temperature of CdS, indicating a clear improvement in crystalline which is also confirmed in the SEM results. The X-ray diffraction line broadening (XDLB) was used to estimate the grain size of the film by utilizing Scherer's formula [Berry. 1967, Bragg. 1912] given as equation (1),

$$D = \left(\frac{K \lambda}{\beta \cos\theta} \right) \qquad (1)$$

Where k is the shape factor constant (0.89), λ is the wave length of CuKα line, θ the Bragg's angle of reflection, β full width half maximum (FWHM) of intense peak. The grain size was found to increase with increasing substrate temperature, which is the same behavior, reported in literature for both Spray Pyrolysed and vacuum evaporated CdS thin films. Here, the grain size calculated by Scherer's formula from the XRD data of CdS is less than 60nm.The grain size of as deposited film is the temperature 250°C and 300°C are 45nm, 60nm respectively. This small grain size is due to the addition of complexing agent [EDTA] [Inamdar. et al., 2007].

3.2 SEM Studies

The SE micrograph of the Cadmium Sulphide thin film is taken to support the XRD observations. Figure 2(a) and 2(b) shows the SE micrographs showing surface topography of Cadmium Sulphide films deposited at 250˚C and 300˚C. The cross sectional view of the film to measure the thickness is shown at the right bottom of the figure (2a & 2b). From the image of figure (2a), the grains are closely placed with some pinhole and it showed compact nano sized grains distribution over the surface and good connectivity between grains. From the micrographs it is clearly seen that the grain size of the film deposited at 250˚C is in the nanometer range they are spherical in shape. The fluffy mass was present in cluster form and they were uniformly distributed. But in Fig. (2b), the grains are larger in size and the space between the grains is wide compared to 250˚C. In this case, increasing the deposition temperature the average grain size, along the preferred orientation corresponding to (111) plane, increases from 45nm (T= 250˚C) to 60nm (T=300˚C).

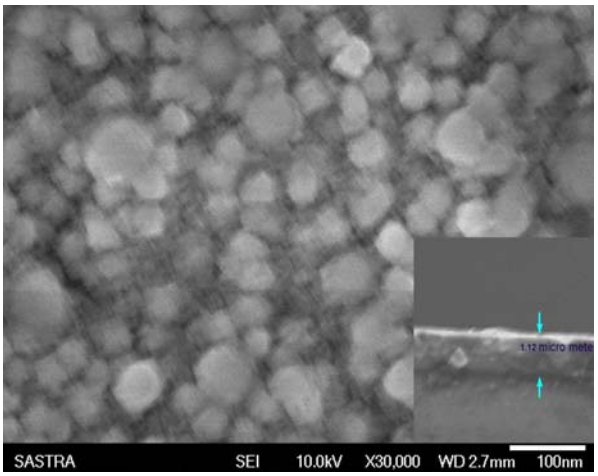

Figure 2a. SEM image of CdS film prepared at 250˚C

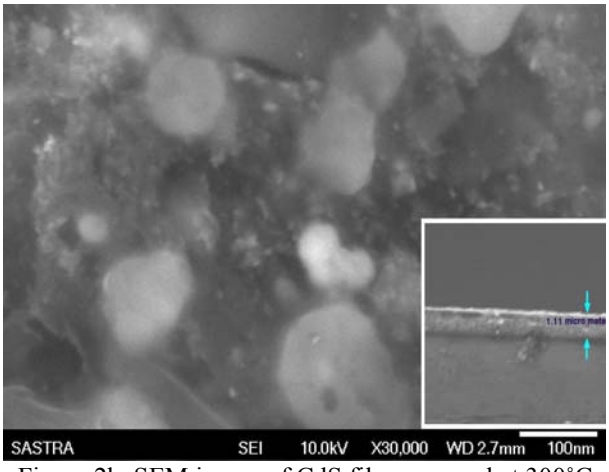

Figure 2b. SEM image of CdS film prepared at 300˚C

This confirms that at higher deposition temperatures, large grain size are obtained, suggesting that crystal growth is limiting step in thin film obtaining. The SEM image of CdS film prepared at 250°C clearly indicates the hardness is maximum, because of the grains are tightly bound to each other.

3.3 Mechanical Studies

In this work a computer controlled Shimadzu DUH 211/ DUH 211-S Ultra low load micro indenter unit is used to calculate the value of hardness (H) and elastic modulus (E) of Cadmium Sulphide thin films deposited at 250°C and 300°C. It estimates the hardness value of the film with a Vickers diamond pyramid indenter whose opposing faces are inclined at an angle of 136°. The indenter tip radius is 0.1μm and the ultra-wide test force range of 0.1 to 1,961mN. All tests were preformed at room temperature. Measurements were made in this work by increasing the loading force in simple steps, to the maximum force of 7mN, then decreasing the loading force by the same steps. For all hardness measurements, approximately four impressions were made at each load, and the average was taken as the representative value. Also, the indentations were done at different regions of the films, space approximately 100nm apart, so that there is no intervention on the P-h curves at each spot. This instrument exhibits depth and load resolution of 0.0001μm-10μm and 0.196μN respectively.

The hardness measurements of the Cadmium Sulphide with molarity of 0.1 prepared with the complexing agent (EDTA) of 0.1M deposited at 250°C and 300°C were recorded as a function of loading force 1-9mN are as shown in Fig (3). It reveals that the hardness of the film slightly increases with increase in load of 1-7mN. At loads greater than 7mN, the hardness saturates to a constant value. Typically, the measured hardness has at 7mN load. The value of hardness is increased in the 1-7mN load range was attributed to work-hardening of the film [Ramajothi. et al., 2004, Dhanraj et al., 1994]. The hardness is highly linear with load, and these values are found to be considerably higher for the thin films as compared to the bulk [Arthur Clive Bishop, 1990]. The value of hardness (H) is as deposited film is calculated using the expression [Oliver. et al., 1992]

$$H = \left(\frac{P_{\max}}{A} \right) \qquad (2)$$

Where 'P_{Max}' is the load, A is projected contact area at that load and H is the hardness value it is expressed in GPa. In this work, the calculated value of hardness at the 7mN load is Cadmium Sulphide thin films are at the substrate temperatures 250°C and 300°C

are 4.89GPa, 4.44GPa respectively. At 250°C temperature the defect density is reduced of CdS leads to work hardening and hence increases in the value of hardness. In ideal circumstances, measured hardness values should be independent of the applied load. But in practice, load dependence is observed [Subhadra et al., 2000]. In this case, the value of hardness was found to increase with load. The grain size calculated from Scherer's relation and found from SEM studies agrees each other and is 45 and 60nm respectively. Generally, due to the better atomic mobility and coalescence during the film growth as the deposition temperature increases to 300°C, there is an increase in grain size which leads to decrease in hardness value obeying Hall-Petch relation [Hall.1951, Petch. 1953], there is an increase in grain size. But, in this case addition of complexing agent decreases the grain size as the temperature decreases. It infers that the surface morphology is dependent on EDTA concentration [Inamdar. 2007, Varasi Krishna. 2003]. According to Mishra et.al, hardness is found to increase with decrease in grain size [Mishra. et al., 2004] which is attributed to the increase in the number of grains, which, in turn, increases the surface energy and reduce dislocations. This increase in hardness may be grain morphology [Zhang. et al., 1995] as well as the formation of nanocrystalline CdS thin film. Figure (4) shows the load-displacement curve of CdS prepared at 250°C and 300°C obtained by increasing then decreasing the loading force of 1-7mN. They are continuous and no pop-in event is found. The CdS films are single phase with grain size of 45nm at 250°C and those grains will act as strain compensation sites which are responsible for the absence of pop-in events as suggested by Coleman et al [Coleman, 2005].

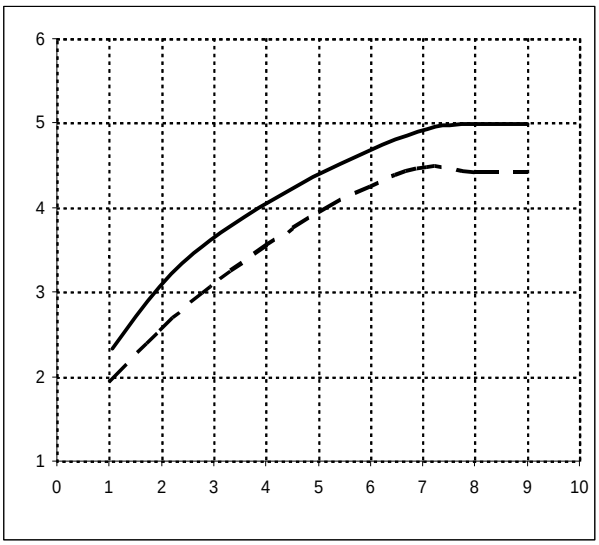

Figure 3. Load Vs Hardness of CdS films

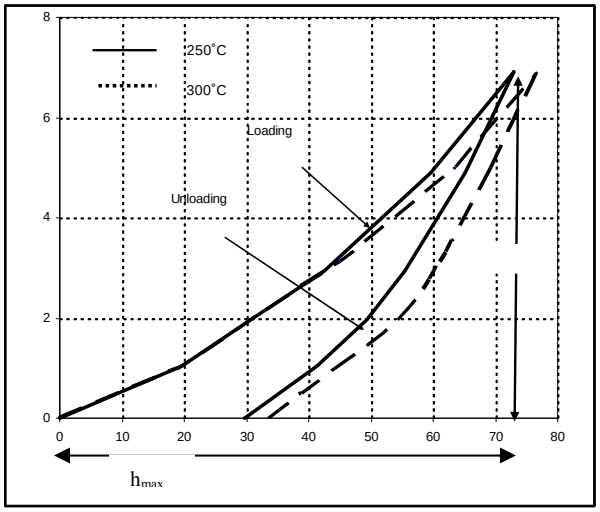

Figure 4. Load Vs Displacement of CdS films

Each indentation consisted of three steps; loading, holding the indenter at peak loads for 10 s, and unloading completely. In this case, curves obtained were continuous and smooth which shows the purely elastic behavior of the film. During indentation the unloading curve `is smooth which shows that it is purely the recovery on relaxation. This suggests that the indenter did not penetrate into the substrate during the indentation process, and no micro cracks and bulging were observed in optical photograph. The entire loading-unloading curve represents the overall elasto-plastic response of the film [Pharr, 1998] The physical properties and models used to determine H and E from indentation load-depth data are based on Oliver-Pharr theory [Oliver, 1992]. The important quantities are the peak load (P_{max}), the maximum depth (h_{max}), residual depth after unloading (h_f) and slope of the upper portion of the unloading curve (S=dP/dh) are found in load-depth curve. The parameter S is known as the elastic contact stiffness. The hardness and elastic modulus can be derived from these values. The fundamental relations to calculate H and E are,

$$E_r = \frac{\sqrt{\pi}}{2} \cdot \frac{S}{\sqrt{Ac}} \qquad (3)$$

Where E_r is the reduced elastic modulus which accounts for the fact that elastic displacements occur in both indenter and the sample. The elastic modulus of as deposited film, E is calculate from E_r using

$$\frac{1}{E_r} = \frac{(1-\nu^2)}{E} + \frac{(1-\nu_i^2)}{E_i} \qquad (4)$$

Where ν is the Poisson ratio for CdS is 0.3, and E_i and ν_i are the elastic modulus and Poisson ratio of the

indenter respectively. The elastic constants E_i= 1141GPa and ν_i = 0.07 [Pharr. 1998] are often used for a diamond. Figure (5) shows that as the penetration depth increases there is slightly increase in elastic modulus of the as deposited film and it is found that elastic modulus do highly linear with depth. At 250°C the maximum penetration depth is 73nm, which is predetermined to be less than 10-15% of minimum thickness of spray coated Cadmium Sulphide thin film, and the elastic modulus is 51.76GPa.The elastic modulus of as deposited film prepared at 300°C is 49.27GPa. The elastic modulus was obtained as average value from more than five measurements of a specimen. The elastic modulus of spray coated CdS thin film increased with decreasing the deposition temperature. The elastic modulus measured by the indentation test is dependent on depth and grain size of as deposited film, but is independent on the error from geometric measurement.

However, we could see a slight increase in elastic modulus while comparing it with the literature value [Martin Vrbanczyk, 2005, Lev Issakovich Berger, 1996]. This higher modulus may be due to the low porosity of the as deposited film.

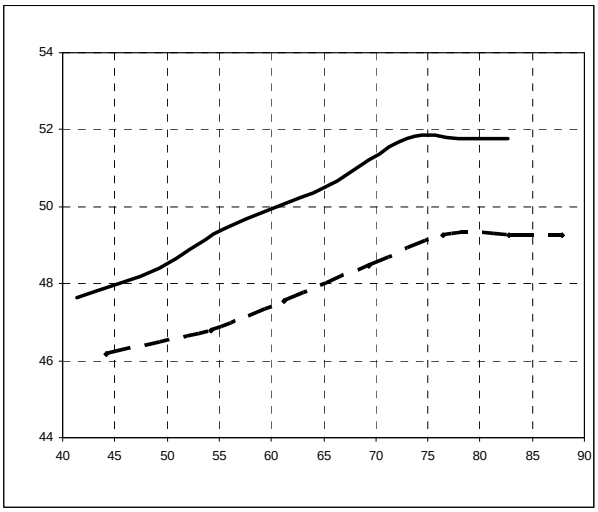

Figure. 5. Displacement Vs Elastic modulus for CdS

4. Conclusions

CdS thin films are prepared by spray pyrolysis technique at 250°C and 300°C. The structural properties of CdS thin films have been investigated by XRD and SEM. The XRD pattern of as deposited films visualize of intense peak oriented along the (111) plane and the grain size found to be in the order of nanometers, and it confirms SEM results. The coating morphology is studied by SEM images and it revels that at lower temperature the grain size are small compared to higher temperature. The hardness and elastic modulus of CdS thin films have been evaluated by ultra low load indentation technique. One can obtain a larger hardness and elastic modulus of 4.89GPa, 51.01GPa in CdS films deposited at 250°C, which is higher than the film prepared at 300°C.

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Merits and Demerits of Boundary Element Methods For Incompressible Fluid Flow Problems

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Abstract:

In this paper, the merits and demerits of boundary element methods (BEMs) for incompressible fluid flow problems are described. BEMs are gaining popularity due to their applications in the vast fields of science and technology and it is also being applied for calculating the solution of incompressible fluid flow problems. Every method has its merits and demerits The efficiency as well as accuracy of a method can be easily checked for a certain problem by its merits as well as demerits for the solution of that problem. So the performance of BEMs in the present case is judged by giving its merits and demerits in details. [Journal of American Science 2009; 5(6):57-61]. (ISSN: 1545-1003).

Keywords:

Merits and Demerits, Boundary Element Methods, Incompressible Flow, CFD.

1. Introduction

Boundary element method (BEM) is a modern numerical technique, which can play an important role for the development of science and technology and it is used for the solution of linear partial differential equations, which are transformed into boundary integral forms. Such forms are considered as exact solutions of the governing partial differential equations. The term' boundary elements' opened eyes within the department of civil engineering at Southampton University, United Kingdom (Brebbia,1978). In this method, the external boundary of a body is discretized into a number of segments over which the function under discussion can vary much in the ways as in finite elements. (Brebbia,1978). In literature, these methods existed under different names such as 'panel methods',' surface singularity methods',' boundary integral equation methods' or 'boundary integral solutions'. BEMs are more popular amongst computational community than 'domain type' like finite element method (FEM) and finite difference method (FDM),etc (Hirt et al.,1978, Markatos,1983; Demuran et al.,1982 and Ecer,1982) due to its character of reducing the dimensionality of a boundary value problem represented by linear partial differential equations. Thus an equation governing a three-dimensional domain is transformed into over its surface and likewise a two-dimensional domain on its boundary contour only. Such reduction in dimensions results in a smaller system of equations, which leads to reduction in data and thus reduction in computational efforts as well as in time. BEMs are well suited to problems with complicated and unbounded regions. It has been applied to obtain the computational solution of a large number of physical problems BEMs are applied in diverse topics as stress analysis, heat transfer and electromagnetic theory, potential theory, fracture mechanics, fluid mechanics, elasticity, elastostatics and elastodynamics etc (Muhammad et al.,2009). Nowadays BEMs are being used in biomedical and environmental problems like circulation of blood and urine in human body and prediction of weather. So, such method can be useful in the numerical biomechanical analysis of systemic circulation. Thus, it can be helpful in diagnosing and in treatment of diseases. In this way, merits of

BEMs can be brought in the service of humanity. BEMs have been classified as direct and indirect techniques, which depends on whether the functions used in derivatives are physical quantities or fictitious density functions (Becker.A.A.).The equation of direct method can be formulated using either as an approach based on Green's function (Lamb,1932, Milne-Thomson,1968 and Kellogg,1929) or a particular case of the weighted residual methods(Brebbia and Walker,1980).The equation of indirect method can be derived from that of direct method. In the early 1980, a surge in research activities on BEMs occurred and this technique found its way in the field of fluid mechanics (Gaul.L., Kogl.M, Wagner.M,2003).In stead of achieving successes in the field of hydrodynamics, there are cases in which computations of BEMs still pose serious challenges(Vaz et al,2003). The flow fields were calculated around three-dimensional bodies by using a lower-order indirect method (Hess and Smith,1962;1967). The direct method was applied to calculate the potential flow problems (Morino et al ,1975).

2. General Mathematical Formulation of Boundary Element Method

The general mathematical formulation of boundary element method can be obtained by using the differential equation

$$L(\phi) = a$$

or $$L(\phi) - a = 0 \text{ in } \varsigma \qquad (1)$$

Where L is an arbitrary linear differential operator with constant coefficients, 'ϕ' is the field variable and 'a' is an arbitrary source distribution inς. The weighted form equation (1) is as follows:

$$\int_{\varsigma} \left(L(\phi) - a\right) \psi \, d\varsigma = 0 \qquad (2)$$

$$\int_{\varsigma} L^{*}(\psi).\phi \, d\varsigma + \int_{\Gamma} \left(G(\phi) \, . \, S^{*}(\psi) - S(\phi) \, . \, G^{*}(\psi)\right) d\Gamma - \int_{\varsigma} a\phi^{*} \, d\varsigma = 0 \qquad (3)$$

By choosing the fundamental solution, the first integral in equation (3) can be eliminated due to the sifting property of the Dirac distribution and equation(3) reduces to

$$\phi(i) = \int_{\Gamma} \left(G(\phi) \, . \, S^{*}(\psi) - S(\phi) \, . \, G^{*}(\psi)\right) d\Gamma - \int_{\varsigma} a\phi^{*} \, d\varsigma \qquad (4)$$

Where 'i' is an arbitrary point within ς and equation (4) only holds for the point 'i' within ς. When the point is moved to the boundary in a special limiting process, the boundary integral equation (BIE) can be obtained (Gaul.L, and Kogl.M, Wagner,2003). In fact, the concept of boundary integral equation laid down the foundation stone of boundary element method (BEM)

3. Merits and Demerits of Boundary Element Methods:

(a) Merits:

(i) Discretization Only On The Boundary:

In BEMs, one only has to discretize the boundary not the entire flow field. In this way, the dimension of the physical problems under consideration is effectively reduced by one order. That is a three-dimensional problem is transformed into two-dimensional one over the boundary and likewise a two-dimensional

problem on the boundary contour only. Thus the problem becomes simple and easy to solve.

(ii) Economical And Time-Saving:

Since the discretization in BEMs takes place only on the boundary for fluid flow problems. The system of equations for such problem is much smaller. Consequently, the amount of data is thus significantly very small and many hours are not spent in preparing and checking the data. So BEM is economical and time-saving.

(iii) Less Number Of Nodes And Elements:

The number of nodes and elements used in BEMs for the solution of a flow problem is needed more than in 'domain' type methods with the same standard of efficiency and accuracy.

(iv) Well-Suited To Infinite And Semi-Infinite Flow Fields:

BEMs are well-suited to infinite and semi-infinite flow fields. In such case, the dimensionality of a flow problem is considerably reduced by one. Thus three-dimensional and two-dimensional flow fields can be reduced by one order. Therefore, in flow past a body, the governing equation for an infinite domain is reduced to one over the finite boundary.

(v) Useful To Laminar Flows:

BEMs are useful for the solution of laminar flow problems. Since all the engineering problems are of turbulent nature, it does not mean that BEMs are totally failure in turbulent flows and even then it can be applied to simple channel flows.

(vi) Suitable To Complex Flow Problems:

BEMs are more suitable to complex flow problems. Because they reduce the size of complicated flow problems into the simple ones which can be solved easily.

(vii) Applicable To Potential Flow Problems:

BEMs can be applied in the best ways to potential flow problems. Such problems of a great significance in computational dynamics (CFD) can be easily tackled by this numerical technique.

(viii) Flow Problems Involving Small Non-Linearity:

Though BEMs are successfully applied to flow problems involving linearity, but it is also applied to fluid flow problems in which non-linearity is of small type.

(ix) Variable Or Unidentified Flow Fields:

BEMs are also useful in flow problems where the flow fields are variable or unidentified types such as problems with free surface flows.

(x) Capability For A Complete Solution:

BEMs posses a unique capability for complete solutions of fluid flow problems in the form of boundary values only.

(xi) Applicable Easily To Incompressible Flow Problems:

BE techniques handle incompressible flow problems effectively, so it can be applied to problems involving incompressible type fluids.

(xii) Flow Field Around Bodies Of Complex Geometry:

Such methods are very useful for calculating the flow fields around bodies of complex configurations.

(b) Demerits:

(i) Non-Homogeneous And Non-Linear Flow Problems:

BEMs are not successfully applied to non - homogeneous and non-linear fluid flow problems. However, these are used to turbulent flow of minor nature. Therefore, these are not useful to apply in the non-linear computations of partial and super-cavitating flows on hydrofoils and marine propellers.

(ii) Flow Problems Where Formulations Impossible:

In flow problems, whose mathematical formulation is impossible, BEMs cannot be applied successfully.

(iii) Mathematical Complexity:

Mathematical complexity is also a great hurdle in the way of implementation of BEMs to flow problems. Engineers are not mostly familiar with the mathematics used in BEMs. So they cannot work properly in this field . To overcome this difficulty, the BE techniques should be included in engineering courses and more books on this topic should be available in the market.

(iv) New Practical Applications:

BEMs have relatively new practical applications in fluid flow problems. their roots are not so deep in such field and it will take time for BEMs to be matured and more useful.

(v) Non-Symmetric And Fully Populated Solution Matrix:

The resulting solution matrix in BEMs is non-symmetric and fully populated with non-zero coefficients, which needs a large space in the computer core memory. This makes situation even more severe.

(vi) Requirement For Knowledge Of A Suitable Fundamental Solution:

For finding he solution of fluid flow problems in BEMs, it is required to have knowledge of suitable fundamental solution. Otherwise it will be difficult to tackle the relevant problems.

4. Conclusion

In this paper, the merits and demerits of boundary element methods (BEMs) for incompressible fluid flow problems have been presented. Like other numerical schemes, BEMs have also merits and demerits. These demerits are less in comparison to merits. Therefore in spite of its some demerits, they are progressing rapidly and their applications in different fields of science and technology are increasing day by day. That is why these numerical schemes are becoming more and more popular amongst the computational community of recent world. Such methods can be very useful in modeling bodies of complex geometry such as airplanes, road vehicles, space shuttle, ships, etc.

Acknowledgement

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Epithelial Sodium Channel (ENaC)

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Abstract: The epithelial sodium channel (ENaC) is a cell membrane-bound ion-channel that is permeable for Na^+, Li^+ and H^+, and it is a major regulator of salt and water reabsorption in a number of epithelial tissues. Abnormalities in ENaC function have been directly linked to several human disease states including Liddle's syndrome, psuedohypoaldosteronism, and cystic fibrosis and may be implicated in states as diverse as salt-sensitive hypertension, nephrosis, and pulmonary edema. ENaC activity in epithelial cells is highly regulated both by open probability and number of channels. In animal kidney, ENaC plays a crucial role in controlling sodium reabsorption to keep the normal blood pressure. The expression of ENaC is abnormally regulated by dietary sodium in salt-sensitively hypertensive rats, and that this abnormal expression would be one of the factors causing salt-sensitive hypertension. [Journal of American Science 2009; 5(6):62-69]. (ISSN: 1545-1003).

Keywords: epithelial sodium channel (ENaC); Aldosterone: pioglitazone; Thiazolidinedione; serum- and glucocorticoid-inducible kinase (SGK); angiotensin-converting enzyme (ACE); inhibitor; hypertension; chronic heart failure. Renal; kidney

1. Introduction

The epithelial sodium channel (ENaC), also named sodium channel non-neuronal 1 (SCNN1) or amiloride sensitive sodium channel (ASSC), is a cell membrane-bound ion-channel that is permeable for Na^+, Li^+ and H^+, and it is a major regulator of salt and water reabsorption in a number of epithelial tissues. Abnormalities in ENaC function have been directly linked to several human disease states including Liddle's syndrome, psuedohypoaldosteronism, and cystic fibrosis and may be implicated in states as diverse as salt-sensitive hypertension, nephrosis, and pulmonary edema. ENaC activity in epithelial cells is highly regulated both by open probability and number of channels. Open probability is regulated by a number of factors, including proteolytic processing, while ENaC number is regulated by cellular trafficking. It is important to understand apical membrane delivery, cell surface stability, endocytosis, retrieval, recycling of ENaC, the molecular partners that have so far been shown to participate in these processes, and sites and mechanisms of hormonal regulation of trafficking by aldosterone, vasopressin, and insulin (Butterworth et al., 2009).

ENaC activity is limiting for sodium reabsorption in the distal nephron. Humans regulate blood pressure by fine-tuning sodium balance through control of ENaC. ENaC dysfunction causes some hypertensive and renal salt wasting diseases. According to the recent report, ENaC is sensitive to phosphatidylinositol 4,5-bisphosphate (PIP2), the target of phospholipase C-mediated metabolism, and phosphatidylinositiol 3,4,5-trisphosphate (PIP3), the product of phosphatidylinositide 3-OH kinase (PI3-K). PIP2 is permissive for ENaC gating possibly interacting directly with the channel. Activation of distal nephron P2Y receptors tempers ENaC activity by promoting PIP2 metabolism. This is important because gene deletion of P2Y2 receptors causes hypertension associated with hyperactive ENaC. Aldosterone, the final hormone in a negative-feedback cascade activated by decreases in blood pressure, increases ENaC activity. PIP3 sits at a critical bifurcation in the aldosterone-signaling cascade, increasing ENaC open probability and number. PIP3-effectors mediate increases in ENaC number by suppressing channel retrieval. PIP3 binds ENaC, at a site distinct from that important to PIP2 regulation, to modulate directly open probability (Pochynyuk et al., 2008).

The renal epithelial sodium channel (ENaC) is of fundamental importance in the control of sodium reabsorption through the distal nephron. ENaC is an important component in the overall control of sodium balance, blood volume and thereby of blood pressure. This is clearly demonstrated by rare genetic disorders of sodium channel activity (Liddle's Syndrome and Pseudohypoaldosteronism type 1 associated with contrasting effects on blood pressure). Subtle dysregulation of ENaC however may also be important in essential hypertension - a common condition and a major cause of cardiovascular morbidity and mortality.

The epithelial sodium channel is formed from three partly homologous subunits. In this review we deals firstly with current views of structural and functional features of the renal epithelial sodium channel with particular emphasis on mechanisms and processes involved in the control of sodium channel activity at the biochemical and cellular levels. We then focus on genetic aspects with reference to the significance of genetic variation in the sodium channel genes in relation to blood pressure. In particular, we review recent investigations on the potential clinical significance of mutations within the genes encoding ENaC subunits in individuals with high blood pressure. Lastly, we also examine the potential value of pharmacological targeting of the renal epithelial sodium channel with the sodium channel inhibitor amiloride for the treatment of hypertension (Sagnella and Swift, 2006).

Lithium is used commonly to treat bipolar mood disorders. In addition to its primary therapeutic effects in the central nervous system lithium has a number of side effects in the kidney. The side effects include nephrogenic diabetes insipidus with polyuria, mild sodium wasting, and changes in acid/base balance. These functional changes are associated with marked structural changes in collecting duct cell composition and morphology, likely contributing to the functional changes (Nielsen et al., 2008).

The apical membrane of many tight epithelia contains sodium channels that are primarily characterised by their high affinity to the diuretic blocker amiloride. These channels adjust the sodium reabsorption for the maintenance of body salt and water homeostasis. In vertebrate animals, ENaC is involved in the reabsorption of sodium in kidney, colon, lung and sweat glands; they also play a role in taste perception.

Amiloride was originally described in 1967 as a potassium-sparing diuretic, the mechanism of action of which is to block the ENaC within the distal tubule of the kidney. In addition, higher doses of amiloride were found to be capable of inhibiting the Na(+)/H(+) exchangers (NHE) and the Na(+)/Ca(2+) exchangers. In time, several amiloride analogs have been synthesized to have a marked increase in their specificity to inhibit the ENaC, the NHE or the Na(+)/Ca(2+) exchangers. Although the NHE inhibitors have received the most recent attention, large-scale clinical trials using NHE inhibitors in ischemic cardiac states have shown them to be either ineffective or associated with an unacceptable risk profile. Aldosterone excess in animal models is known to cause cardiovascular injury, and blockade of mineralocorticoid receptors in human beings with heart disease improves outcomes. However, the exact mechanisms of aldosterone injury in animal models of hypertensive disease and protection with mineralocorticoid receptor antagonists in human trials of heart failure remain unknown. These effects are unexplained by changes in BP, potassium, or sodium balance. An additional possibility is that aldosterone action and mineralocorticoid receptor blockade is conferred by alterations in ENaC activity. Emerging experimental evidence suggests the possibility that systemic or central ENaC inhibition or both may be an alternative to the treatment of hypertension and cardiovascular disease states. Clinical trials to evaluate further the potential beneficial cardiovascular effects of ENaC blockade are needed. This article reviews the case for ENaC inhibition as a potential target for cardiovascular and renal protection in human beings (Teiwes and Toto, 2007).

The ENaC has a central role in sodium transport across membranes. It is expressed on the apical cell surface of renal tubular epithelia and also on other aldosterone-responsive epithelial cells. In the kidney, ENaC contributes to the regulation of blood pressure via changes in sodium balance and blood volume. Rare monogenetic disorders associated with hypertension have been described, such as Liddle syndrome, which gives rise to increased sodium reabsorption in the kidney via increased ENaC activity. There are many other variants in the genes encoding ENaC subunits, some of which occur with sufficient frequency as to be termed polymorphic variants. The Thr594Met polymorphism of the ENaC beta-subunit gene SCNN1B occurs exclusively in Black individuals, with a frequency of 6-8% in those with hypertension. It increases cAMP mediated ENaC sodium current in affected B lymphocytes, and has been associated with hypertension in a Black South London population.There is preliminary evidence that amiloride is effective as monotherapy in hypertensive individuals with the Thr594Met polymorphism and in patients with resistant hypertension, who have evidence of increased amiloride-sensitive sodium channel activity. If these preliminary studies are corroborated in larger studies, then amiloride may provide an important new strategy for blood pressure control in selected individuals (Swift and MacGregor, 2004).

The epithelial sodium channel (ENaC) is a membrane protein made of three different but homologous subunits (a, b, and g) present in the apical membrane of epithelial cells of, for example, the distal nephron. This channel is responsible for salt reabsorption in the kidney and can cause human diseases by increasing channel function in Liddle's syndrome, a form of hereditary hypertension, or by decreasing channel function in pseudohypoaldosteronism type I, a salt-wasting disease in infancy. This review briefly discusses recent

advances in understanding the implication of ENaC in Liddle's syndrome and in pseudohypoaldosteronism type I, both caused by mutations in the SCNN1 (ENaC) genes. Furthermore, it is still an open question to which extent SCNN1 genes coding for ENaC might be implicated in essential hypertension. The development of Scnn1 genetically engineered mouse models will provide the opportunity to test the effect of environmental factors, like salt intake, on the development of this kind of salt- sensitive hypertension (Hummler, 2003).

The epithelial sodium channel (ENaC) is of fundamental importance in the control of sodium fluxes in epithelial cells. Modulation of sodium reabsorption through the distal nephron ENaC is an important component in the overall control of sodium balance, blood volume and thereby of blood pressure. This is clearly demonstrated by rare genetic disorders of sodium-channel activity (Liddle's syndrome and pseudohypoaldosteronism type 1), associated with contrasting effects on blood pressure. The mineralocorticoid aldosterone is a well-established modulator of sodium-channel activity. Considerable insight has now been gained into the intracellular signalling pathways linking aldosterone-mediated changes in gene transcription with changes in ion transport. Activating pathways include aldosterone-induced proteins and especially the serum- and glucocorticoid-inducible kinase (SGK) and the small G-protein, K-Ras 2A. Targeting of the ENaC for endocytosis and degradation is now emerging as a major mechanism for the down-regulation of channel activity. Several proteins acting in concert are an intrinsic part of this process but Nedd4 (neural precursor cell expressed developmentally down-regulated 4) is of central importance. Other mechanisms known to interact with ENaC and affect sodium transport include channel-activating protease 1 (CAP-1), a membrane-anchored protein, and the cystic fibrosis transmembrane regulator. The implications of research on accessory factors controlling ENaC activity are wide-ranging. Understanding cellular mechanisms controlling ENaC activity may provide a more detailed insight not only of ion-channel abnormalities in cystic fibrosis but also of the link between abnormal renal sodium transport and essential hypertension (Gormley et al., 2003).

The activity of epithelial sodium channels (ENaC) is increased by phosphatidylinositides, especially phosphatidylinositol 4,5-bisphosphate (PI(4,5)P(2)) and phosphatidylinositol 3,4,5-trisphosphate (PI(3,4,5)P(3)). Stimulation of phospholipase C by either adenosine triphosphate (ATP)-activation of purinergic P2Y receptors or epidermal growth factor (EGF)-activation of EGF receptors reduces membrane PI(4,5)P(2), and consequently decreases ENaC activity. Since ATP and EGF may be trapped in cysts formed by the distal tubule, it is possible that ENaC inhibition induced by ATP and EGF facilitates cyst formation in polycystic kidney diseases (PKD). However, some results suggest that ENaC activity is increased in PKD. In contrast to P2Y and EGF receptors, stimulation of insulin-like growth factor-1 (IGF-1) receptor by aldosterone or insulin produces PI(3,4,5)P(3), and consequently increases ENaC activity. The acute effect of aldosterone on ENaC activity through PI(3,4,5)P(3) possibly accounts for the initial feedback for blood volume recovery after hypovolemic hypotension. PI(4,5)P(2) and PI(3,4,5)P(3), respectively, interacts with the N terminus of beta-ENaC and the C terminus of gamma-ENaC. However, whether ENaC selectively binds to PI(4,5)P(2) and PI(3,4,5)P(3) over other anionic phospholipids remains unclear (Ma et al., 2007).

The appropriate regulation of sodium (Na(+)) absorption in the aldosterone-sensitive distal nephron (ASDN) is essential to precisely match urinary Na(+) excretion to dietary Na(+) intake whilst taking extra-renal Na(+) losses into account. There is increasing evidence that Na(+) transport in the connecting tubule (CNT) is of particular importance for the maintenance of body Na(+) balance and for the long-term control of extra-cellular fluid volume and arterial blood pressure. Na(+) transport in the CNT critically depends on the activity and abundance of the amiloride-sensitive epithelial sodium channel (ENaC) in the luminal membrane of the CNT cells. As a rate-limiting step for transepithelial Na(+) transport, ENaC is the main target of hormones (e.g. aldosterone, angiotensin II, vasopressin and insulin/insulin-like growth factor 1) to adjust transepithelial Na(+) transport in this tubular segment (Loffing and Korbmacher, 2009).

2. Structure

ENaC consists of 4 subunits that are named α-, β-, γ-, δ-ENaC. Each of the subunits consists of two transmembrane helices and an extracellular loop. The amino- and carboxy-termini of all polypeptides are located in the cytosol. One subunit consists of about 510 to 920 amino acid residues, which is made of an intracellular N-terminus region followed by a transmembrane domain, a large extracellular loop, a second transmembrane segment and a C-terminal intracellular tail.

Human ENaC-alpha subunit sequence (669 amino acid):

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      1 megnkleeqd ssppqstpgl mkgnkreeqg lgpepaapqq ptaeeealie fhrsyrelfe
     61 ffcnnttihg airlvcsqhn rmktafwavl wlctfgmmyw qfgllfgeyf sypvslninl
    121 nsdklvfpav tictlnpyry peikeeleel driteqtlfd lykyssfttl vagsrsrrdl
    181 rgtlphplqr lrvpppphga rrarsvassl rdnnpqvdwk dwkigfqlcn qnksdcfyqt
    241 yssgvdavre wyrfhyinil srlpetlpsl eedtlgnfif acrfnqvscn qanyshfhhp
    301 mygncytfnd knnsnlwmss mpginnglsl mlraeqndfi pllstvtgar vmvhgqdepa
    361 fmddggfnlr pgvetsismr ketldrlggd ygdctkngsd vpvenlypsk ytqqvcihsc
    421 fqesmikecg cayifyprpq nveycdyrkh sswgycyykl qvdfssdhlg cftkcrkpcs
    481 vtsyqlsagy srwpsvtsqe wvfqmlsrqn nytvnnkrng vakvniffke lnyktnsesp
    541 svtmvtllsn lgsqwslwfg ssvlsvvema elvfdllvim flmllrrfrs rywspgrggr
    601 gaqevastla ssppshfcph pmslslsqpg papspaltap ppayatlgpr pspggsagas
    661 sstcplggp
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  TITLE     Hormonal regulation and genomic organization of the human
            amiloride-sensitive epithelial sodium channel alpha subunit gene
  JOURNAL   Pediatr. Res. 46 (2), 208-214 (1999)
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Human ENaC-beta subunit sequence (640 amino acid):

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      1 mhvkkyllkg lhrlqkgpgy tykellvwyc dntnthgpkr iicegpkkka mwflltllfa
     61 alvcwqwgif irtylswevs vslsvgfktm dfpavticna spfkyskikh llkdldelme
    121 avlerilape lshanatrnl nfsiwnhtpl vlidernphh pmvldlfgdn hngltsssas
    181 ekicnahgck mamrlcslnr tqctfrnfts atqaltewyi lqatnifaqv pqqelvemsy
    241 pgeqmilacl fgaepcnyrn ftsifyphyg ncyifnwgmt ekalpsanpg tefglklild
    301 igqedyvpfl astagvrlml heqrsypfir degiypmsgt etsigvlvdk lqrmgepysp
    361 ctvngsevpv qnfysdyntt ysiqaclrsc fqdhmirncn cghylyplpr gekycnnrdf
    421 pdwahcysdl qmsvaqretc igmckescnd tqykmtisma dwpseasedw ifhvlsqerd
    481 qstnitlsrk givklniffq efnyrtiees aannivwlls nlggqfgfwm ggsvlclief
    541 geiiidfvwi tiiklvalak slrqrraqas yagppptvae lveahtnfgf qpdtaprspn
    601 tgpypseqal pipgtpppny dslrlqpldv iesdsegdai
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Reference:

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  AUTHORS   McDonald,F.J., Price,M.P., Snyder,P.M. and Welsh,M.J.
  TITLE     Cloning and expression of the beta- and gamma-subunits of the human
            epithelial sodium channel
  JOURNAL   Am. J. Physiol. 268 (5 PT 1), C1157-C1163 (1995)
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Human ENaC-gama subunit sequence (649 amino acid):

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      1 mapgekikak ikknlpvtgp qaptikelmr wyclntnthg crrivvsrgr lrrllwigft
     61 ltavalilwq callvfsfyt vsvsikvhfr kldfpavtic ninpykystv rhlladleqe
    121 trealkslyg fpesrkrrea eswnsvsegk qprfshripl lifdqdekgk ardfftgwkr
    181 kvggsiihka snvmhieskq vvgfqlcsnd tsdcatytfs sginaiqewy klhymnimaq
    241 vplekkinms ysaeellvtc ffdgvscdar nftlfhhpmh gncytfnnre netilstsmg
    301 gseyglqvil yineeeynpf lvsstgakvi ihrqdeypfv edvgteieta mvtsigmhlt
    361 esfklsepys qctedgsdvp irniynaays lqiclhscfq tkmvekcgca qysqplppaa
    421 nycnyqqhpn wmycyyqlhr afvqeelgcq svckeacsfk ewtlttslaq wpsvvsekwl
    481 lpvltwdqgr qvnkklnktd lpkllifykd lnqrsimesp ansiemllsn fggqlglwms
    541 csvvcvieii evffidffsi iarrqwqkak ewwawkqapp cpeaprspqg qdnpaldidd
    601 dlptfnsalh lppslgtqvp gtpppkyntl rlerafsnql tdtqmldel
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Reference:

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  AUTHORS   McDonald,F.J., Price,M.P., Snyder,P.M. and Welsh,M.J.
  TITLE     Cloning and expression of the beta- and gamma-subunits of the human
            epithelial sodium channel
  JOURNAL   Am. J. Physiol. 268 (5 PT 1), C1157-C1163 (1995)
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Human ENaC-delta subunit sequence (704 amino acid):

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      1 maflsrtspv aaasfqsrqe argsillqsc qlppqwlste awtgewkqph ggaltsrspg
     61 pvapqrpchl kgwqhrptqh naackqgqaa aqtpprpgpp sappppkeg hqeglvelpa
    121 sfrelltffc tnatihgair lvcsrgnrlk ttswgllslg alvalcwqlg llferhwhrp
    181 vlmavsvhse rkllplvtlc dgnprrpspv lrhlelldef arenidslyn vnlskgraal
    241 satvprhepp fhldreirlq rlshsgsrvr vgfrlcnstg gdcfyrgyts gvaavqdwyh
    301 fhyvdilall paawedshgs qdghfvlscs ydgldcqarq frtfhhptyg scytvdgvwt
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Reference:
AUTHORS Yamamura,H., Ugawa,S., Ueda,T., Nagao,M., Joh,T. and Shimada,S.
TITLE Epithelial Na+ channel delta subunit is an acid sensor in the human oesophagus
JOURNAL Eur. J. Pharmacol. 600 (1-3), 32-36 (2008)

3. Location and function

ENaC is located in the apical membrane of polarized epithelial cells particularly in the kidney, lung and colon. It is involved in the transepithelial Na^+ transport that accomplishes with Na^+/K^+-ATPase. ENaC plays a major role in the Na^+ and K^+ homeostasis of blood, epithelia and extraepithelial fluids by resorption of Na^+. The activity of ENaC in colon and kidney is modulated by the mineralcorticoid aldosterone. It can be blocked by either triamterene or amiloride, which are used medically to serve as diuretics.

ENaC exists in taste receptor cells also, where it in involved in salt taste perception. In rodents the entire salt taste is mediated by ENaC, whereas in human about 20% taste comes from the ENaC.

Units β and γ are associated with Liddle's syndrome. Amiloride and triamterene are potassium-sparing diuretics which act as epithelial sodium channel blockers.

4. Interaction with Cystic fibrosis transmembrane conductance regulator

ENaC interaction with **Cystic fibrosis transmembrane conductance regulator** (**CFTR**) is arguably of the most important pathophysiological relevance in cystic fibrosis. CFTR is a membrane bound protein responsible for chloride transport. In a normal sweat gland, CFTR and ENaC are responsible for salt reabsorption from the sweat glands. CFTR has an *stimulatory* effect on ENaC in the sweat glands only. In cystic fibrosis, the CFTR channel does not work, so ENaC is also inhibited. Hence, the sweat of the patient can physically be tasted to be salty. This was a common technique to help diagnose the disease prior to modern methods. In the airway, CFTR has an *inhibitory* effect on ENaC everywhere *except* the sweat glands. Normally, chloride is secreted into the airway mucous and sodium is absorbed. However, in cystic fibrosis, chloride is not secreted and ENaC is not inhibited. Hence, sodium absorption markedly increases. Lower salt in the mucous results in very thick and viscous mucous, containing far less water than normal (recall that salt has a water retaining property via osmosis and a depletion will result in less water retained). This causes many problems from increased difficulty breathing to a predisposition to catching respiratory tract diseases.

5. Families

ENaC includes 4 subfamilies: α (alpha), β (beta), γ (gamma) and δ (delta). The proteins exhibit the same apparent topology, each with two transmembrane spanning segments, separated by an extracellular loop. The extracellular domains are highly conserved and contain numerous cysteine residues, with flanking C-terminal amphipathic transmembrane regions which pays roles in the formation of the hydrophilic pores of the oligomeric channel protein complexes.

Vertebrate ENaC proteins are similar to degenerins of Caenorhabditis elegans deg-1, del-1, mec-4, mec-10 and unc-8. These proteins can be mutated to cause neuronal degradation, and are also thought to form sodium channels.

6. Genes

The exon–intron architecture of the three genes encoding the three subunits of ENaC have remained highly conserved despite the divergence of their sequences.

Human ENaC-alpha subunit gene 2010 bp, mRNA:

```
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Reference:

```
  AUTHORS   Bangel,N., Dahlhoff,C., Sobczak,K., Weber,W.M. and Kusche-Vihrog,K.
  TITLE     Upregulated expression of ENaC in human CF nasal epithelium
  JOURNAL   J. Cyst. Fibros. 7 (3), 197-205 (2008)
   PUBMED   17766193
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Reference:

```
AUTHORS   Bangel,N., Dahlhoff,C., Sobczak,K., Weber,W.M. and Kusche-Vihrog,K.
TITLE     Upregulated expression of ENaC in human CF nasal epithelium
JOURNAL   J. Cyst. Fibros. 7 (3), 197-205 (2008)
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Human ENaC-gama subunit gene 1950 bp, mRNA:

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Reference:

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AUTHORS   Bangel,N., Dahlhoff,C., Sobczak,K., Weber,W.M. and Kusche-Vihrog,K.
TITLE     Upregulated expression of ENaC in human CF nasal epithelium
JOURNAL   J. Cyst. Fibros. 7 (3), 197-205 (2008)
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7. Discusssion

In animal kidney, ENaC plays a crucial role in controlling sodium reabsorption to keep the normal blood pressure. It was reported that the expression of ENaC mRNA in the kidney of Dahl salt-sensitive (DS) rats was abnormally regulated by aldosterone. The expression of α-ENaC mRNA in DS rats was abnormally increased by high sodium diet in contrast to Dahl salt-resistant (DR) rats, while it was normally increased by low sodium diet in DS rats similar to DR rats. The expression of beta- and gamma-ENaC mRNA in DS rats was also abnormally increased by high sodium diet unlike DR rats. The expression of serum and glucocorticoid-regulated kinase 1 (SGK1) mRNA was elevated by high sodium diet in DS rats, but it was decreased in DR rats. The expression of ENaC and SGK1 mRNA is abnormally regulated by dietary sodium in salt-sensitively hypertensive rats, and that this abnormal expression would be one of the factors causing salt-sensitive hypertension (Aoi et al., 2007).

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6/5/2009

Assessment of Compatible Substratum for *Andrographis paniculata* Standard Seed Germination Testing

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Abstract:

Andrographis paniculata (Burm. f.) Wallich *ex* Nees contains a bitter compound called andrographolide is commonly used for medicinal purposes. The herb has been revered for treating infectious diseases and highly regarded also as having a preventative effect from many diseases, due to its powerful immune strengthening benefits. The propagation of *A. paniculata* through seed is somewhat difficult which may be due to various germination problems. In view of the above, the present investigation was conducted with an objective to assess the compatible substratum for standard seed germination test of *Andrographis* seed. The seeds were collected and stored for six months at optimum temperature. Four substrata namely filter paper, top soil, saw dust and riverbed sand was collected for the experiment. Sand and soil were sieved with a 2 mm sieve to ensure uniform particle size. A standard germination test was done under partly sterilised and non-sterilised substratum with proper maintenance of light (11 hrs) and temperature (25^0C) by adding water up to 60 –70 % WHC. The 16 days test showed varied germination index and number of secondary roots. The result showed that the sterilized filter paper has proved most effective and compatible substratum for the *Andrographis paniculata* standard seed germination test. This led to uniform and quick germination with proper secondary roots and primary leaves. It can be suggested that due to scarcity of filter papers, sand substratum can also be used as an alternate as it showed more uniform germination than the rest two substrata. [The Journal of American Science. 2009; 5(6): 70-75]. (ISSN 1545-1003).

Key words: Substratum, Sterilized, Non-sterilized, *Andrographis paniculata*, Germination

Introduction

Andrographis paniculata contains a bitter compound called andrographolide; (alkaloid of pharmaceutical importance) is commonly used for medicinal purposes. *Andrographis* also called King of Bitters, is a traditional Chinese, Southeast Asian and Indian herb, and used for centuries in Ayurvedic medicine. The herb has been revered for treating infectious diseases and highly regarded also as having a preventative effect from many diseases, due to its powerful immune strengthening benefits. The demand of *Andrographis paniculata* is increasing day by day due to its importance in the treatment of different ailments.

Seeds are fundamental to agriculture and natural ecosystem. Production of high quality seeds is fundamental to the success of agriculture. Every farmer is sensitive to need for the rapid uniform seedling emergence and establishment of an even and productive stand. Crop production relies heavily on high quality planting seeds. Therefore, Government of India enacted Seeds Act so that seed sold conform to the minimum limits of physical and genetic purity, germination, moisture content and seed health. These seed quality parameters (known as Seed Standards) have been notified for more than 95 crops viz. cereals, pulses, vegetables etc. However, no such standards of seed quality parameters are available for medicinal crops. Seed testing protocols are also not available, which is a pre requisite for testing the seeds and also for recommending minimum limits of

germination (Parihar, 2006; Parihar and Kumar, 2006). Seed testing protocols are regularly updater by ISTA (International Seed Testing Association) on the basis of research work done globally through publication of research papers. The latest ISTA rules (ISTA, 2008) contain seed testing protocols of a large number of species cultivated all over the world and it forms the basic reference book for all kinds of seed testing activities and also for the international seed trade. As the seed trade developed between countries, seed testing played an important role in guaranteeing good quality seed to the farmer (Gassim, 1988).

It has become mandatory to standardise the seed testing and cultivation practices. In view of the above, studies have been carried out on germination ecology of *A. paniculata* locally known as *'Kalmegh'* and widely used in India in the treatment of the various ailments, in order to formulate seed testing protocols by obtaining information on seed germination, dormancy status and mechanism, and seed moisture relation for storage etc. The propagation of *A. paniculata* generally occurs through seeds, although it has many germination problems. The plant grows wild in tropical, moist and deciduous forests and widely cultivated in southern Asia, where it is used as dried of fresh leaves or the aerial portions of the plant to treat infections. Kalmegh can be grown on a variety of soil. In the natural habitat, it is found growing in clay to sandy soil in various locations. However, sandy loamy soil rich in organic matter is good for its growth and yield (Farooqi and Sreeramu, 2001). Saraswathy *et al*., (2006) have studied the seed ecological aspects on Kalmegh and reported problem in seed germination. It was assumed that seeds of Kalmegh possessed the combined dormancy of physical and innate nature. Among substrata that can be used for seed testing are paper towel, kimpack, blotter paper, filter paper, cotton wool, sawdust, and soil (Muliokela and Kaliangile, 1995; Louwaars and Marrewijk, 1996). Paper towels and sand are the most commonly used for testing seed of grain crops. Skinner and Schroeder (1978) reported that in soybean rolled towels gave more uniform results than sand. Thus the present study was undertaken with an objective to assess compatible substratum for standard seed germination test of *Andrographis paniculata*.

Materials and Methods

The present investigation was conducted at the Seed Testing Laboratory, Department of Seed Science and Technology, HNB Garhwal Central University, Srinagar Uttarakhand, India. The seeds were collected from Sushila Tiwari Herbal Garden, Rishikesh, Uttarakhand, India and stored for six months at optimum temperature. The experiment was laid out in a Randomized Block Design (RBD) with 4 replications for each substratum.

Seeds require certain conditions for normal germination. The most important requirements are substrata, moisture, temperature and light. The substrata serve as a moisture reservoir and provide a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrates are paper, sand and soil. Most widely used paper substrates are filter paper; these are easy to handle versatile and comparatively cheap. To use as substrata for germination testing, different substratum namely filter paper, top soil, saw-dust and riverbed sand were collected. Sand and soil were sieved with a 2 mm sieve to ensure uniform particle size. The standard germination test was done using partly sterilised (by using autoclave) and non-sterilised substratum with proper maintenance of light (11 hrs) and temperature (25^0C). The four substrata were separately mixed with water up to 60 –70% water holding capacity (WHC). Each substratum were replicated four times and every replication contains twenty five seeds which evenly-spaced on the top of substratum and covered with the substratum up to about 2 cm level. This treatment is eco-friendly and cheaper than the other seed treatments.

Seed germination was recorded from the 3rd days after sowing (DAS) up to 13 days consecutively and germination index (G.I.) was computed by using the formula: $G.I. = \sum n/d$

Where, n =number of seedlings emerging
d = days after planting

Germination percent was calculated based on the final recorded germination value of each replicate and mean was computed. After final emergence, 5 seedlings from each replicate were selected randomly to record the number of secondary roots and primary leaves and pooled data were subjected

to analysis of coefficient of variability and means were compared using least significant difference (LSD) test at 0.05 probability level (Steel and Torrie, 1984).

Results and Discussion

The highest germination index was observed on sand substratum (non-sterilized condition) followed by soil on the same condition and lowest was recorded in saw-dust substratum of sterilized condition (Fig.1). But when the GI variation was considered between the two substrata conditions, significant and insignificant variation was found in soil and saw dust, respectively. Rapid and uniform emergence is essential for optimum field emergence and plant stand under all environmental conditions and especially under sub-optimum conditions. In the natural habitat, Kalmegh is found growing in clay to sandy soil in various locations. However, sandy loamy soil rich in organic matter is good for its growth and yield (Farooqi and Sreeramu, 2001). In the present study the germination index recorded maximum in sand media of non-sterilized condition followed by soil, filter paper and saw-dust media. In all the four substrata significant variation was found between sterilized and non-sterilized conditions except filter paper substratum test (Table 1). It is evident from the recorded observations that there was no profound effect of sterilized or non-sterilized media if the seeds have good quality. This may be the reason that either germination index or germination percent, the maximum values was recorded in non-sterilized condition. However, ISTA has recommended sterilized media for standard seed germination test under optimum condition. Saraswathy, et al., (2006) have also conducted the similar study aimed to standardize the procedure for the evaluation of germination and vigour of true seeds and to identify suitable substratum.

Seed germination test under different temperature and substrate conditions was conducted by De Almeida et al., (2009) in which they reported good performance on seed germination using the optimum temperatures with paper substrates. Renata Aparecida et al., (2004) found that the substrates apparently allowed the best combinations of water and oxygen availability for the seeds. Seed germination can take place in any kind of substrate as long as it allows for a good aeration. Importance of good substrate as an important factor for fig tree seed germination have been justified by the findings of Shuling Lin, *et al*., (2008). Gunilla Oleskog and Kenneth Sahlén. (2000) have compared moisture conditions and Scots pine (*Pinus sylvestris* L.) seed germination percentages in four types of seedbed substrates and suggested that the preparation should enhance not only the substrate's water-holding capacity, but its thermal conductivity as well. Fitch, Elizabeth A. *et al*., (2007) have carried out the similar seed germination testing and suggested that seeds of the rare annuals *Lesquerella perforata* Rollins and *L. Stonensis* rollins (Brassicaceae) germinated to higher percentages on topsoil and filter paper than on masonry sand and clay sand. In addition, mucilage production was consistently less on topsoil than on the 2 types of sands. An increase in mucilage thickness was correlated with a reduction in germination. They recommended germinating seeds of both Lesquerella species on topsoil or filter paper for best results. Effects of seed age, germination substrate, gibberellic acid, light, and temperature on seed germination on *Flourensia cernua* (Asteraceae) have been conducted by Valencia-Diaz et al., (2003) and investigated whether low germination was due to moisture conditions provided by the germination substrate, or specific conditions of light and temperature. Germination was higher on an agar substrate than on a substrate of filter paper with cotton suggesting the advantage of a constant moisture condition. They suggested that a reduced germination might have been caused by androgamic depression and not caused by the substratum.

The germination percent was recorded maximum in sterilised condition of sand substratum followed by soil substratum. The germination percent obtained on soil and filter paper was comparable. Although germination percent was high on soil and insignificant difference with sand, a high variation was found (Table-1) and the use of soil substratum in seed testing may mislead the result and this was not in accordance with the ISTA's (1987) recommendation. But least variation was observed between sterilised and non-sterilised condition in the sand and filter paper substrata which showed a uniform germination irrespective of sterilised or non-sterilized. During experimentation the saw-dust media took a long mean germination period with low germination percent which revealed that saw dust substratum was not suitable for standard seed germination test of *Andrographis*. In the recorded data of the present investigation, although sand

substratum was found best for seed germination but filter paper or paper towel is suggested as it is easy to handle and use, cheap, non-toxic, and free from pathogens. However, sometime filter paper or towel paper may not readily be available and often costly in many developing countries (Louwaars and Marrewijk, 1996); sand substratum can be used as it is cheaper, readily available, easy-to-use substratum and are comparable to internationally acceptable standards with uniform results. This substratum can also provide uniform moisture for germination in seed testing and also re-usable by sterilizing. The highest secondary root development was recorded on filter paper substratum (sterilised condition) followed by sand on the same condition. In all the substrata tests, the recorded values of primary leaves were observed similar to secondary leaves, so, coefficient of variation and standard error was found zero (0) as there was no variation in the result. Thus the higher contribution of unaccountable sources of variation (lumped together as error) to the mean of germination and germination index and other traits indicate that many other extraneous factors (for example light, humidity/moisture and temperature conditions) need to be considered in seed testing. The recommendation that seed testing should be done under controlled conditions (temperature, light, humidity, etc.) could also be explained against this background. Similarly, the magnitude of the contributions of the known sources of variation to the means for seedling traits indicate that the choice of substratum should receive a higher priority when seed testing involves seedling evaluation. A combination of suitable substratum that will permit satisfactory expression of relevant seedling traits and a high degree of control of atmospheric condition to a level with minimal fluctuation is required for seed testing.

After considering all the pooled and analysed data, of the four substrata used in this study, sterilised sand followed by unsterilized have given the best results. The results herein reported seem also to indicate that the substrate may have a significant influence on the rate of seed germination. Under the conditions of this study, seedling growth on saw-dust was very unsatisfactory compared to that was obtained from other substrata. Its use will not permit optimal expression of the inherent qualities of *Andrographis* seed lots leading to false conclusions. But it may be considered that filter paper with sterilised condition will be better than sand as the merits are already discussed and may be recommendable for the A*ndrographis* seed germination testing. The sand also allowed the best combinations of water and oxygen availability for the seeds. Seed germination can take place in any kind of substrate as long as it allows for a good aeration. Importance of good substrate is an important factor for seed germination that has already been justified.

Table 1: Comparison of means and variation for germination and other seedling traits.

Substrata	Germination index		Germination percent (%)		No. of secondary roots	No. of secondary roots	No. of primary leaves	No. of primary leaves
	Sterilized	Non-sterilized	Sterilized	Non-sterilized	Sterilized	Non-sterilized	Sterilized	Non-sterilized
Sand	22.057	46.54	79	78	8	4.45	2	2
Saw dust	9.452	16.785	36	60	1.95	4.45	2	2
Filter paper	32.25	31.267	69	72	12.1	9.15	2	2
Soil	25.772	43.847	62	75	2.9	4.75	2	2
SE	3.097	4.397	5.933	5.094	1.525	0.743	0	0
CV% (σ)	42.866	39.353	29.878	22.145	75.757	40.421	0	0

Any two means differ significantly from each other at P=0.05

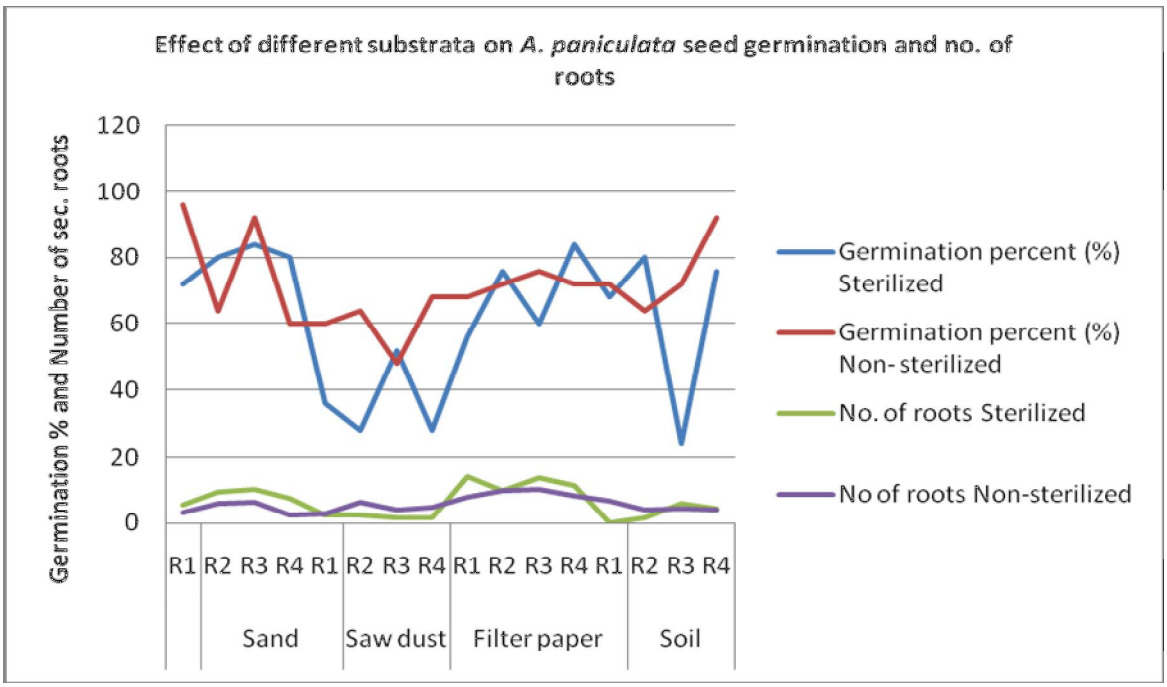

Fig. 1: Assessment of compatible substratum for *A. paniculata* seed germination testing.

Conclusion

From the above findings it may be summarized that the filter paper with sterilised condition can be recommended for the *andrographis* standard seed germination testing due to uniform and quick germination with proper secondary roots and primary leaves. If the filter paper is not available it can be replaced by sand substratum as an alternate as it showed more uniform germination with good secondary roots.

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rs, Chlorophyll *a* and Zooplankton of an rine Creek in Lagos.

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Abstract: The monthly variations in water quality parameters, chlorophyll *a* and zooplankton in Badagry creek, Lagos were investigated for a period of six months (October, 2007 - March, 2008). The hydrological characteristics showed trends that were related to rainfall pattern in the region and effects of tidal situation. The slightly alkaline marine environment expressed higher biological oxygen demand, lower nitrate and phosphate in the wet months while dissolved oxygen, transparency, salinity, total dissolved solids, pH, conductivity were recorded increases with the dry season. Productivity of the creek as measured by chlorophyll *a* was also observed to increase in the dry season. Zooplankton diversity (S) and abundance (N) were significantly higher in the dry than the wet season. The zooplankton spectrum was dominated by copepods (6 calanoid and 4 cyclopoid forms). Other zooplankton groups comprised two cladocerans, one mysid and an array of larval forms. Margalefôs (d) and Shannon-Wiener (Hs) indices were lower in the wet than the dry months while species equitability (j) was generally lower in the dry than the wet season months. The water chemistry characteristics, adult and juvenile zooplankton composition of the creek points to an estuarine system that acts additionally as a breeding and nursery ground for both endemic and migratory pelagic and benthic organisms. [Journal of American Science 2009;5(6):76-94]. (ISSN: 1545-1003)

Key words: water quality, primary production, chlorophyll a, zooplankton spectrums, meroplankton

1. Introduction

The creeks and lagoons of south-western Nigeria, apart from their ecological and economic significance, serve as sink for the disposal of an increasing array of waste types (Onyema, 2007). Sewage, wood waste, refined oil, waste heat, municipal and industrial effluents among others find their way unabated into immediate coastal waters through conduits such as storm water channels, rivers, creeks and lagoons (Akpata *et. al.*, 1993; Chukwu and Nwankwo, 2004). The Badagry creek towards the harbour is exposed to unique stressors such as habour related wastes discharges (Onyema *et al.*, 2006). According to Onyema *et. al.*, (2006) waste discharges from the Lagos Island, Ikoyi and Victoria Island find their way unabated into the Five Cowrie creek. This creek adjoins the Lagos lagoon just like the Badagry creek. Floating garbage / debris and oil base discharges especially from commercial boat operators are very frequent sites within the creek. In the Badagry creek, harbour and port related activities and their associated waste input also impact the creek. The region is exposed to high levels of human and vehicular (motor cars, boat and ship) traffic.

According to Kadiri (1999) the phytoplankton of coastal waters of Nigeria particularly the fresh and brackish zones could be adjudged floristically diverse. Nwankwo and Gaya (1996) and Solarin and Kusemiju (2003) are of the view that, the coastal wetlands around Lagos are nursery ground for an array of aquatic biota. Two physiographic factors, rainfall and salinity, determine the hydro-climatic conditions of the Lagos

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uel and d flood eeks are also known to affect the hydrodynamics of the Lagos lagoon and adjoining creeks such that rainfall dilutes the lagoon water, breaks down any environmental gradient and enriches the environment (Nwankwo *et al*, 2003; Onyema, 2007).

However information on the chlorophyll *a* and zooplankton species of the creek ecosystems in Lagos is scanty. Published studies on the zooplankton include Olaniyan (1969) which reported on the plankton of the Lagoons of South-Western Nigeria and Akpata *et. al.* (1993) which studied the effects of organic pollution on plankton and benthic population of Lagos lagoon. More recent studies include Onyema *et. al.* (2003, 2007), Emmanuel and Onyema (2007) and Onyema and Ojo (2008) for the region. The aim of this project was to investigate the water quality parameters, Chlorophyll *a*, zooplankton composition and abundance in the Badagry creek in Lagos.

2. Materials and Methods

2.1. Description of Study site

The Badagry creek (Fig. 1) is approximately 177km long (FAO, 1969). It is an adjoining creek to the Lagos lagoon, and part of the Lagos lagoon complex in the South-western part of Nigeria. It is the connection through which the Yewa and Ologe lagoons flow into Lagos lagoon (Egborge, 1988).

The study site for this investigation was located at the Apapa Wharf (Quay) area of the Badagry creek (Buoy 24) at about Latitude 06^0 26ô01N and Longitude 03^0 22ô26E (Fig. 1). This area, like all parts of South Western Nigeria experiences a wet season (May-November) and a dry season (December-April). The region experiences tidal influences from the sea via the Lagos lagoon to which it opens. Within the rising creek, rising tide ushers in high water levels which increasing salinity, while at low tide, the water level and salinity falls.

The shore of the study site is characterized by mangrove plants including *Rhizophora racemosa* (Red Mangrove) and *Avicenna* sp. (White Mangrove) and clusters of water hyacinths on the surface of the water (especially in the wet season) and along the edges, with *Rhizophora racemosa* being the dominant riparian vegetation in areas with minimal or no human constructions or activities.

The creek is flanked on one side (southward shore) with mangrove assemblages, a sparsely populated fishing community showing minimum urbanization and on the other side by the Apapa Wharf. The main anthropogenic activities in the area are harbour related activities with a lot of ship ocean vessels and boats either docked or leaving. Commercial boating activities are also common in the creek area. Pollution is suspected from the ships mostly as ballast water and other harbour related activities and waste discharges. Films of oil are also a common sight.

2.2. Collection of Water and Plankton samples

Monthly surface water samples were collected for water quality analysis for six months from October 2007 ï March 2008 at the study site. The samples were collected in well labeled 750ml plastic bottles with screw caps. Plankton samples were collected each

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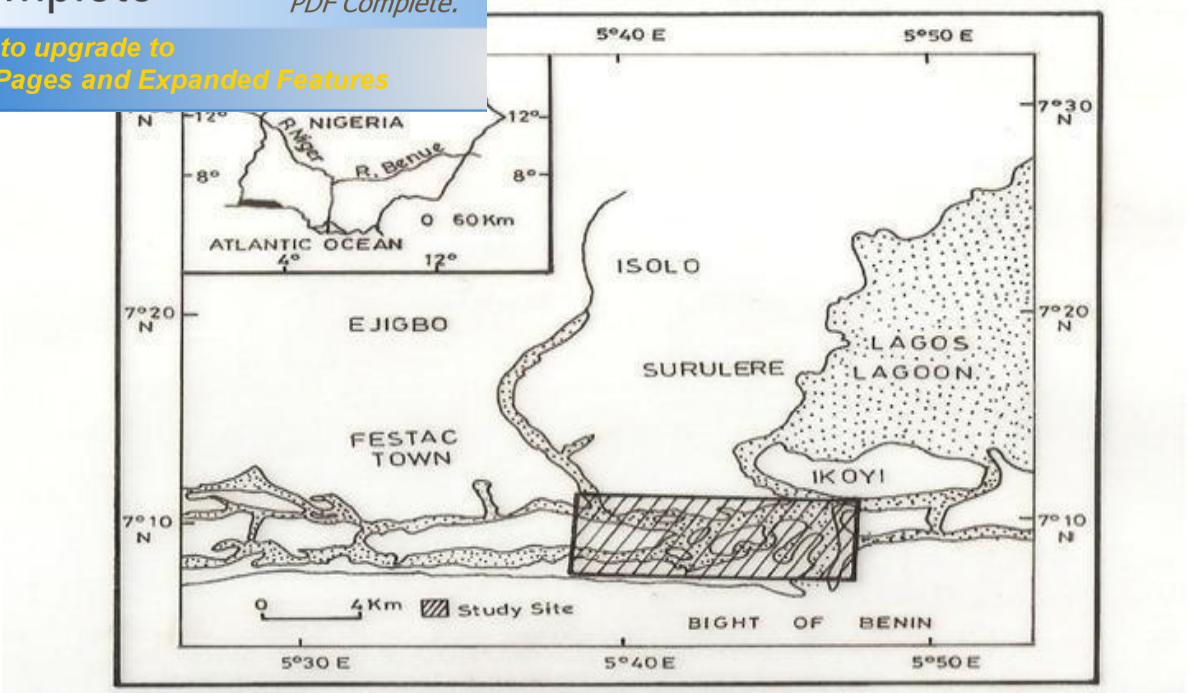

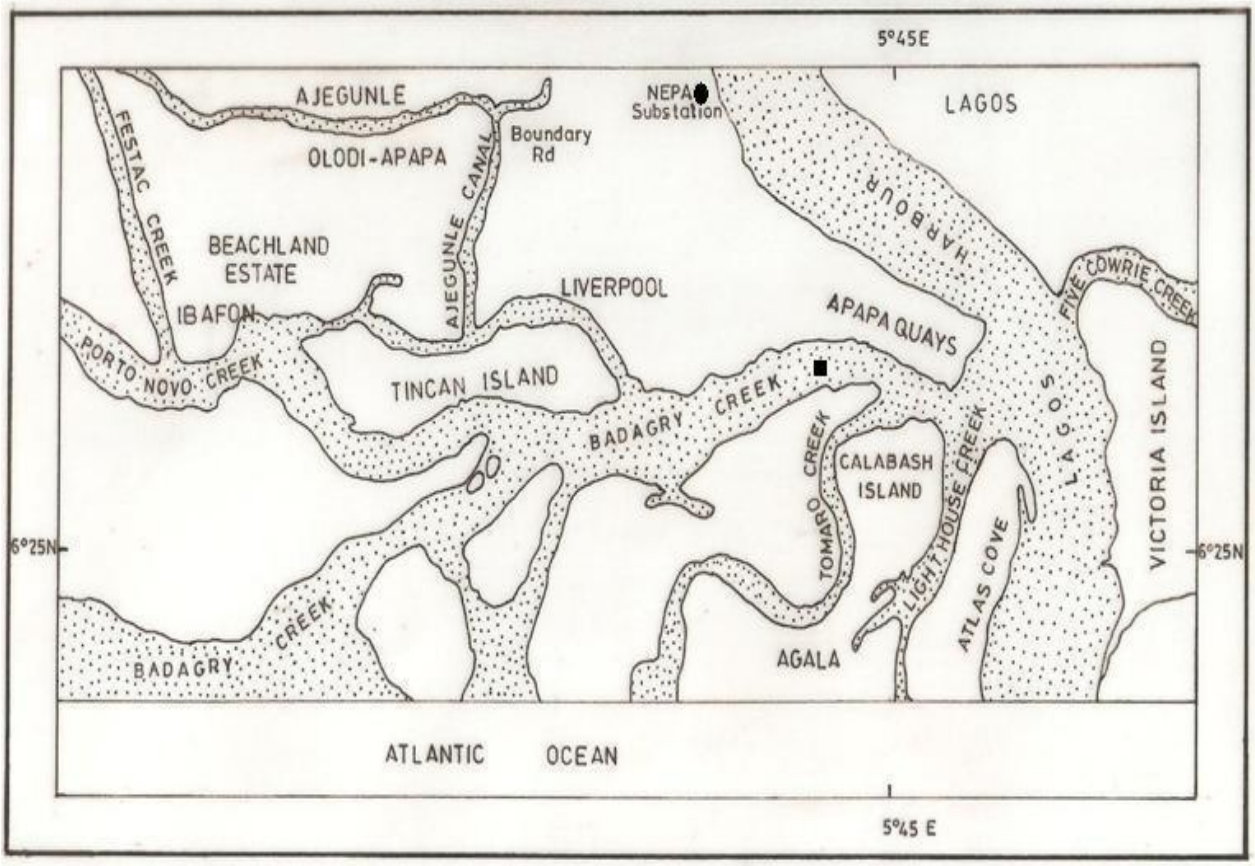

Fig.1: The Apapa area of Lagos showing major Creeks and Sampling site ■

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standard
for five
knots).
Samples were collected between 09.00 and 12.00hr.
The samples were stored in well labeled 500ml plastic containers with screw caps and preserved with 4% unbuffered formalin. The plastic containers were labeled appropriately to reflect the date, name of site and contents.

2.3. Analysis of water quality parameters.

Methods and devices for the analysis of water quality parameters are shown in Table 1.

2.4. Biological Characteristics

2.4.1. Chlorophyll *a* (µg/l)

Chlorophyll *a* concentration of each sample was determined using a Fluorometer equipped with filters for light emission and excitation. 200ml of the water sample was filtered through a 0.45µm fiber membrane filter after which the residue on the filter was transferred to a tissue blender, covered with 3ml of $90^0/_0$ aqueous acetone and macerated for 1min. The sample was then transferred into a centrifuge tube, capped and allowed to stand for 2hr in the dark at 4^0C (in a refrigerator). Thereafter, it was centrifuged at 500g for 20min and the supernatant decanted. Volume left after decanting was noted. Different readings were taken from the flourometer (which had been pre-calibrated with 2, 5, 10 and 20µg standard chlorophyll solutions) at x1, x3, x10, x30 sensitivity settings and noted. The calibration factors to convert flourometric readings for each sensitivity to concentration of Chlorophyll *a* was derived using the equation below and values expressed in mg/L.

$$F_s = \frac{C_a}{R_s}$$

Where; F_S = Calibration factor for sensitivity settings

R_S = Flourometer reading for sensitivity settings

C_a = Concentration of Chlorophyll *a*

2.4.2. Zooplankton analysis

Plankton samples were allowed to settle in the lab for at least 24hr and concentrated by filtering via a filter paper to 20ml (filtrate). For each bottle five drops of well mixed samples were thoroughly investigated. On each occasion, one drop of sample was investigated using the Drop Count Method described by Onyema (2007). For each mount as many transects were thoroughly investigated with each transect at right angles with the first. Zooplankton species were examined, identified and counted using a Carl Zeiss Standard IV monocular microscope also consulting appropriate texts to aid identification (Newell and Newell, 1966; Wimpenny, 1966; Olaniyan, 1975; Gibbons, 2001; Waife and Frid, 2001). The number of each taxa occurring in each field and the total number of taxa per group were recorded as number of organisms per ml.

2.4.3. Community Structure

2.4.3.1. Species Richness index (d)

The Species richness index (d) proposed by Margalef (1951) was used to evaluate the community structure of each sample by applying the following equation.

$$d = \frac{S-1}{\ln N}$$

Where; d = Species Richness Index, S = number of species in the population, N = total number of individuals in the population

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mation of water quality parameters.

		od / Device	Reference(s)
1	Air temperature (°C)	Mercury ï in ï glass thermometer	Nwankwo (1984)
2	Water temperature (°C)	Mercury ï in ï glass thermometer	Onyema (2008)
3	Transparency (cm)	Secchi disc method	Onyema (2008)
4	Depth (cm)	Graduated pole	Brown (1998)
5	Rainfall (mm)	Acquired from NIMET, Oshodi, Lagos	
6	Total Dissolved Solids (mg/L)	Cole Palmer TDS meter	
7	Total Suspended Solids (mg/L)	Gravimetric method	APHA (1998)
8	Chloride (mg/L)	Argentometric method	APHA (1998)
9	Total hardness (mg/L)	Titrimetric method	APHA (1998)
10	pH	Electrometric / Cole Parmer Testr3	
11	Conductivity (µS/cm)	Philip PW9505 Conductivity meter	
12	Salinity (ă)	HANNA Instrument	APHA (1998)
13	Alkalinity (mg/L)	Titration method	APHA (1998)
14	Acidity (mg/L)	Titration method	APHA (1998)
15	Dissolved oxygen (mg/L)	Titration method	APHA (1998)
16	Biological oxygen demand (mg/L)	Incubation and Titration	APHA (1998)
17	Chemical oxygen demand (mg/L)	Titration method	APHA (1998)
18	Nitrate ï nitrogen (mgL)	Colorimetric method	APHA (1998)
19	Phosphate ï phosphorus (mg/L)	Colorimetric method	APHA (1998)
20	Sulphate (mg/L)	Turbidimetric method	APHA (1998)
21	Silica (mg/L)	Colorimeter (DR2010)	APHA (1998)
22	Calcium (mg/L)	Titrimetric method	APHA (1998)
23	Magnesium (mg/L)	Titrimetric method	APHA (1998)
24	Copper (mg/L)	Atomic Absorption Spectrophotometer Perkin Elmer 5000 AAS	Perkin Elmer Application methods (2002)
25	Iron (mg/L)	Atomic Absorption Spectrophotometer Perkin Elmer 5000 AAS	Perkin Elmer Application methods (2002)
26	Zinc (mg/L)	Atomic Absorption Spectrophotometer Perkin Elmer 5000 AAS	Perkin Elmer Application methods (2002)
27	Chlorophyll a (µg/L)	Florometric method	APHA (1998)

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Wiener

The Species diversity index (Hs) (Ogbeibu, 2005) of each sample was evaluated using the equation below.

$$Hs = \frac{N \log N - \sum P_i \log P_i}{N}$$

Where; Hs = Shannon-Weiner Index, N = total number of individuals in the population, *i* = counts denoting the *ith* species ranging from 1 to *i.*, P_i = proportion that the *ith* species represents in terms of number of individuals with respect to the total number of individuals in the sampling space as a whole.

2.4.3.3. Equitability or Evenness (j)

Species equitability or evenness (Pielou, 1969) of each sample was evaluated using the equation below.

$$j = \frac{Hs}{H_{max}}$$

Where; H_s = Shannon-Wiener Index, H_{max} = logarithm of the number of species in the population.

2.4.3.4. Simpson's Dominance Index (C)

Simpsonôs dominance index (C) (Ogbeibu, 2005) for each sample was estimated using the equation below.

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

Where n_i = number of individuals of the *ith* species, N = total number of individuals.

2.4.3.5. Correlation Coefficient (γ)

The Spearmanôs Rank Correlation Coefficient (Ogbeibu, 2005) for the relationship between biotic structure and environmental variables was determined using the following equation.

$$\gamma = \frac{1 - 6\sum D^2}{n\,(n^2 - 1)}$$

Where ɔ = correlation coefficient; $\times D^2$ = sum of squares of difference of the ranks; n = number of months.

3.0. Results

Monthly variations in the water quality parameters at the Apapa Wharf (Quay) area of the Badagry creek (Buoy 24) between October, 2007 and March, 2008 are presented in Table 1. Air temperatures during the study ranged from 23.9°C in February to 31°C in November while the mean temperature over the period was 27.6°C. Air temperatures were relatively higher in the dry season than the wet season. Water temperature values were also generally higher in the dry months than the wet months. The lowest value (25.2°C) was recorded in February while the highest value (31.4°C) was recorded in December. Mean water temperature was 28.1°C. Transparency at the study site was higher in the dry months than in the wet months. It ranged from 67.9cm recorded in November to 170.5cm recorded in February with a mean value of 118.9cm. Total dissolved solids were highest in February (18,288mg/L) and lowest (868 mg/L) in October with a mean value of 10019.3mg/L. Higher TDS values were recorded in dry months than in the wet months. Total suspended solids were higher in the dry months than in the wet months. The highest value (125mg/L) was recorded in March while the lowest value (12mg/L) occurred in November. Rainfall at the study site ranged from 8.9mm recorded in December to 87.9mm recorded in October.

Salinity during the period investigated increased steadily from 0.90ă recorded in October to 20.8ă recorded in February while average value was 11.20ă .

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the wet widely [illegible] value of 5843.35mg/L. The lowest value (406.0mg/L) was recorded in October while the highest value (10,966.0mg/L) was recorded in February. Chloride ion concentrations were higher in the dry than the wet months. Conductivity during the study ranged from 1,664 to 34,900µS/cm. The highest value (34,900µS/cm) was recorded in February while the lowest value (1,664µS/cm) was recorded in October. Mean conductivity during the study was 19839.83µS/cm. The pH was alkaline and was higher in the wet months than the dry months. It ranged from 7.33 recorded in October and December to 7.53 recorded in February while the average value for the period of study was 7.44. Acidity was higher in the dry months than in the wet months. It increased from 2.0mg/L recorded in October to 8.8mg/L recorded in January and then decreased gradually to 6.6mg/L in March. Mean acidity during the study was 5.70mg/L. Alkalinity was higher in the dry months than in the wet months ranging from 70.0mg/L recorded in October and November to 1400.0mg/L recorded in March with a mean value of 583.33mg/L. Dissolved oxygen at the study site was relatively higher in the dry months than in the wet months. It ranged from 3.73mg/L recorded in November to 5.3mg/L recorded in February. Biochemical oxygen demand at the study site was generally high ranging from 22 to 70mg/L. The highest value (70mg/L) was recorded in January while the lowest value (22mg/L) was obtained in October. BOD_5 was relatively higher in the wet months than in the dry months. Chemical oxygen demand was highest (400mg/L) in December while the lowest value (125mg/L) was recorded in January. COD values were higher in the dry season than in the wet months.

The total hardness varied widely from 486.5 to 6950.1mg/L. The lowest value (486.5mg/L) and the highest (6950.1mg/L) were recorded in October and February respectively. Total hardness was significantly higher in the dry season than in the wet season. The calcium concentration at the study site ranged from 27.8 to 1800mg/L. Calcium concentration was highest (1800mg/L) in February and lowest in October. Data obtained showed that Calcium concentration was higher in the dry months than the wet months. Magnesium concentration at the study site was higher in the dry months than the wet months ranging from 102.3mg/L recorded in October to 736.0mg/L in February. The nitrate concentration was higher in the dry months than the wet months ranging between 2.0 and 10.1mg/L with an average value of 4.25mg/L. Nitrate was highest (10.1mg/L) in January while the lowest value (2.0mg/L) was recorded in October. Phosphate concentrations were higher in the dry months than the wet months. The highest (2.50mg/L) and lowest (0.28mg/L) values were recorded in January and October respectively. Sulphate concentration at the study site ranged widely from 4.5mg/L recorded in October to 902.3mg/L recorded in February. Sulphate concentration was generally higher in the dry months than in the wet months.

Silica concentration at the study site was higher in the dry months than in the wet months and ranged from 2.2 to 4.2mg/L. Silica concentration was highest (4.2mg/L) in December and lowest (2.2mg/L) in October with a mean value of 3.08mg/L. Copper values were fairly constant ranging between 0.002mg/L and 0.004mg/L. The lowest value (0.002mg/L) was recorded in October, December and January respectively while the highest value (0.004mg/L) was recorded in February and March. The mean value for the period of study was 0.003mg/L. Iron concentrations ranged from 0.10mg/L to 0.26mg/L. The lowest (0.10 mg/L) and highest (0.26mg/L) values were recorded in October and January respectively while the mean value was 0.18mg/L. Iron values were relatively higher in the dry

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ues were
months
ber and
January to 0.025mg/L in March. Mean value for the period of study was 0.13.

3.2. Biological Characteristics

3.2.1. Chlorophyll *a* (µg/L)

Chlorophyll *a* concentration ranged from 4µg/l recorded in October to 16µg/L recorded in November and February respectively. Mean chlorophyll *a* concentration was 11.5µg/l. Chlorophyll *a* values were higher in the dry months than the wet season months (Fig. 2 and 3).

3.2.2. Zooplankton spectrum

An inventory of zooplankton species at the Badagry creek between October, 2007 and March, 2008 are presented in Table 2. Zooplankton population and diversity were more abundant in the dry months than in the wet months. A total of 5 groups of zooplankton were identified with the copepods constituting 74% of the number of individuals recorded (Fig. 4). The copepods were represented by two (2) orders, Calanoida and Cyclopoida, with the most abundant copepod species being *Arcatia clausii* representing 44.86% of the total zooplankton population (Fig. 4). Other copepod species identified were *A. discaudata*, *A. tonsa*, *Paracalanus parvus*, *P. scotti*, *Temora stylifera*, *Cyclops* sp., *Corycaeus obtusus* and *Oithona* sp. and *Oncaea venusta*. The mysids were represented by *Mysis* sp. while there were a number of unidentified Cnidarians from the class Scyphozoa. The cladocerans were represented by *Alona* sp. and *Penilia avirostris* while the larvaceans were the least abundant group represented by *Oikopleura* sp (Table 3). Meroplanktonic forms encountered include juvenile stages of different animal phyla such as Arthropoda (zoea larva), Chordata (Fish larva) and Mollusca (Gastropod larva) (Fig. 5). Juvenile stages represented 22.56% of the total zooplankton groups observed (Table 3; Fig. 4) and were more abundant in the dry months than the wet months.

3.3.3. Zooplankton community structure

Monthly variations in community structure are as presented in Table 4. Species diversity (S), richness (d) and Simpsonôs Dominance (C) indices were higher in the dry season while species equitability index (j) was higher in the wet season.

Correlation coefficient (ɔ) between water quality parameters and species richness and abundance at the Badagry creek.

The Spearmanô rank correlation coefficient matrix between water quality parameters and zooplankton species richness and abundance at the Badagry creek are presented in Table 5. Spearmanôs Correlation Coefficient associations that shows positive and negative relationships (Ó+0.40 or Ò-0.40) for water quality parameters, Chlorophyll *a*, Species Diversity and Abundance are further presented in Table 6.

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Parameters at the Badagry creek (October, 2007 – March, 2008).

PARAMETERS	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean	Std. Dev.
Air temperature (°C)	27	31	29	28.5	23.9	26.2	27.6	2.46
Water temperature (°C)	27.1	28	31.4	27.4	25.2	29.4	28.0833	2.12
Transparency (cm)	81	67.9	112.8	126.4	170.5	155	118.933	40.24
Rainfall (mm)	87.9	19.5	8.9	74.4	17.6	44.5	42.1333	32.74
Total Dissolved Solids (mg/L)	868	2420	6910	13350	18288	18280	10019.3	7731.33
Total Suspended Solids (mg/L)	32	12	115	120	23	123	70.8333	53.57
pH at 26°C	7.33	7.44	7.33	7.43	7.53	7.6	7.44	0.099
Acidity (mg/L)	2	2.8	6	8.8	8	6.6	5.7	2.75
Alkalinity (mg/L)	70	70	700	280	980	1400	583.33	539.80
Salinity (‰)	0.9	2.3	8.7	15	20.8	19.5	11.2	8.57
Conductivity (µS/cm)	1664	4480	16095	27300	34900	34600	19839.8	14701.3
Dissolved Oxygen (mg/L)	3.9	3.7	4	4	5.3	4.6	4.25	0.60
Biological Oxygen Demand (mg/L)	70	33	48	22	28	34	39.1667	17.39
Chemical Oxygen Demand (mg/L)	230	150	400	125	192	70	194.5	114.72
Total Hardness (mg/L)	486.5	625.5	2085	4170	6950.1	6860.1	3529.53	2932.01
Chloride (mg/L)	406	928.1	4060	7900	10966	10800	5843.35	4731.69
Calcium (mg/L)	27.8	44.6	150.2	489.5	1800	1720	705.35	834.053
Magnesium (mg/L)	102.3	123	417.1	736	612.5	620.3	435.2	270.11
Zinc (mg/L)	0.008	0.012	0.011	0.008	0.015	0.025	0.01317	0.0064
Iron (mg/L)	0.1	0.2	0.17	0.26	0.15	0.18	0.17667	0.053
Copper (mg/L)	0.002	0.003	0.002	0.002	0.004	0.004	0.00283	0.00098
Nitrate (mg/L)	2	3.3	4	10.1	0.8	5.3	4.25	3.26
Sulphate (mg/L)	4.5	120.3	360.2	330.6	902.3	989	451.15	406.10
Phosphate (mg/L)	0.28	1.9	0.3	2.5	0.8	0.88	1.11	0.90
Silica (mg/L)	2.2	3.2	4.2	2.8	3.3	2.8	3.08	0.67
Chlorophyll *a* (µg/L)	4	16	11	12	16	10	11.5	4.46

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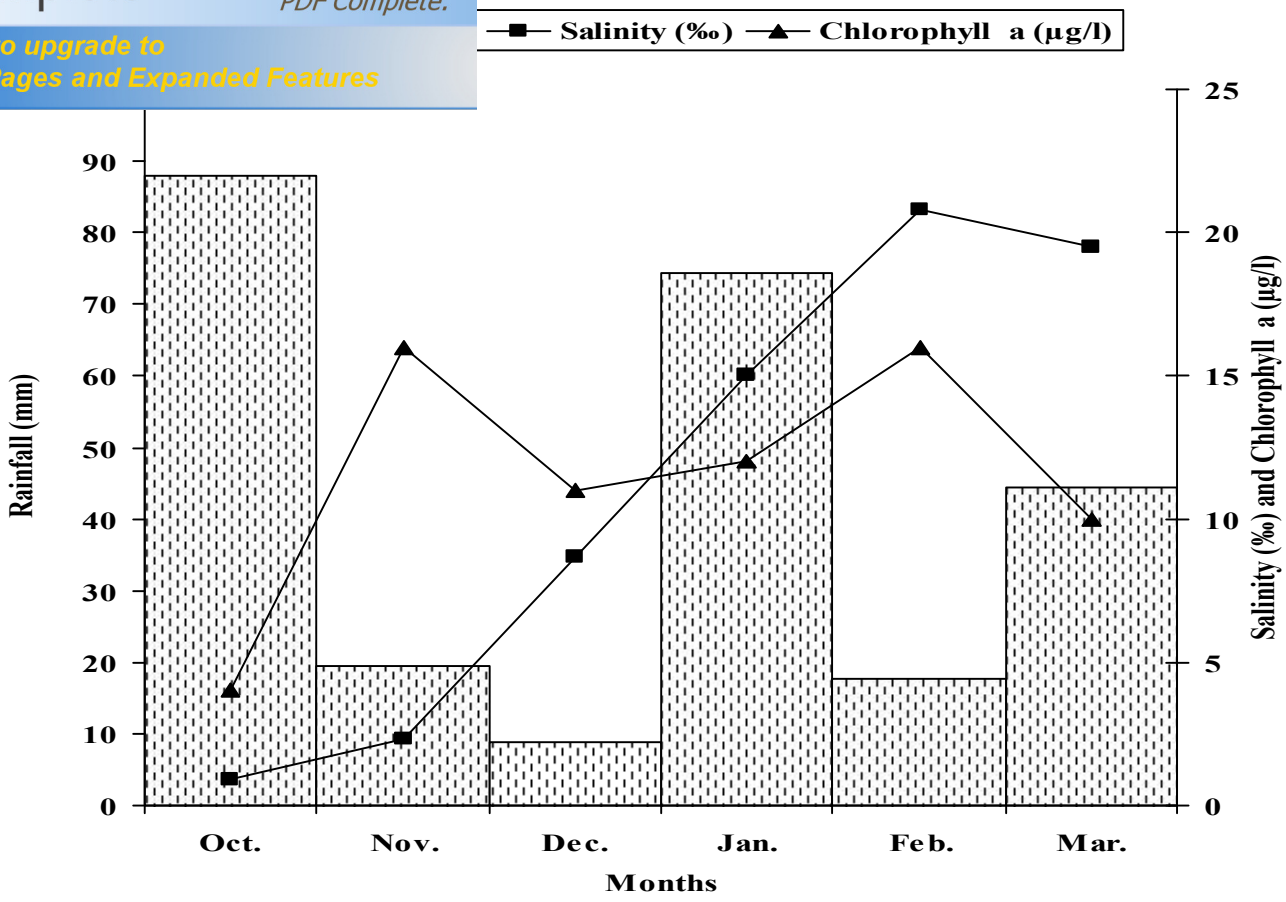

Fig. 2: Monthly variations in Rainfall, Salinity and Chlorophyll *a* at the Badagry creek (October, 2007 ï March, 2008).

Table 3: An inventorial of the Zooplankton of the Badagry creek (October, 2007- March, 2008).

TAXA
PHYLUM I: ARTHROPODA
CLASS I: CRUSTACEA
SUB-CLASS I: COPEPODA
ORDER I: CALANOIDA
Acartia clausii Giesbrecht
Acartia discaudata Giesbrecht
Acartia tonsa Giesbrecht
Paracalanus parvus Claus
Paracalanus scotti Fruchtl
Temora stylifera Dana

ORDER II: CYCLOPOIDA
Corycaeus obtusus Dana
Cyclops sp.
Oithona plumifera Baird
Oncaea venusta Phillipi

SUB-CLASS II: MALACOSTRACA
ORDER: MYSIDACEA
Mysis sp.

SUB-CLASS III: BRANCHIOPODA
ORDER: CLADOCERA
Alona sp.
Penilia avirostris Dana

JUVENILE STAGES
Copepod eggs
Lucifer foxoni zoea larva
Megalop larva
Nauplii larva of Barnacle
Nauplii larva of Copepods
Zoea larva

PHYLUM II: CNIDARIA
CLASS: SCYPHOZOA
Unidentified jellyfish

PHYLUM: MOLLUSCA
JUVENILE STAGES
Gastropod larva

PHYLUM: CHORDATA
CLASS: LARVACEA
Oikopleura sp.

JUVENILE STAGES
Fish eggs
Fish larvae

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Table 4: Community Structure Indices at the Badagry creek.

MONTHS	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
Species diversity (S)	7	8	13	14	12	11	10.83
Species abundance (N)	50	60	560	475	550	320	335.83
Margalef's Index (d)	1.53	1.71	1.90	2.11	1.74	1.73	1.79
Shannon-Weiner Index (Hs)	0.80	0.86	0.78	0.93	0.74	0.55	0.78
Equitability Index (j)	0.94	0.95	0.70	0.81	0.69	0.53	0.77
Simpson's Dominance Index (C)	0.18	0.15	0.25	0.16	0.27	0.50	0.25

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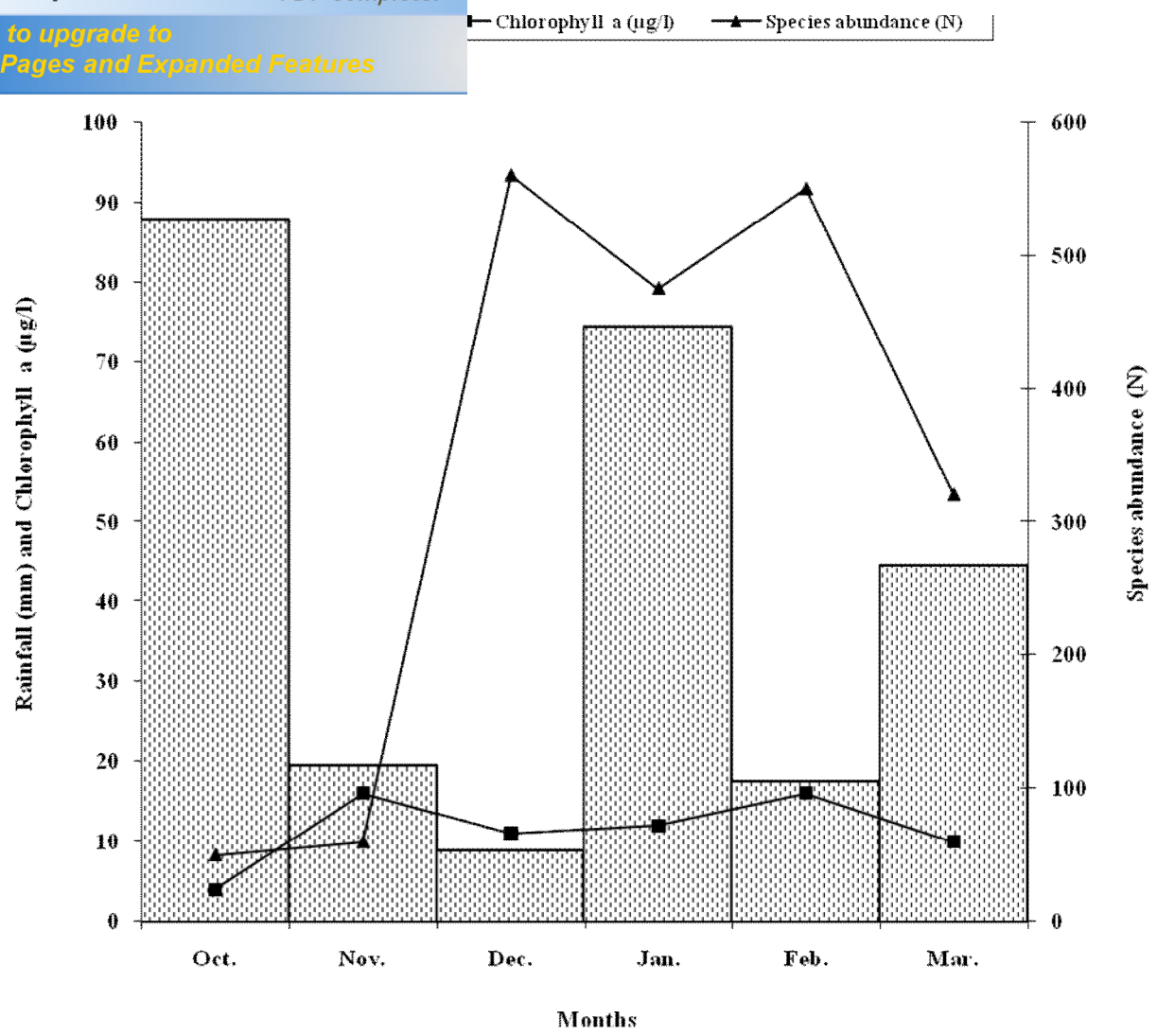

Fig. 3: Monthly variations in Rainfall, Chlorophyll *a* and Species abundance at the Badagry creek (October, 2007 ï March, 2008).

Table 3: Relative Abundance of Zooplankton Groups (per ml) at Badagry creek (October, 2007 ï March, 2008).

ZOOPLANKTON GROUP	POPULATION	% COMPOSITION
Copepoda	1500	74.44
Juvenile stages	450	22.33
Malacostraca	30	1.49
Cnidaria	20	0.99
Branchiopoda	10	0.50
Larvacea	5	0.00
TOTAL	2015	100

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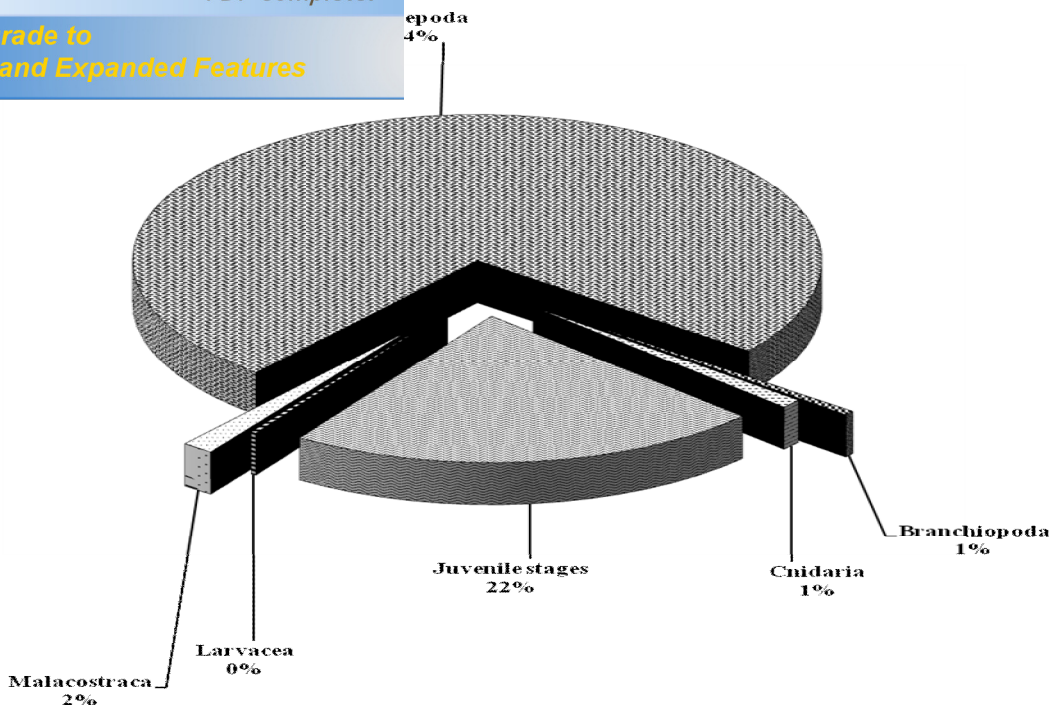

Fig. 4: Relative abundance of Zooplankton groups at the Badagry creek.

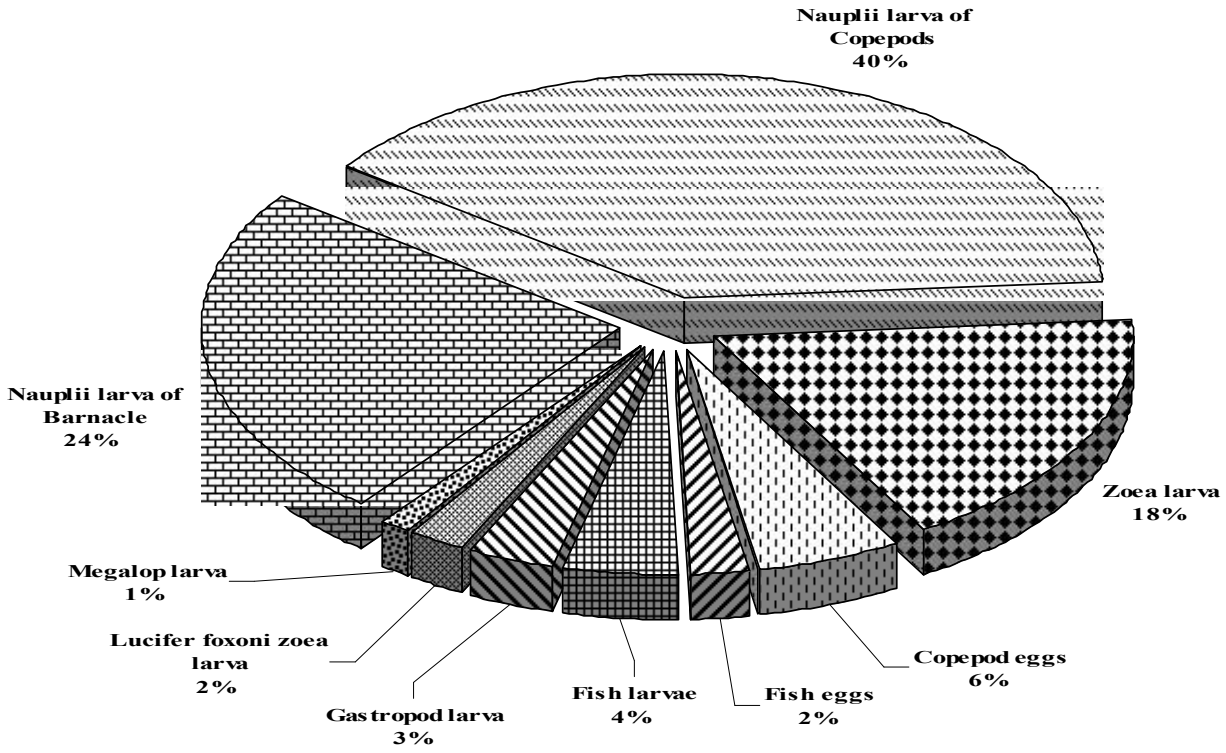

Fig. 5: Relative abundance of zooplankton juvenile stages.

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rrelation Co-efficient Matrix of Water Quality Parameters, Chlorophyll *a*, Species and Diversity at the Badagry creek (October, 2007 - March, 2008).

	Air temp.	Water temp.	Transparency	Rainfall	TDS	TSS	pH	Acidity	Alkalinity	Salinity	Conductivity	DO	BOD	COD	Total Hardness	Chloride	Calcium	Magnesium	Zinc	Iron	Copper	Nitrate	Sulphate	Phosphate	Silica	Chlorophyll ï *a*	Species diversity	Species abundance
Air temp.	1.00																											
Water temp.	0.50	1.00																										
Transparency	0.79	-0.20	1.00																									
Rainfall	-0.09	-0.29	-0.20	1.00																								
TDS	-0.67	-0.19	0.98	-0.17	1.00																							
TSS	0.50	0.64	0.37	0.11	0.42	1.00																						
pH	0.50	-0.32	0.71	-0.22	0.82	0.05	1.00																					
Acidity	0.42	-0.09	0.83	-0.15	0.86	0.57	0.49	1.00																				
Alkalinity	-0.63	0.19	0.85	-0.38	0.83	0.44	0.70	0.56	1.00																			
Salinity	-0.68	-0.18	0.98	-0.20	-0.78	0.42	0.78	0.89	0.82	1.00																		
Conductivity	-0.64	-0.14	0.97	-0.19	0.99	0.47	0.77	0.90	0.82	0.99	1.00																	
DO	-0.90	-0.45	0.90	-0.29	0.82	-0.06	0.70	0.58	0.75	0.83	0.80	1.00																
BOD	0.03	0.20	-0.51	0.34	-0.68	-0.22	-0.68	-0.74	-0.32	-0.67	-0.68	-0.36	1.00															
COD	0.17	0.44	-0.24	-0.36	-0.43	0.02	-0.74	-0.17	-0.17	-0.37	-0.37	-0.20	0.51	1.00														
Total Hardness	-0.74	-0.24	0.97	-0.17	0.99	0.34	0.84	0.98	0.86	0.98	0.98	-0.87	-0.61	-0.44	1.00													
Chloride	-0.69	-0.20	0.97	-0.16	0.99	0.42	0.80	0.87	0.83	0.99	0.99	0.83	-0.66	-0.41	0.99	1.00												
Calcium	-0.81	-0.32	0.92	-0.21	0.92	0.14	0.89	0.61	0.87	0.91	0.89	0.92	-0.49	-0.47	0.96	0.92	1.00											
Magnesium	-0.46	-0.06	0.86	-0.54	0.91	0.64	0.56	0.98	0.63	0.92	0.93	0.58	-0.71	-0.30	0.85	0.91	0.67	1.00										
Zinc	-0.41	0.17	0.59	-0.31	0.64	0.26	0.81	0.24	0.87	0.61	0.61	0.54	-0.30	-0.46	0.69	0.63	0.78	0.36	1.00									
Iron	0.44	0.13	0.11	-0.05	0.31	0.48	0.24	0.57	-0.05	0.30	0.34	-0.20	-0.80	-0.37	0.19	0.29	-0.02	0.55	-0.03	1.00								
Copper	-0.56	-0.31	0.63	-0.42	0.67	-0.19	0.92	0.26	0.72	0.64	0.61	0.77	-0.45	-0.53	0.74	0.66	0.87	0.31	0.84	-0.09	1.00							
Nitrate	0.36	0.25	0.06	-0.38	0.22	0.73	0.03	0.49	-0.08	0.22	0.27	-0.34	-0.47	-0.33	0.11	0.22	-0.12	0.54	-0.10	0.85	-0.36	1.00						
Sulphate	0.70	-0.80	0.93	-0.36	0.93	0.31	0.85	0.67	0.95	0.93	0.92	0.87	-0.52	-0.34	0.96	0.93	0.97	0.72	0.83	0.06	0.83	-0.05	1.00					
Phosphate	0.43	-0.24	-0.10	0.16	0.12	0.09	0.24	0.32	-0.33	0.10	0.13	-0.26	-0.73	-0.58	0.04	0/10	-0.10	0.30	-0.19	0.88	-0.07	0.70	-0.14	1.00				
Silica	0.22	0.53	0.14	-0.87	0.09	0.21	-0.12	0.28	0.26	0.14	0.14	0.83	-0.24	0.64	0.04	0.09	-0.03	0.15	0.02	0.18	-0.01	-0.10	0.17	-0.16	1.00			
Chlorophyll ï *a*	0.09	-0.21	0.27	-0.72	0.36	-0.22	0.49	0.41	0.16	0.37	0.36	0.33	-0.81	-0.17	0.32	0.34	0.31	0.29	0.16	0.51	0.49	-0.02	0.34	0.49	0.52	1.00		
Species diversity	-0.18	0.20	0.65	-0.24	0.66	0.70	0.20	0.93	0.44	0.70	0.73	0.34	-0.62	0.12	0.17	0.67	0.35	0.88	0.07	0.60	-0.01	0.56	0.47	0.25	0.51	0.35	1.00	
Species abundance	-0.38	0.13	.75	-0.39	0.68	0.53	0.19	0.88	0.55	0.73	0.73	0.55	-0.48	0.30	0.62	0.69	0.46	0.80	0.11	0.32	0.11	0.24	0.57	-0.03	0.62	0.35	0.94	1.00

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ociations for Chlorophyll *a*, Species Diversity and Abundance

		ies diversity (S)	Species abundance (N)
Air temp.	x	x	x
Water temp.	x	x	x
Rainfall	(-)	x	x
TDS	x	(+)	(+)
TSS	x	(+)	(+)
Transparency	x	(+)	(+)
Salinity	x	(+)	(+)
Chloride	x	(+)	(+)
Conductivity	x	(+)	(+)
pH	(+)	x	x
Acidity	(+)	(+)	(+)
Alkalinity	x	(+)	(+)
DO	x	x	x
BOD	(-)	(-)	(-)
COD	x	x	x
Total Hardness	x	(+)	(+)
Calcium	x	(+)	(+)
Magnesium	x	(+)	(+)
Zinc	x	x	x
Iron	(+)	(+)	x
Copper	(+)	x	x
Nitrate	x	(+)	x
Sulphate	x	(+)	(+)
Phosphate	(+)	x	x
Silica	(+)	(+)	(+)
Chlorophyll *a*	1	(+)	(+)
Species diversity	(+)	1	(+)
Species abundance	x	(+)	1

Key:

(+) Ÿ Strongly positive (Ó+0.40)

(-) Ÿ Strongly negative (Òī 0.40)

x Ÿ not strongly correlated

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y of hydrological characteristics of the Badagry creek is in agreement with earlier observations on some creeks in South-western Nigeria (Nwankwo and Amuda, 1993; Onyema and Nwankwo, 2006; Onyema, 2007; Onyema and Ojo, 2008). According to these reports, two physiographic factors rainfall and salinity determine the hydro-climatic conditions of the creek ecosystems of South-western Nigeria and subsequently the biotal spectrum. According to Nwankwo (1996) and Nwankwo *et al.* (2003) reported that the dynamic interplay between tidal seawater incursion and flood water inflow from adjoining rivers and creeks are also known to affect the hydrodynamics of the Lagos lagoon.

High air (23.9° - 31°C) and water (25.2° - 31.4°C) temperatures recorded during the study are typical of the region (Nwankwo *et. al.,* 2003; Onyema *et al*., 2003). However the range of water temperature values are in contrast to earlier observations by Hill and Webb (1958) and Sandison and Hill (1966) which reported that water temperature in the Lagos lagoon never varied more than 4°C. This may be due to increased insolation arising from greater solar radiation, possibly a reflection of global warming trends. Air and water temperatures were relatively higher in the dry months (Dec. ï Feb.) than in the wet months which could be attributed to reduced cloud cover conditions and subsequent increase in solar radiation (Onyema *et al*., 2003).

Transparency was observed to increase progressively with the dry season months. The reduction in transparency levels in the wet months may be connected with the incursion of the creek by majorly flood waters with corresponding introduction of allochtonous materials from the adjacent land. This confirms earlier report by Nwankwo (1990) which highlighted that the seasonal variation of transparency in coastal waters of South-western Nigeria is linked to the rainfall pattern and associated floods.

The salinity values observed throughout the period of the study suggests that the study site is a brackish environment. The high salinity values during the dry season may be attributed to low rainfall, high evaporation rate coupled with low humidity, increased tidal seawater incursion, reduced flood water and water inflow from associated rivers and creeks. According to Onyema *et. al.* (2003) and Emmanuel and Onyema (2007) the salinity regime in the Lagos lagoon is seasonal with high salinities reported from December to April and low salinities observed between May and November. In agreement with this, the salinities were higher from December to March and lower in October and November. Hence hydro-meteorological forcings may be implicated in the control of the water quality conditions of the Badagry creek, namely freshwater associated with rains and seawater incursion (Emmanuel and Onyema, 2007; Onyema and Emmanuel, 2009).

The pH values recorded during the study were alkaline, but were higher in the dry season months than the wet season months. This increase may be due to the buffering effect of seawater as a result of increased tidal seawater incursion. According to Nwankwo (1988), dissolved oxygen decreases with increased temperature and biological oxygen demand due to increased metabolic activities of most species. Furthermore biochemical oxygen demand values higher than 8mg/L according to Hynes (1960) point to severe pollution. The low dissolved oxygen levels (<5.3) recorded during the study coupled with very high biochemical oxygen demand levels within the creek (>22mg/L) are indicators of severe pollution stress within the creek. The increased DO content of the Badagry creek during the dry season months may be as a result of high transparency and increased productivity by both the macrophyte vegetation and algae around the area. Lower DO levels in the wet season may be ascribed to flood and municipal drains depositing waste (organic, inorganic and debris) thereby leading to increased fouling, turbidity and consequently a reduction in primary productivity.

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February and a minor peak occurring in the late rainy season between August and November. The pattern of variation of Chlorophyll *a* values observed during this study is in agreement with Kadiri (1993). Chlorophyll *a* values were also generally observed to be higher in the dry season than in the wet months confirming earlier observations by Ogamba *et. al.* (2004). This may be attributed to high light intensity, reduced cloud cover and more stable conditions which permitted maximum use of available nutrients by the phytoplankton hence an increase in biomass (Onyema and Emmanuel, 2009). Further to this, Erondu and Chindah (1991) and Kadiri (1999) are of the view that, alkalinity is regarded as a measure of the productivity of natural waters. Positive correlation between alkalinity and chlorophyll *a* values recorded during the period of study confirms the afore-mentioned relationship between alkalinity and productivity. For instance, dissolved oxygen levels throughout the period of study were comparatively lower in the wet months than the dry. Furthermore, chlorophyll *a* values were also lower in the wet than the dry months. It is possible that higher primary productivity in the dry months gave rise to higher chlorophyll *a* concentrations which lead to a similar trend in dissolved oxygen concentrations since oxygen is a by-product of photosynthesis.

Generally, zooplankton diversity was higher in the dry than in the wet months. More stable conditions including water flow characteristics, light penetration, reduced rainfall and increased salinity conditions experienced in the dry season could have encouraged the development of a richer zooplankton spectrum within the creek, while freshwater conditions during the wet months reduced zooplankton abundance. Similar observations have been made by Kusemiju *et. al.* (1993), Onyema *et. al.* (2003, 2007) and Onyema and Nwankwo, (2009) in similar environments in the region. The high species abundance and diversity, recorded in December may be attributed to a bloom in phytoplankton population which according to Nwankwo (2004), may have occurred in the preceding period. The zooplankton community was dominated by calanoid copepods mainly *Arcatia clausii* and *Paracalanus parvus* confirming earlier reports by Onyema *et. al.*, (2003, 2007) and Onyema and Ojo (2008).

The abundance of an array of developmental stages in the zooplankton spectrum especially crustaceans of known estuarine and migratory fauna may point to the suitability of the Badagry creek as a nursery and breeding ground. This observation is in consonance with reports of Nwankwo and Gaya (1996) and Solarin and Kusemiju (2003). According to Onyema *et. al.* (2007), the occurrence of fish eggs, larvae and juvenile stages of known marine forms may confirm suggestions that the Lagos lagoon is populated by immigrant forms from the sea particularly during the dry season. A similar situation may exist in the Badagry creek.

The dominance of calanoid copepods particularly *Acartia clausii* may have accounted for the low species richness index (<2.11) and low species diversity index (<0.93) recorded during the study. Itôs important to note that Table 6 very likely represents relationships (directly or indirectly) between these water quality parameters and zooplankton species occurrence.

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Role of phase interactions in formation of photoluminescent and dielectric properties of polymeric nanocomposites PP + CdS

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Abstract: In present work has been investigated the influence of phase interactions in formation of photoluminescent and dielectric properties of polymeric nanocomposites on the basis PP + CdS. Has been shown that the increasing of concentration of initial solutions leads to adhesion of CdS nanoparticles i.e. with increasing of concentration the more Cd^{2+} and S^{2-} ions are not used on formation of new germs, but ones are used on coagulation of initial particles. It is supposed when the sizes of nanoparticles are commensurable with supermolecular formation, then polymeric macromolecules effectively excite new additional luminescent centers by light influense. It is also shown that boundary phase interactions in polymeric nanocomposites PP+CdS plays important role on formation of its photoluminiscent properties. It means that it is possible to adjust photoluminiscent properties not only by component and its geometrical parameters matching, but also by impact on conditions of boundary and interphase effects. [Journal of American Science 2009; 5(6):95-101]. (ISSN: 1545-1003).

Keywords: nanocomposite, photoluminescent, nanoparticle

Introduction

Semiconductor materials as cluster, distributed in organic polymeric matrix is a question of great scientific and practical importance of scientists, working on problems, related to physics and chemistry of microsize systems [1-2]. Such kind materials reveal unusual electronic and optical properties. For preparation nanosize semiconductors are used several methods such as ash-gel technology [3], Lengmure-Blodjet method [4], molecular-beam epitaxy [5] and multicyclic treatment method [6]. One of the main obstacles of possible application of the structures with semiconductor nanoclusters in optic electronics is low effectiveness of cluster luminescence, caused by high density of surface. Surface density depends on preparation method, further treatment of nanocluster and matrix, containing nanoparticles. Investigation of composite structures, ascertainment of links between intermolecular forms characters and polymers properties allows pointedly regulate the structure of prepared material with demanded properties. Studying of the structure of such kind materials allows predict its properties, and the changes of the properties give the information of nanocomposite structure. In the present work has been studied photoluminiscence of CdS nanoparticles in polymeric polypropylene matrix.

The samples and experiment method

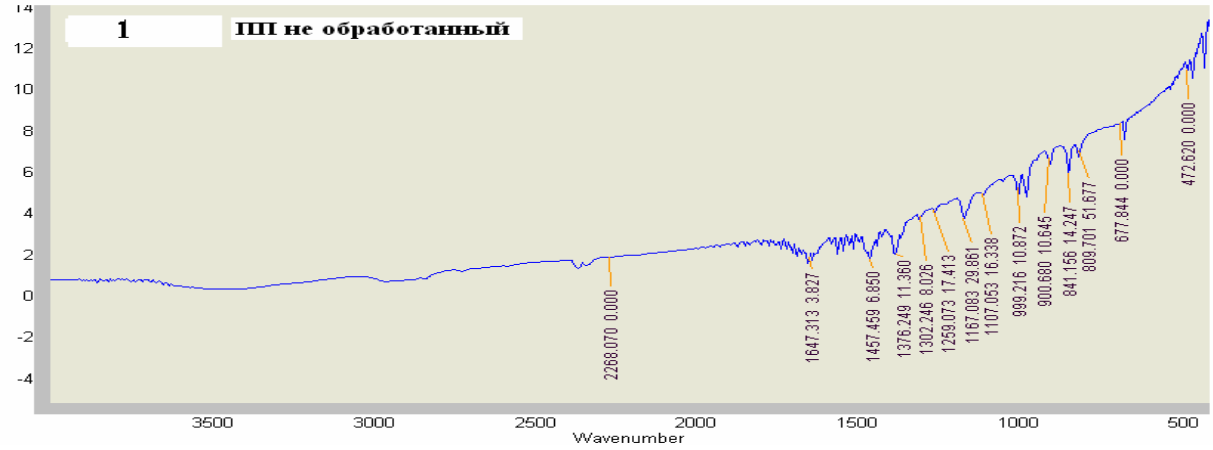
In this work is given the results of research of photoluminescent properties of nanocomposites on the basis of polypropylene (PP) and filler CdS treated in wavelength interval λ= 300-1000 nm. The polymeric powder (size of particles 0, 5-1,0 mkm) with aim to increase the reactivity towards the transition metal ions was treated by electrical discharge in various intervals of time [7]. The treatment of powder was carried in quartz tube (d=15mm, wall thickness=1 mm), high voltage passed into the tube trough fluorineplastic pipe. Clearance between electrode and tube surface was filled by PP powder (d=50mm). The nanocomposite polymer + CdS was prepared by treatment of samples of powder of PP in solution of $Na_2S{\times}9H_2O$ with following concentrations 0,1 M, 0,5 M and 1 M. Further from that powder was prepared the samples of nanocomposites PP + CdS by hot-pressing method at the melting point of PP. Photoluminescent spectra have been studied on spectrofluorimeter Cary Eclipse in wavelength interval 300-1000 nm. Has been studied the relief of nanocomposites samples by AFM spectroscopy. The sizes of nanoparticles and distribution of CdS in polymeric matrix have been studied by electron microscopy method. Dielectric permeability and tg of dielectric loss angle were measured by means automatic bridge E8-4 with 1 kHz frequency. Developing of oxidative destructive processes in nanocomposites PP + CdS, obtained by hot-pressing method at the melting point of PP and treated by electric discharge in various time intervals, were studied by IR spectroscopy method.

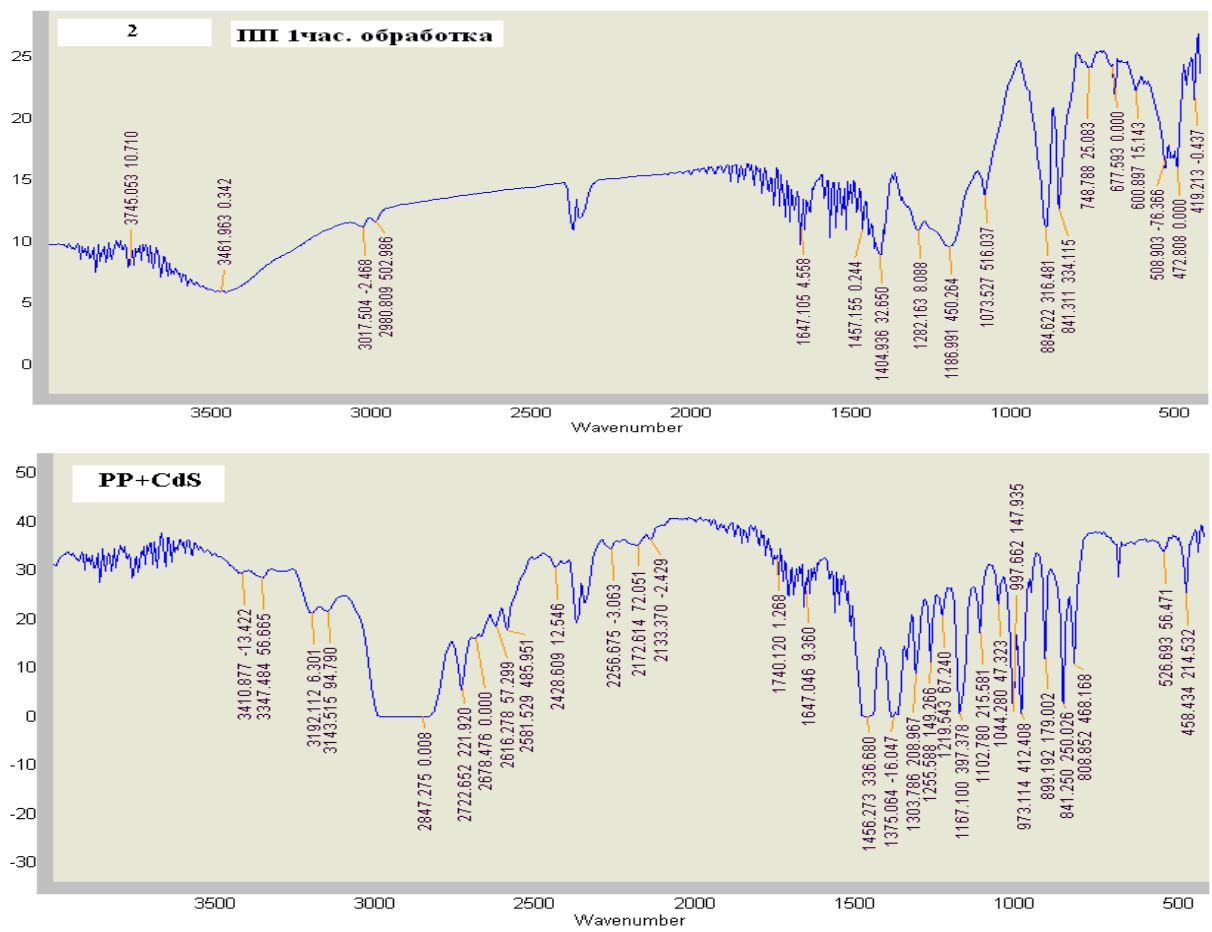
1. The results and discussion

The spectra, presented in Pic.1 are IR spectra of PP and nanocomposite PP + CdS samples, treated and not treated by electric discharge. It is clear from the pic.1 that there is strong change in IR spectra especially in wavelength region 3461 sm^{-1}, 1456-1186 sm^{-1} and 864-500$см^{-1}$. Change in IR spectra especially in wavelength region 3461 sm^{-1}, is connected with formation of hydroxyl groups in polymer. Depending on duration of treatment, was observed the increasing of absorption band strength in wavelength region 2950 sm^{-1} and 2846 sm^{-1}, to result from the activation of CH valence vibrations in spectra of polypropylene. One of the major parameters influencing on distribution of dispersed phase in sample volume is the complex formation ability of polymeric matrix towards the transition metal ions complex formation ability of polymeric matrix stimulates the formation of CdS nanoparticles. It is also shown in IR spectra of nanocomposite PP + CdS samples, treated by electric discharge, the activation of absorption band strength of CH valence, deformation vibrations and vibrations mutual influence of CH and CH_2 groups were observed.

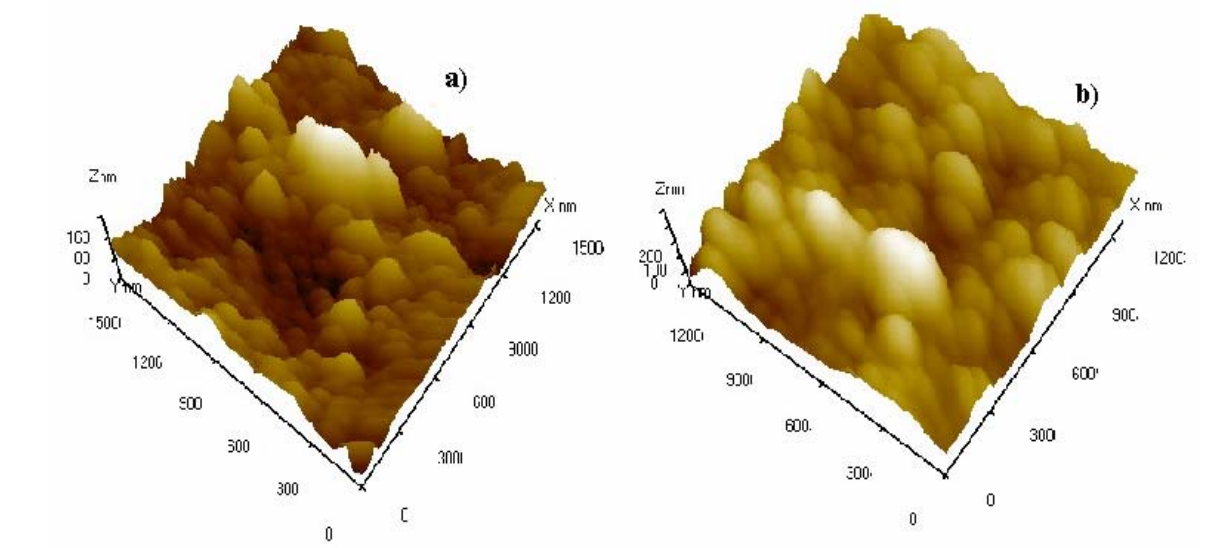
Have been studied by the atomic-force microscope (AFM) the relief of nanocomposites PP + CdS samples, obtained from PP powder, treated and untreated by electrical discharge in air quality in 0,5 hours (Pic.2). As it is seen in the pic.2 the relief of treated samples in various intervals of time becomes rough. The increasing of exposure time leads to increasing of concentration of CdS particles in polymeric matrix to certain extend. As it is seen from pic.2 the size of CdS particles in polymeric matrix is 15-18 nm. Earlier we found that ability of polymeric matrix to form complex increase with discharge treatment, i.e. the majority of dispersed component forms around the oxidation centers in polymer. The AFM-scanning of PP + CdS samples relief shows the increasing the CdS nanoparticles on the samples surface. The concentration change of CdS in PP with duration of discharge treatment seemingly is correlated with forming of oxidizing centers in polymer, which are the nuclease center for CdS[8].

We also found [8] the CdS nanoparticles size is 15-27 nm and do not depend the time of discharge treatment, and the concentration of CdS nanoparticles in polymeric matrix depends the duration of discharge treatment. The increasing of discharge treatment duration evidently leads to structural damage of polymer. The AFM-scanning pic.2 and electron-microscope spectroscopy investigations pic.3 show that CdS nanoparticles are equally distributed in polymeric matrix.

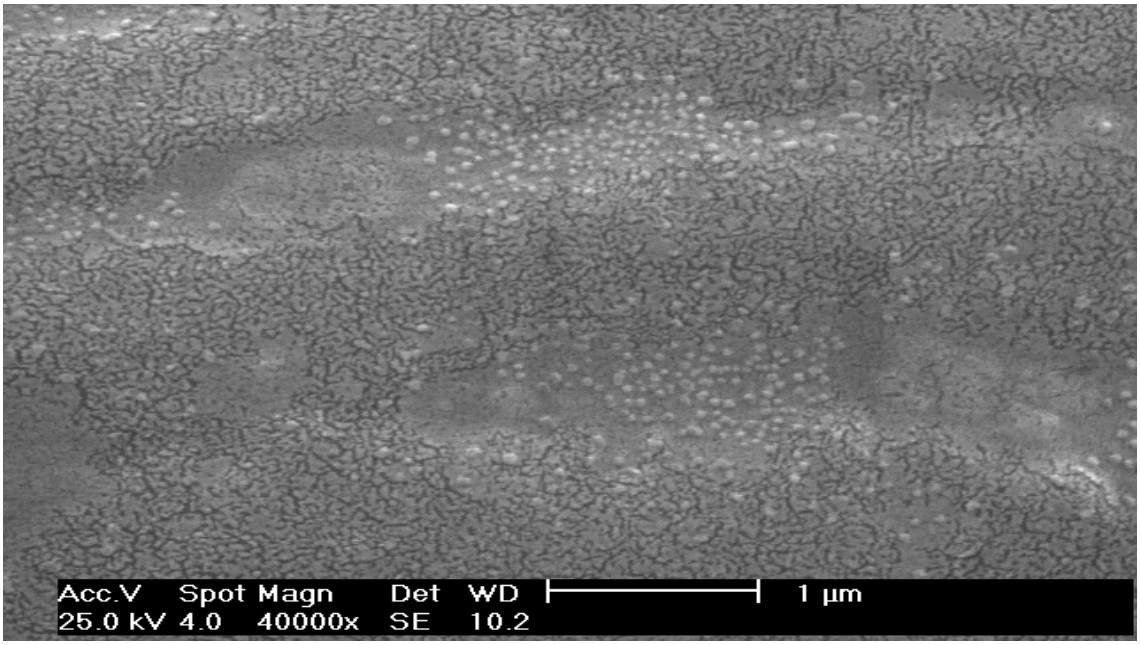




Pic.1 **IR spectra of PP and nanocomposite samples, treated and not treated by electric discharge**



Pic.2 3D image observed by AFM of nanocomposite PP + CdS
a) Untreated powder of PP by electric discharge in air quality
b) Treatment duration of PP powder 30 minutes by electric discharge in air quality

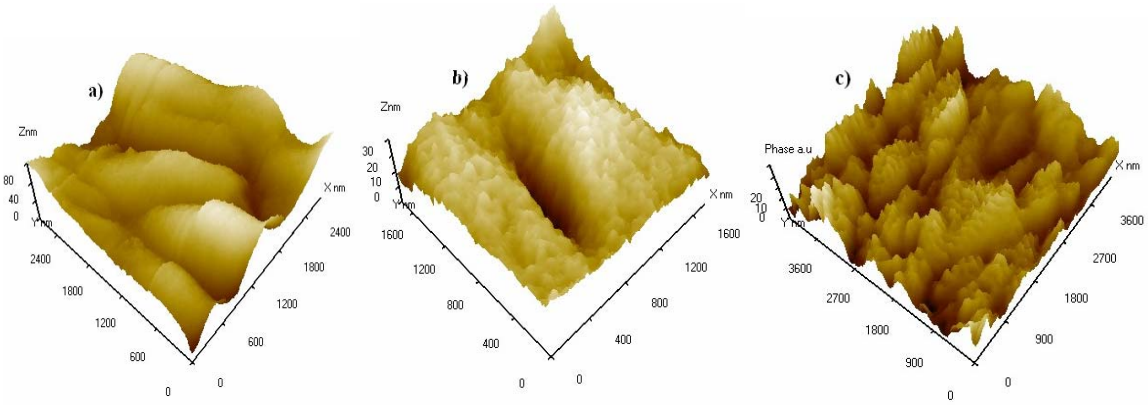


Pic.3 Electron-microscopic image of CdS nanoparticle in polypropylene

Has been studied the influence of concentration of initial solutions on size of formed CdS nanoparticles. The experiments show that increasing of concentration of initial solutions leads to increasing of CdS size nanopparticles in polypropylene matrix, i.e. in the process of nanoparticle formation CdS stick in germ crystal center.

There are AFM images of PP+CdS nanocomposite, prepared from 0,1M, 0,5M и 1M solutions $CdCl_2 \times H_2O$ and $Na_2S \times 9H_2O$ on pic. 4 It is found that increasing of concentration leads to increasing of CdS nanoparticles size in polypropylene. In 0,1M solution we observed formation of 15-25 nm sized nanoparticles, and in 0,5M, 1M solutions the size of nanoparticles were 35-40 nm and 70-90 nm correspondingly.

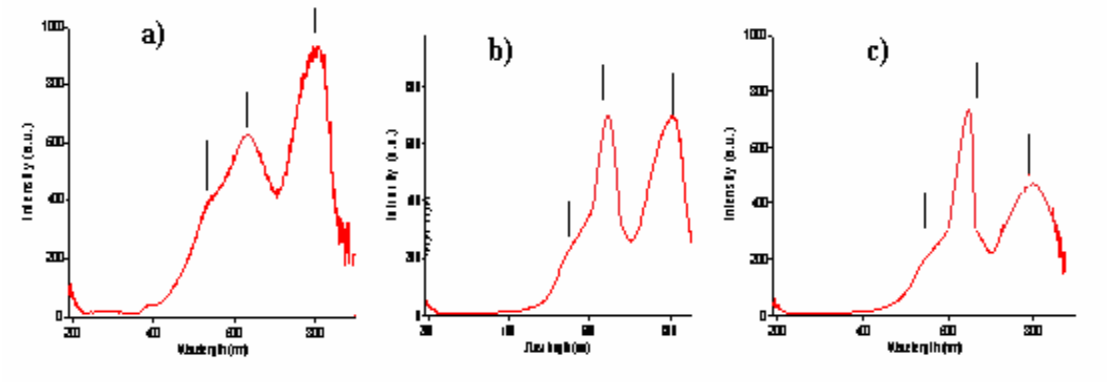
It is due to the more ions Cd^{2+} и S^{2-} are used not for formation of new germs, but on coagulation of initial particles.



Pic. 4 AFM image of PP+CdS nanocomposite, prepared from 0,1M, 0,5M и 1M solutions $CdCl_2 \times H_2O$ and $Na_2S \times 9H_2O$.

Also have been studied luminescent spectra of nanocomposite PP + CdS, prepared from solutions with various concentrations on Cary Eclipse., treated and untreated by electrical discharge in various intervals of time in the pic.5. It is clear for all samples luminescent spectra there are three basic maximums in wavelength interval λ=534 nm 627 nm and 809 nm. It is clear that increasing CdS

nanoparticle size the maximum at λ=809 nm inherently decrease, but the intensity at λ=627 nm increases.



Pic.5 Photoluminescent spectra of nanocomposite PP + CdS, prepared from 0,1M(a), 0,5M(в) и 1M (c) solutions of $CdCl_2 \times H_2O$ и $Na_2S \times 9H_2O$.

By our opinion the observed maximums at λ_1=627 nm are connected with thickness and properties of boundary layer and interaction degree of composite CdS+PP components, which is by its physical and chemical properties differs of polymer and semiconductor. Observed maximum at λ=534 nm characteristic for CdS in volume. The maximum at λ=809 нм is connected with recombination through defect levels in matrix and CdS nanoparticle. As it seen from pic.5 the increasing of CdS size nanoparticle leads to suppression of fluorescence at λ=809 nm. Obtained IR and fluorescence spectroscopy data let us explain character of the maximums changes at λ=627 nm and 809 nm by π^* - π pass in conjugated bonds –C – C -, and - C=O. IR spectroscopy of nanocomposite samples shows as a result of degradation of molecular bonds in polymer at the process of formation of nanocomposite CdS+PP and further reactions of free radicals, forms interphase layer on the boundary of composite components. Borrowing energy of these bonds nanoparticles and polymer pass to exited state and changes in photoluminescence spectra are observed. It is known formation of chemical bond between photosemiconductors atoms and separate functional groups of polymer brings to strengthening of adhesion durability, but the physical interactions of electrostatic and Van-der-vaals forces are accompanied with week adhesion. Adhesion durability of fotoactive semiconductor and polymeric matrix is defined by interaction character on interphase boundary. Due to high activity of nanoparticle in polymeric matrix it reveals high interphase interactions. By our opinion macromoleculas of polymer can effectively excite new additional luminescent centers in semiconductor fillers, when size of nanoparticles are commensurable with supermolecular formation (lamella, fibrils, spherolites). Molecule passes on excited state after light absorption, and then is deactivated by radiating or not radiating, by intermolecular and intramolecular mechanisms. The transfer of electron excitement energy comes to be from donor to acceptor in nanocomposite as well as in low molecular compounds. One of the factors stipulating the effectiveness of energy transfer in polymer is migration of energy. It should be noted for double phase nanocomposite structure supermolecular formation has structure of nanoheterogenic morphology. It is known from molecular chemistry [8] the average distance of energy transmission between chromophor groups is 5 nm. Also low size supermolecular formation has higher mobility. High mobile supermolecular structure is sensitive to light.

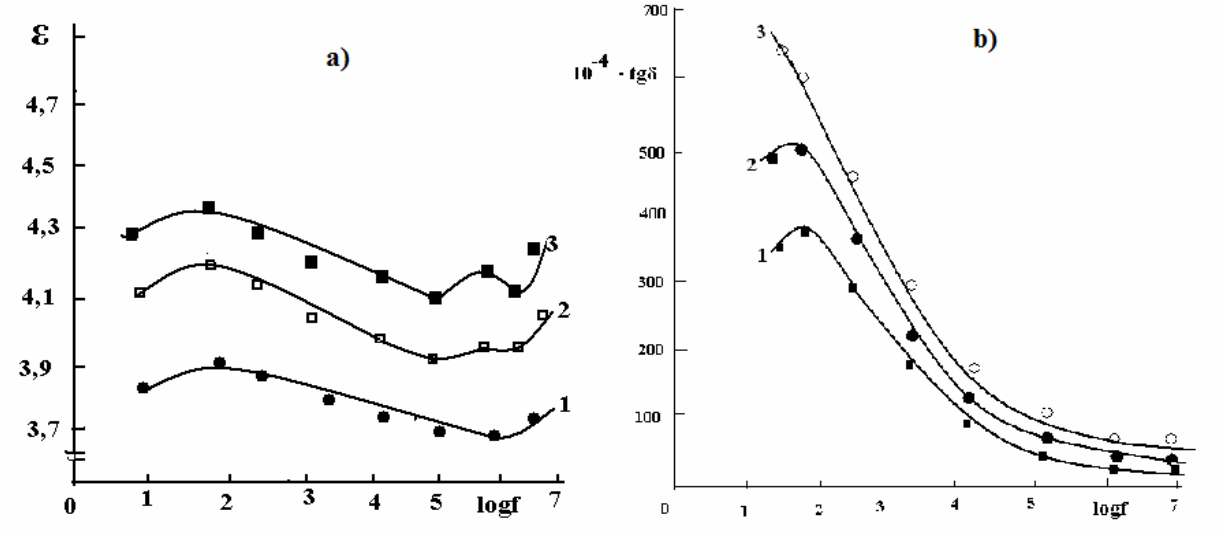
Have been studied dielectric properties of nanocomposite on the basis izotactic propylene, treated by discharge in air quality which is higher than breakdown strength of air and filler CdS, depending on temperature and frequency.

There is on pic.6 dependence of dielectric permeability (ε) and tg of dielectric loss angle ($tg\delta$) on frequency for nanocomposite PP+CdS treated by discharge in various time interval. As it is seen from pic.6 the increasing of frequency the values ε and $tg\delta$ of nanocomposite decrease, the increasing of treatment interval of polymer powder dielectric permeability (ε) and tg of dielectric loss angle ($tg\delta$) increase at that.

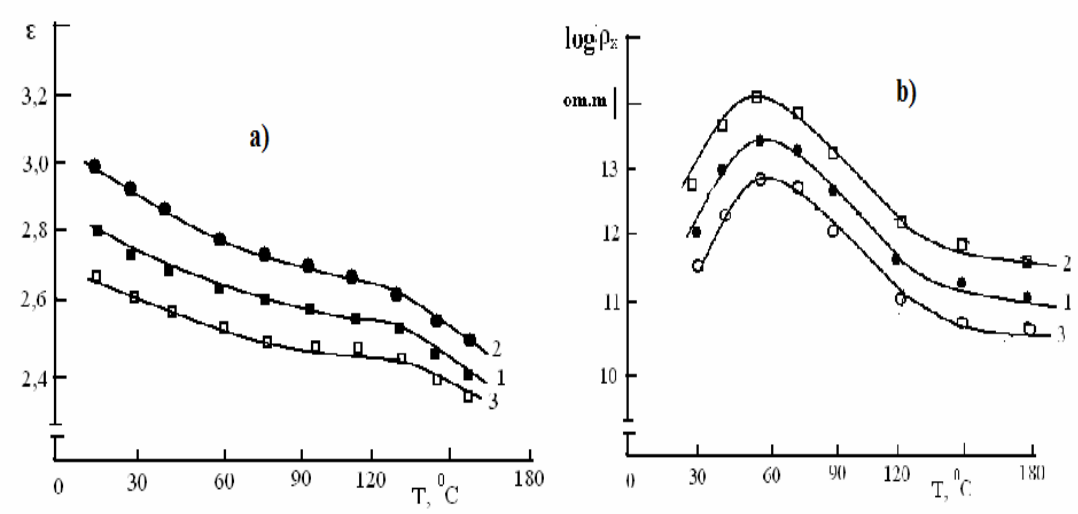
The increasing of ε and $tg\delta$ depending on time interval shows that electric discharge treatment increases the traps concentration, and as a result increases dielectric permeability. Decreasing ε of

nanocomposite with increasing of frequency value is probably connected with deterioration of polarization process.

There is dependence of dielectric permeability (ε) and resistivity on temperature for nanocomposite PP+CdS treated by discharge in various time interval on pic.7. As it is seen the increasing of temperature up to 1350C the values ε decreases slowly, and then quickly, the with increasing of treatment interval of polymer powder dielectric permeability (ε) first increases and then decreases at that. Analogous results are observed depending on $\log \rho_x$ of temperature, i.e. resistivity increases first and then decreases, depending treatment duration



Pic.6 Dependence of dielectric permeability (a) and tg of dielectric loss angle (b) on frequency for nanocomposite PP+CdS 1.PP+CdS untreated by discharge 2.PP+CdS treated in 30 min. 3. PP+CdS treated in 1hour



Pic.7 Dependence of dielectric permeability (a) and resistivity (b) on temperature for nanocomposite PP+CdS 1. PP+CdS untreated by discharge 2. PP+CdS treated in 30 min. 3. PP+CdS treated in 1hour

Changes of ε and $tg\delta$ for PP+CdS, treated by discharge in various time interval, caused by frequency change are connected with deterioration of polarization process, and changes of ε and $tg\delta$,

caused by temperature are connected with changes in supermolecular structure of polymer and interphase interactions between components of boundary layer.

So, we can conclude that boundary phase interactionsin polymeric nanocomposites PP+CdS plays important role on formation of its photoluminiscent properties. It means that it is possible to adjust photoluminiscent properties not only by component and its geometrical parameters matching, but also by impact on conditions of boundary and interphase effects.

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