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Model for Predicting the Concentration of Iron Dissolved during Nitric Acid Leaching of Iron Oxide Ore in Oxalic Acid Solution

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Abstract: Model for predicting the concentration of iron dissolved during nitric acid leaching of iron oxide ore in oxalic acid solution has been derived. The model;

$$\%Fe = 0.0133\left(\frac{\alpha}{\mu}\right)$$

was found to depend on the value of the final solution pH and weight-input of iron oxide ore during the experiment. It was observed that the validity of the model is rooted on the expression $\%Fe = N(\alpha/\mu)$ where both sides of the relationship are correspondingly approximately almost equal. The maximum deviation of the model-predicted dissolved %Fe values from the corresponding experimental values was found to be 30% which is quite within the acceptable range of deviation limit of experimental results. Dissolved iron concentration per unit mass of iron oxide ore input evaluated from experimental and model-predicted results are 0.0058%/g and 0.006%/g respectively, indicating proximate agreement. [New York Science Journal. 2009;2(6):1-12]. (ISSN: 1554-0200).

Keywords: Model, Iron Dissolution, Nitric and Oxalic Acid, Iron Oxide Ore, Leaching.

1. Introduction

The prospect of several organic and inorganic acids in dissolving iron has been evaluated in several studies. Sidhu et al.[1] evaluated the dissolution of iron oxides and oxyhydroxides in hydrochloric and perchloric acids. Lim-Nunez and Gilkes [2] used synthetic metal-containing goethite and haematite in their evaluation while Borghi et al. [3] studied the effect of EDTA and Fe(II) during the dissolution of magnetite. The industrial use of sulphuric acid and other inorganic acids to dissolve iron oxide has not fared too well. Chiarizia and Hotwitz [4] studied the dissolution of goethite in several inorganic acids belonging to the families of the carboxylic and diphosphoric acids in the presence of reducing agents. Ambikadevi and Lalithambika [5] evaluated the effectiveness of several organic acids (such as acetic, formic, citric, ascorbic acids etc.) used for dissolving iron from iron compounds. Oxalic acid was found to be the most promising because of its acid strength, good comlexing characteristics and high reducing power, compared to other organic acids. Using oxalic acid, the dissolved iron can be precipitated from the leach solution as ferrous

oxalate, which can be re-processed to form pure haematite by calcinations [6]. Many researchers have studied the use of oxalic acid to dissolve iron oxide on a laboratory scale [7-13]. Lee et al [14] used 0.19-0.48M oxalic acid to dissolve hydrated iron oxide. Iron dissolution was found [14] to reach 90% for a 20% slurry within 60mins. using 0.19M oxalic for the finer fraction (< 150µm) containing 0.56% Fe_2O_3. The coarser fraction (>150µm) containing 1.06% Fe_2O_3 achieved a lower iron removal, reaching a steady state of only 78% after 1 h of leaching. Although the pH was not measured or controlled, it was expected that the liquor pH is < pH1 at the oxalic acid concentration range studied (0.19-0.48). Taxiarchou et al.[6] found that the maximum iron dissolution of only 40% is within 3 h at temperatures in the range 90-100^{0}C. At 0.5M oxalate and all temperatures (25, 60 and 80^{0}C) the dissolution of iron was faster at a lower pH in the range pH 1-5 studied. Biological processes for iron dissolution have been evaluated by several researchers based on the use of several micro organisms that were easily sourced and isolated. Mandal and Banerjee [15] recently presented their findings on the study of the use of Aspergillus niger and their cultural filtrates for dissolving iron present in iron compounds.

Nwoye [16] derived a model for evaluating the final pH of the leaching solution during leaching of iron oxide ore in oxalic acid solution. The model evaluates the pH value as the sum of two parts, involving the % concentrations of Fe and Fe_2O_3 dissolved. The model can be expressed as;

$$\gamma = 0.5\left(\frac{K_1}{\%Fe} + \frac{K_2}{\%\,Fe_2O_3}\right) \quad (1)$$

Where

K_1 and K_2 = dissolution constants of Fe and Fe_2O_3 respectively.

γ = final pH of leaching solution (after time t).

It was also found that the model [16] could predict the concentration of Fe or Fe_2O_3 dissolved in the oxalic acid solution at a particular final solution pH by taking Fe or Fe_2O_3 as the subject formular. The prevailing process conditions under which the model works include: leaching time of 30mins., constant leaching temperature of 30^{o}C, average ore grain size; 150µm and 0.1M oxalic acid.

Nwoye [17] has reported that the heat absorbed by oxalic acid solution during leaching of iron oxide ore can be predicted using the model he derived which works under the process condition; initial pH 6.9, average ore grain size; 150µm and leaching temperature; 30^{0}C. The model [17] can be stated as

$$Q = K_N\left(\frac{\gamma}{\%Fe_2O_3}\right) \quad (2)$$

Where

Q = Quantity of heat absorbed by oxalic acid solution during the leaching process. (J)

γ = Final pH of the leaching solution (at time t).

$\%Fe_2O_3$= Concentration of haematite dissolved in oxalic acid solution during the leaching process.

K_N = 4.57(Haematite dissolution constant in oxalic acid solution) determined in the experiment [17].

Nwoye [17] carried out further work on the model using the same process conditions and observed that on re-arranging the model as;

$$\%Fe_2O_3 = K_N\left(\frac{\gamma}{Q}\right) \quad (3)$$

the concentrations of haematite predicted deviated very insignificantly from the corresponding experimental values. In this case, the value of Q was calculated by considering the specific heat capacity of oxalic acid. Values of heat absorbed by the oxalic acid solution during the leaching of iron oxide ore as predicted by the model [17] agree with the experimental values that the leaching process is endothermic. This is because all the predicted values of the heat absorbed by the oxalic acid solution were positive. The model shows that the quantity of heat absorbed by oxalic acid solution during the leaching process is directly proportional to the final pH of the solution and inversely proportional to the concentration of haematite dissolved.

Nwoye et al.[18] derived a model for calculating the concentration of leached iron during leaching of iron oxide ore in sulphuric acid solution. The model is expressed as;

$$\%Fe = e^{-2.0421(\ln T)} \quad (4)$$

The model was found to predict %Fe (leached) very close to the values obtained from the experiment, being dependent on the values of the final leaching solution temperature measured during the leaching process. It was observed that the validity of the model is rooted in the expression ln(%Fe) = N(InT) where both sides of the expression are correspondingly approximately equal. The positive or negative deviation of each of the model-predicted values of %Fe (leached) from those of the experimental values was found to be less than 37%.

Nwoye et al.[19] derived a model for predicting the final solution pH at determined initial pH and leaching time during leaching of iron oxide ore in hydrogen peroxide solution. It was observed that the validity of the model is rooted in the mathematical expression; $(\ln t)^{1/2} = N(\beta^C/\alpha^C)$ where both sides of the relationship are approximately equal to 2. The model is expressed as;

$$\beta = \text{Antilog}[0.2439\text{Log}(\alpha^{4.1}(\ln t)^{1/2}/3.6)] \quad (5)$$

The model shows that the initial solution pH is dependent on the values of the final solution pH and leaching time. The respective positive or negative deviation of the model-predicted final pH from its corresponding experimental value was found to be less than 8%, which is quite within the acceptable deviation limit of experimental results depicting the validity of the model.

Model for predictive analysis of the concentration of dissolved iron during leaching of iron oxide ore in sulphuric acid solution was derived by Nwoye et al.[20]. The model expressed as;

$$\%Fe = 0.987(\mu/T) \quad (6)$$

was found to predict %Fe dissolved with high degree of precision being dependent on the values of the leaching temperature and weight of iron oxide ore added. It was observed that the validity of the model is rooted in the expression %Fe = N(μ/T) where both sides of the relationship are correspondingly approximately equal. The positive or negative deviation of each of the model-predicted values of %Fe

(dissolved) from those of the experimental values was found to be less than 19% which is quite within the acceptable range of deviation limit for experimental results, hence depicting the usefulness of the model as a tool for predictive analysis of the dissolved iron during the process.

Model for calculating the solution pH during hydrogen peroxide leaching of iron oxide ore has also been derived by Nwoye et al [21]. It was observed that the validity of the model is rooted in the expression $In\gamma = K_C[(\%Fe_2O_3/\%Fe)^N]$ where both sides of the equation are correspondingly approximately equal to 2. The model expressed as;

$$\gamma = \exp\left[K_C[(\%Fe_2O_3/\%Fe)^N]\right] \qquad (7)$$

The final solution pH was found to depend on the values of the % concentrations of dissolved iron and haematite from experiment. The respective deviation of the model-predicted pH values from the corresponding experimental values was found to be less than 20% which is quite within the acceptable range of deviation limit of experimental results.

The aim of this work is to derive a model for predicting the concentration of iron dissolved during nitric acid leaching of Agbaja (Nigeria) iron oxide ore in oxalic acid solution.

2. Model

During the leaching process, the iron ore (being in solid phase) was assumed to be stationary. The leaching occurs as a result of the attack on the ore by hydrogen ions from the nitric and oxalic acid within the liquid phase (in the presence of oxygen).

2.1 Model Formulation

Results of previous research work [22] carried out were used for this work.

Statistical and computational analysis of these results [22] presented in Table 1, gave rise to Table 2 which indicate that;

$$\%Fe = N\left(\frac{\alpha}{\mu}\right) \quad \text{(approximately)} \qquad (8)$$

Introducing the value of N into equation (8)

$$\%Fe = 0.0133\left(\frac{\alpha}{\mu}\right) \qquad (9)$$

Where

%Fe = Concentration of dissolved iron during the leaching process.

N = 0.0133 (Oxalic-nitric acid leachibility ratio during leaching of iron oxide ore) determined in the experiment [22].

(μ) = Weight-input of iron oxide ore during the leaching process.(g)

(α) = Final pH of leaching solution at the time t, when %Fe is evaluated.

Equation (9) is the derived model**.**

Table 1: Variation of concentration of dissolved iron with weight-input of iron oxide ore and final solution pH.[22]

%Fe	(μ)	(α)
0.0377	2	6.10
0.0304	3	5.82
0.0193	4	5.80
0.0185	5	5.76
0.0098	6	5.71
0.0087	7	5.64

Table 2: Variation of %Fe with N(α/μ)

%Fe	N(α/μ)
0.0377	0.0406
0.0304	0.0258
0.0193	0.0193
0.0185	0.0153
0.0098	0.0127
0.0087	0.0107

3. Boundary and Initial Condition

In a cylindrical flask of height; 30cm, iron oxide ore was placed prior to the addition of nitric and oxalic acid which were used as leaching solutions. Initially, the flask was assumed to be free of bacteria and other micro organisms. It was assumed that atmospheric oxygen affected the process initially. Weights input of iron oxide ore considered for the work ranged from 2-7g. Other process conditions used include: initial pH of leaching solution; 6.0, leaching time; 30 minutes, leaching temperature of 25^{o}C, average ore grain size; 150μm, nitric and oxalic acid concentrations at 0.08 and 0.05mol/litre respectively.

The boundary conditions considered for the model formulation were: assumption of a zero gradient for the liquid scalar and also gas phase at the top of the particles. It was also assumed that atmospheric oxygen interacted with the non flowing leaching solution and also with the top and bottom part of the ore particles (which were in the gas and liquid phases respectively). The sides of the particles were assumed to be symmetrical. These process conditions are presented in details in the report [22].

4. Model Validation

The validity of model was established by calculating the deviation of the model-predicted %Fe values from values obtained from the experimental work [22] carried out.

It was believed that deviations of model-predicted %Fe values from the corresponding experimental values resulted from non-consideration (during model formulation) of the surface properties of the ore and the physiochemical interactions between the ore and leaching solution which were found to have played

vital roles during the leaching process [22]. Based on the foregoing, it is expected that a correction factor be added to the model-predicted values to make up for those factor neglected during the model formulation.

The deviation (Dv) (%) of model-predicted %Fe values from the corresponding experimental %Fe values is expressed as;

$$Dv = \frac{Pv - Ev}{Ev} \times 100 \quad (10)$$

Where Pv = Model- predicted %Fe values
Ev = Experimental %Fe values

On the other hand, correction factor (Ct) is expressed as the negative of the deviation. Therefore

$$Ct = -Dv \quad (11)$$

Substituting equation (10) into equation (11)

$$Ct = -100\left(\frac{Pv - Ev}{Ev}\right) \quad (12)$$

Addition of Ct values obtained from equation (12) to the model-predicted values of %Fe gives exactly %Fe values as obtained from the experiment [22].

5. Results and Discussion

The derived model is equation (9).

Dissolution of iron per unit mass of iron oxide ore added during the leaching process was determined following comparison of the dissolved iron per unit mass of iron oxide ore obtained by calculations involving experimental results, and that obtained directly from the model.

Dissolution of iron per unit mass of iron oxide ore added, D_i (%/g) was calculated from the equation;

$$D_i = D/\mu \quad (13)$$

Therefore, a plot of concentration of dissolved iron against the mass of iron oxide ore added, as in Fig. 1 using experimental results in Table 1, gives a slope, S at points (2, 0.0377) and (7, 0.0087) following their substitution into the mathematical expression;

$$S = \Delta D/\Delta\mu \quad (14)$$

Eqn. (14) is detailed as

$$S = D_2 - D_1/ \mu_2 - \mu_1 \quad (15)$$

Where

ΔE = Change in the concentrations of iron dissolved D_2, D_1 at two different weight-input values μ_2, μ_1. Considering the points (2, 0.0377) and (7, 0.0087) for (μ_1, D_1) and (μ_2, D_2,) respectively, and substituting them into eqn. (15), gives the slope as -0.0058%/g which is the concentration of dissolved iron per unit mass of iron oxide ore used during the actual experimental leaching process. Also similar plot (as in Fig. 2) using model-predicted results gives a slope. Considering points (2, 0.0406) and (7, 0.0107) for (μ_1, D_1) and (μ_2, D_2,) respectively and substituting them into eqn. (15) gives the value of slope, S as -0.0060%/g. This is the model-predicted concentration of dissolved iron per unit mass of iron oxide ore used for the leaching process. The negative sign preceding both 0.0058 and 0.0060 is not part of the values of the concentrations of dissolved iron per unit mass of iron oxide ore

used as obtained from the experiment [22] and derived model but indicative of the inverse relationship between the concentrations of dissolved iron and the weight–input of iron oxide ore as obtained in the experiment [22] and the derived model which resulted to negative slopes. A comparison of these two values of dissolved iron concentrations per unit mass of iron oxide ore used shows proximate agreement. This indicates a very high degree of validity for the model.

An ideal comparison of the concentration of dissolved iron per unit mass of iron oxide ore used as obtained from experiment and as predicted by the model for the purpose of testing the validity of the model is achieved by considering the R^2 values. The values of the correlation coefficient, R calculated from the equation;

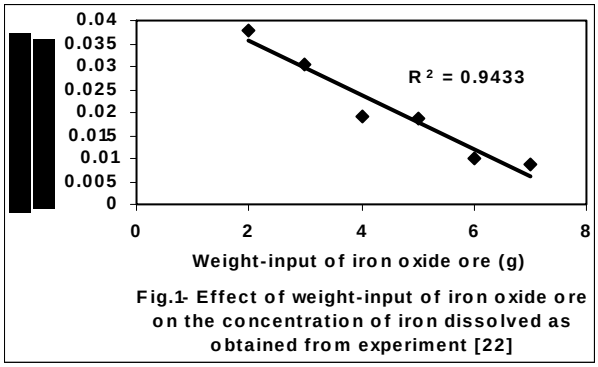

Fig.1- Effect of weight-input of iron oxide ore on the concentration of iron dissolved as obtained from experiment [22]

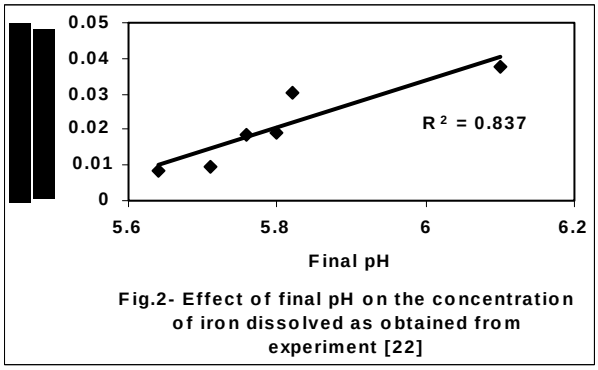

Fig.2- Effect of final pH on the concentration of iron dissolved as obtained from experiment [22]

$$R = \sqrt{R^2} \qquad (16)$$

using the r-squared values (coefficient of determination) from Figs.1-4 show a very close correlation;(0.9712),(0.9149) and (0.9276),(0.9778) between values of the concentration of dissolved iron obtained from experiment and derived model respectively. This also shows that the model- predicted concentrations of dissolved iron are very much in proximate agreement with the corresponding dissolved iron concentration obtained from experiment [22]. Fig.4 shows that final pH contributed more significantly to the validity of the model compared with the weight-input of iron oxide ore (Fig.3). This is shown in their respective R^2 values.

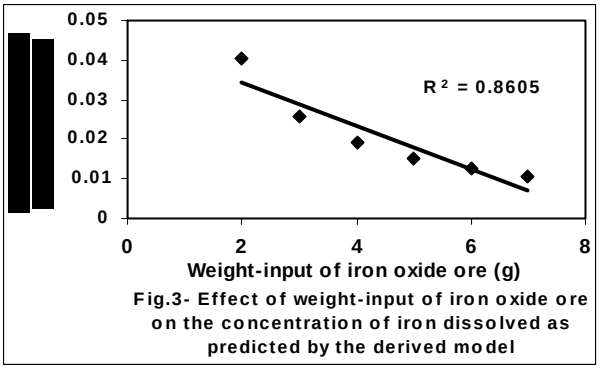

Fig.3- Effect of weight-input of iron oxide ore on the concentration of iron dissolved as predicted by the derived model

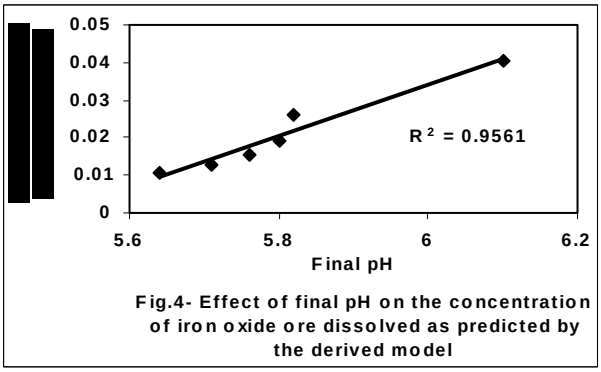

Fig.4- Effect of final pH on the concentration of iron oxide ore dissolved as predicted by the derived model

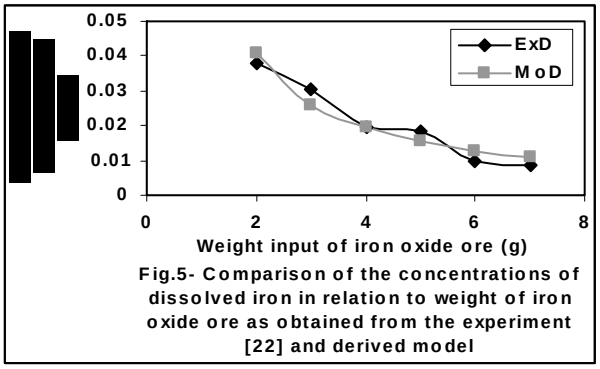

Fig.5- Comparison of the concentrations of dissolved iron in relation to weight of iron oxide ore as obtained from the experiment [22] and derived model

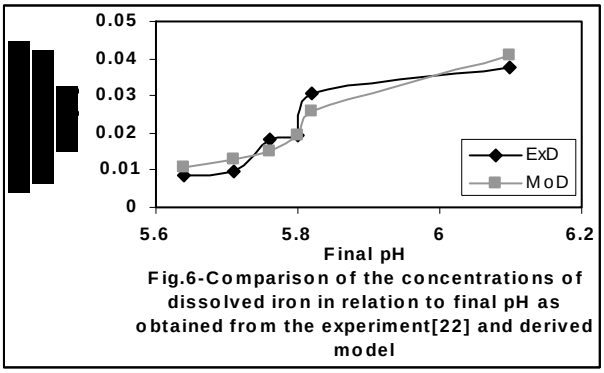

Fig.6-Comparison of the concentrations of dissolved iron in relation to final pH as obtained from the experiment[22] and derived model

Effect of final solution pH and weight-input of iron oxide ore on the deviation (from experimental values) of model-predicted concentration of dissolved iron

Comparison of Figs. 5 and 6 show that both values of the dissolved iron concentration obtained from the experiment [22] (line ExD) and the derived model (line MoD) in relation to both the weight-input of iron oxide ore and final solution pH are generally quite close hence depicting the reliability and validity of the model. However, Fig.5 and 6 show inverse and direct relationship respectively in agreement with Table 1 which is made up of data from the experiment [22].

It was found that the validity of the model is rooted in the expression %Fe = N(α/μ) where both sides of the expression are correspondingly approximately almost equal. Table 2 also agrees with equation (8) following the values of %Fe = N(α/μ) evaluated from Table 1 as a result of the corresponding computational analysis. The maximum deviation of the model-predicted concentration of dissolved iron from the corresponding experimental value is 30% which is quite within the acceptable deviation range of experimental results, hence depicting the usefulness of the model. The positive and negative deviations (of the model-predicted concentration of dissolved iron) from actual experimental values show distinct undulating relationship with the final solution pH, the weight-input of iron oxide ore and the actual concentration of dissolved iron (Figs.7- 9).

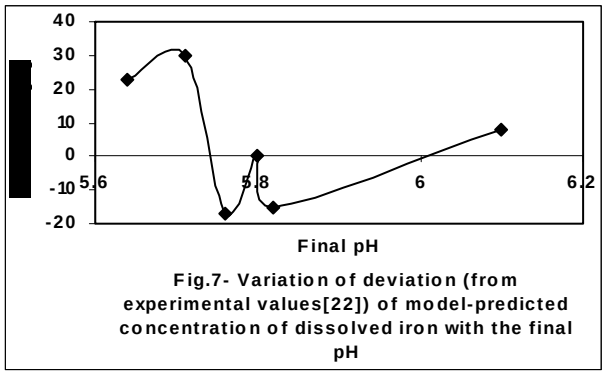

Fig.7- Variation of deviation (from experimental values[22]) of model-predicted concentration of dissolved iron with the final pH

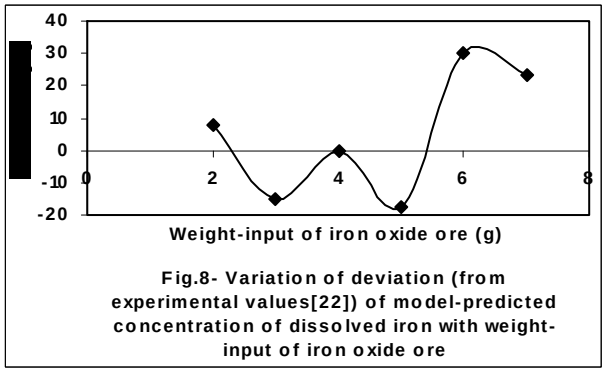

Fig.8- Variation of deviation (from experimental values[22]) of model-predicted concentration of dissolved iron with weight-input of iron oxide ore

Figs.7-9 indicate that the highest and least deviations (30 and 7.7%) which are same in relation to both the final solution pH obtained (at the end of the leaching process) and the weight-input of iron oxide ore corresponds to the model-predicted dissolved iron concentrations 0.0127 and 0.0406% respectively.

Comparison of Figs. 7-8 shows that these percent deviations also correspond to the final solution pH; 5.71 and 6.1 and also iron oxide ore weight-input; 6 and 2g respectively.

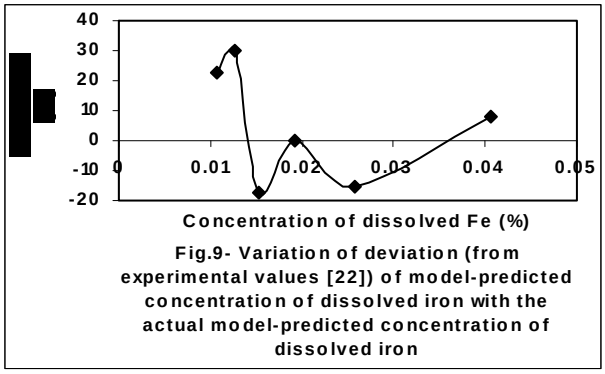

Fig.9- Variation of deviation (from experimental values [22]) of model-predicted concentration of dissolved iron with the actual model-predicted concentration of dissolved iron

Effect of final solution pH and weight-input of iron oxide ore on the correction factor to the model-predicted concentration of dissolved iron

Figs. 10 and 11 also show that correction factor to the model-predicted concentration of dissolved iron depict an undulating relationship with the final solution pH and weight-input of iron oxide ore. Figs.3, 4, 10 and 11 indicate that the highest and least correction factors (-30 and -7.7%) which are same in relation to both the final solution pH obtained (at the end of the leaching process) and the weight-input of iron oxide ore also corresponds to the dissolved iron concentrations 0.0127 and 0.0406% respectively.

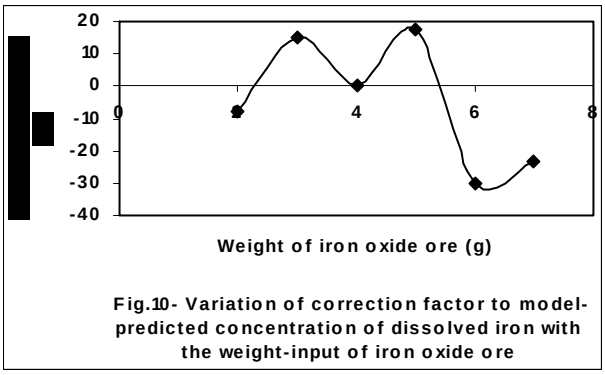

Fig.10- Variation of correction factor to model-predicted concentration of dissolved iron with the weight-input of iron oxide ore

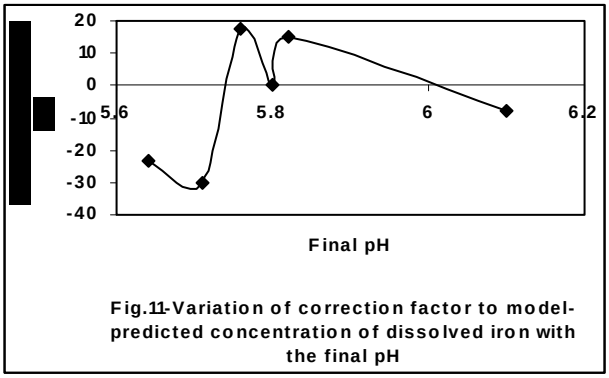

Fig.11-Variation of correction factor to model-predicted concentration of dissolved iron with the final pH

The percent correction factors also correspond to the final solution pH; 5.71 and 6.1 as well as iron oxide ore weight-input; 6 and 2g respectively.

Comparison of Figs.7, 8, 10 and 11 shows that the orientation of the curves of the correction factor against final pH and weight-input of iron oxide ore are opposite that of the deviation against final pH and weight-input of iron oxide ore . This is attributed to the fact that correction factor is the negative of the deviation as shown in eqns. (11) and (12). It is believed that the correction factor takes care of the effects of the surface properties of the ore and the physiochemical interaction between the ore and the leaching solution which (affected experimental results) were not considered during the model formulation.

6. Conclusion

The model predicts the concentration of iron dissolved during nitric acid leaching of iron oxide ore in oxalic acid solution. The validity of the model is rooted on the expression $\%Fe = N(\alpha/\mu)$ where both sides of the expression are correspondingly approximately almost equal. The maximum deviation of the model-predicted %Fe values from the corresponding experimental %Fe values is 30% which is quite within the acceptable range of deviation limit of experimental results. The two values of dissolved iron concentrations per unit mass of iron oxide ore used as obtained from experiment and derived model show proximate agreement hence indicating a very high degree of validity for the model.

It is expected that more process parameters should be incorporated into the model in further works with the aim of reducing the deviations of the model-predicted %Fe values from those of the experiment.

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Model for Computational Analysis of the Concentration of Phosphorus Removed during Leaching of Iron Oxide Ore in Oxalic Acid Solution

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Abstract: Model for computational analysis of the concentration of phosphorus removed (relative to the final pH of leaching solution) during leaching of iron oxide ore in oxalic acid solution has been derived. The model; $P = e^{[1.2\alpha]}$ was found to be dependent on the value of the final solution pH measured during the leaching process. It was observed that the validity of the model is rooted on the expression $\ln P = N\alpha$ where both sides of the relationship are generally approximately equal to 4. The maximum deviation of the model-predicted concentration of dissolved phosphorus from the corresponding experimental values is 22.87% which is quite within the acceptable range of deviation limit of experimental results. Dissolved phosphorus concentration per unit mass of iron oxide ore input evaluated from experimental and model-predicted results are 6.3625 mg/kg/g and 6.7188 mg/kg/g respectively, indicating proximate agreement. [New York Science Journal. 2009;2(6):13-23]. (ISSN: 1554-0200).

Keywords: Model, Phosphorus Dissolution, Oxalic Acid, Iron Oxide Ore, Leaching.

1. Introduction

Lee et al. [1] reported that the leaching of 3g/L pure haematite (98.2% purity, 105-140µm size range) using 0.048-0.48M oxalic acid at 80-100^{0}C passed through a maximum peak at pH 2.5. Dissolution of haematite was found [1] to be slower than magnetite ($FeO.Fe_2O_3$) and other hydrated iron oxide such as goethite (α-FeOOH), lapidochrosite (γ-FeOOH) and iron hydroxide ($Fe(OH)_3$).

The dissolution of iron oxide is believed to take place via a photo-electro chemical reduction process, involving a complicated mechanism of charge transfer between the predominant oxalate species, namely ferric oxalate $Fe(C_2O_4)_3^{3-}$, ferrous oxalate $Fe(C_2O_4)_2^{2-}$ acting also as an auto catalyst, and the oxalate ligand on the iron oxide surface [2].

The dissolution of iron oxides in oxalic acid was found to be very slow at temperatures within the range 25-60^{o}C, but its rate increases rapidly above 90^{o}C [3]. The dissolution rate also increases with increasing oxalate concentration at the constant pH values set within the optimum range of pH 2.5-3.0. At this optimum pH, the dissolution of fine pure haematite (Fe_2O_3) (105-140µm) follows a diffusion-controlled shrinking core model [3].

Taxiarchour et al [4] reported that it took close to 40h to dissolve 80% of pure haematite slurry (97% purity, 0.022% w/v or 0.21% g/L Fe_2O_3) at pH 1. He stated that even at 90^{0}C, it required close to 10h to achieve 95% dissolution of iron of the slurry at pH 1. They also dissolved iron using 0.1-0.5M oxalic acid (pH1-5) to dissolve iron from a 20% w/v slurry (83% of particle size in the range 0.18-0.35mm, containing 0.029% Fe_2O_3). The iron oxide concentration in the leach is equivalent to 0.058g/L Fe_2O_3.

The speciation of Fe(III) oxalate and Fe(II) oxalate has been found [5] to be governed by pH and total oxalate concentration. For a having pH › 2.5 and an oxalate concentration higher than 0.1M, the most predominant Fe(III) complex ion existing is $Fe(C_2O_4)^{3-}_3$. At these conditions, (pH › 2.5 and an oxalate concentration higher than 0.1M) the predominant Fe(II) complex species is $Fe(C_2O_4)^{2-}_2$.

Nwoye [6] derived a model for quantitative analysis of dissolved iron in oxalic acid solution in relation to the final pH of the solution during leaching of iron oxide ore;

$$\gamma = 0.5\left(\frac{K_1[\%Fe_2O_3]+K_2[\%Fe]}{[\%Fe][\%Fe_2O_3]}\right) \quad (1)$$

Where

K_1 and K_2 = Dissolution constants of Fe and Fe_2O_3 respectively.

γ = pH of leaching solution after time t (mins.).

The values of the dissolution constants compared with those of % Fe and % Fe_2O_3 from the experiment [6] indicate clearly that the constants K_1 and K_2 are numerical equivalence of the chemical resistance to the dissolution of Fe and Fe_2O_3 (respectively) in oxalic acid solution. It was found that $K_1 \approx 2K_2$ indicating twice chemical resistance to the dissolution Fe compare to that of Fe_2O_3. This expression agreed with the higher percentage of Fe_2O_3 dissolved compared to that of the corresponding Fe. The model also predicted the final pH of the leaching solution when the concentrations of Fe and Fe_2O_3 dissolved (at a temperature of 30^0C and average ore grain size; 150μm) are known.

Nwoye et al [7] derived a model for predicting the concentration of dissolved iron during leaching of iron oxide ore in sulphuric acid solution. The model is stated as;

$$\%Fe = 0.35(\alpha/T)^3 \quad (2)$$

Where

T = Solution temperature at the time t, when the concentration of dissolved iron is evaluated. (^{0}C)

0.35= (pH coefficient for iron dissolution in sulphuric acid solution during the leaching process) determined in the experiment [7].

α = Final pH of the leaching solution at the time t, when the concentration of dissolved iron is evaluated.

The model (formulated at conditions; leaching temperature of 25^0C, initial solution pH 5.0 and average grain size; 150μm) is dependent of the final pH and temperature of the leaching solution. The model shows that the concentration of iron dissolved during the leaching process is directly proportional to the third power of the ratio of final leaching and temperature.

Final pH of leaching solution has been found to depend on the leaching time, initial pH for the leaching solution and the leaching temperature [8,9].

Models for computational analysis of the concentration of dissolved haematite and heat absorbed by oxalic acid solution during leaching of iron oxide ore have been derived [10]. These models are:

$$\%Fe_2O_3 = K(\gamma/\mu) \quad (3)$$

$$Q = K_C \mu \quad (4)$$

Where

$\%Fe_2O_3$ = Concentration of dissolved haematite in oxalic acid solution.

γ = Final pH of the leaching solution at time t at which $\%Fe_2O_3$ was obtained.

μ = Weight of iron oxide added into the oxalic acid leaching solution (g)

K = Constant of proportionality associated with haematite dissolution

K_C = Constant of proportionality associated with heat absorption

Q = Quantity of heat absorbed by oxalic acid solution during the leaching process (J)

Nwoye [10] found that optimization of the weight input of iron oxide ore could be achieved using the model; ($\%Fe_2O_3 = K(\gamma/\mu)$) by comparing the concentrations of dissolved haematite at different weights input of the iron oxide ore, with the view to identifying the optimum weight input of iron oxide ore that gives the maximum dissolution of Fe_2O_3. The model also indicates that the concentration of haematite dissolved during the leaching process is directly proportional to the final pH of the leaching solution and inversely proportional to the weight input of the iron oxide ore.

It was also found [10] that values of Q obtained from both the experiment and model ($Q = K_C \mu$) agree to the fact that leaching of iron oxide ore using oxalic acid solution is an endothermic process, hence the absorbed positive heat energy by the leaching solution. The quantity of heat energy absorbed by the oxalic acid solution during the leaching process (as calculated from the model; $Q = K_C \mu$) was found to be directly proportional to the weight input of the iron oxide ore. These results were obtained at initial pH 6.9, average grain size of 150μm and leaching temperature of 30^0C. The constants of proportionality K and K_C associated with the respective derived models were evaluated to be 0.0683 and 66.88 respectively.

Several works [11-16] have been carried out to remove phosphorus from steel during steel making. All these works carried out, pointed out low treatment temperature and high oxygen activity as the only

essential and unavoidable process conditions which can enhance the rate of dephosphorization. High activity of CaO; a product of decomposition of $CaCO_3$ and a slag forming material is required for enhancement of the dephosphorization process with the phosphorus forming part of the slag. This process involves pyrometallurgy and is capital intensive.

It has been reported [17] that the removal of phosphorus from iron can be achieved only by oxidation during steel making, under a basic slag.

Nwoye [18] derived a model for predicting the time for dissolution of pre-quantified concentration of phosphorus during leaching of iron oxide ore in oxalic acid solution as:

$$\tau = \text{Log}\left(\frac{\left(\frac{P^{1/4}}{1.8}\right)}{\text{LogT}}\right) \qquad (5)$$

Where

T= Leaching temperature (^{0}C) in the experiment [19], taken as specified leaching temperature (^{0}C) aiding the expected dissolution of phosphorus .

N= 1.8 (Dissolution coefficient of phosphorus in oxalic acid solution during leaching of iron oxide ore) determined in the experiment [19].

P = Concentration of dissolved phosphorus (mg/Kg) in the experiment [19], taken as pre-quantified concentration of phosphorus expected to dissolve after a leaching time t (mg/Kg) in the model.

τ = Leaching time (sec.) in the experiment [19], taken as time for dissolution of the pre-quantified concentration of phosphorus (hrs) in the model.

The model was found to depend on a range of specified leaching temperatures (45-70^{0}C) for its validity. It was found [19] that the time for dissolution of any given concentration of phosphorus decreases with increase in the leaching temperature (up to 70^{0}C), at initial pH 5.5 and average grain size of 150μm.

Nwoye et al. [20] also formulated a model for predicting the concentration of phosphorus removed during leaching of iron oxide ore in oxalic acid solution. The model is expressed as;

$$P = 150.5/\mu\alpha \qquad (6)$$

It was found to predict the removed phosphorus concentration, with utmost dependence on the final pH of the leaching solution and weight input of the iron oxide ore. The model indicates that the concentration of phosphorus removed is inversely proportional to the product of the weight input of the iron oxide ore and the final pH of the leaching solution. Process conditions considered during the formulation of the model [20] include: leaching temperature of 25^{0}C, initial solution pH 5.5 and average ore grain size; 150μm).

Nwoye [21] derived a model for the evaluation of the concentration of dissolved phosphorus (relative to the final pH of the leaching solution) during leaching of iron oxide ore in oxalic acid solution. It was observed that the validity of the model is rooted in the relationship $\ln P = N/\alpha$ where both sides of the expression are approximately equal to 4. The model expressed as;

$$P = e^{(12.25/\alpha)} \qquad (7)$$

depends on the value of the final pH of the leaching solution which varies with leaching time. In all, the positive or negative deviation of the model-predicted phosphorus concentration from its corresponding value obtained from the experiment was found to be less than 22%.

Nwoye [22] also derived a model for predicting the concentration of phosphorus removed during leaching of iron oxide ore in oxalic acid solution. The model is expressed as;

$$P = [(1.8(T)^{\tau})]^4 \qquad (8)$$

was found to be dependent on leaching temperature ranging from 45-70^{0}C and specified leaching time of 0.1381hr (497secs.) recorded during experiment, for its validity. It was found that the validity of the model is rooted in the expression $(P^{1/4})/N = (T)^{\tau}$ where both sides of the expression are correspondingly almost equal. The maximum deviation of the model-predicted values of P from the corresponding experimental values was found to be less than 29% which is quite within the range of acceptable deviation limit of experimental results.

Biological processes for phosphorus removal have also been evaluated based on the use of several types of fungi, some being oxalic acid producing. Anyakwo and Obot [23] recently presented their results of a study on the use of Aspergillus niger and their cultural filtrates for removing phosphorus from Agbaja (Nigeria)

iron oxide ore. The results of this work [23] show that phosphorus removal efficiencies at the end of the 49 days of the leaching process are 81, 63 and 68% for 5, 100 and 250 mesh grain sizes respectively.

An attempt has been made in the past [24] to leach Itakpe iron oxide ore using oxalic acid solution in order to determine the maximum concentration of phosphorus that is removable. Results of chemical analysis of the ore indicate that the percentage of phosphorus in the ore is about 1.18%, which from all indication is quite high and likely to affect adversely the mechanical properties of the steel involved; hence the need for dephosphorization. It was reported [24] that phosphorus can be removed from iron oxide ore through a process associated with hydrometallurgy. Phosphorus was removed at a temperature of 25^0C and initial solution pH 2.5, leading to the dissolution of the phosphorus oxide formed. This involved using acid leaching process to remove phosphorus from the iron oxide ore in readiness for steel making process.

The aim of this work is to derive a model for computational analysis of the concentration of phosphorus removed relative to the final leaching solution pH during leaching of Itakpe (Nigeria) iron oxide ore in oxalic acid solution. This derivation is embarked on in furtherance of the previous work [25].

2. Model

The ore is assumed to be stationary in the reaction vessel during the leaching process and contains the un-leached iron as part of reaction remnants. The ore is attacked by hydrogen ions from oxalic acid within the liquid phase, and in the presence of oxygen.

2.1 Model Formulation

Results from experimental work [25] carried out at SynchroWell Research Laboratory, Enugu were used for the model derivation. These results are as presented in Table 1.

Computational analysis of these experimental results [25] shown in Table 1, resulted to Table 2 which indicate that;

$$\ln P = N\alpha \quad \text{(approximately)} \qquad (9)$$

$$P = e^{N\alpha} \qquad (10)$$

Introducing the value of N into equation (10)

$$P = e^{[1.2\alpha]} \qquad (11)$$

Where

P = Concentration of phosphorus removed during the leaching process (mg/Kg)

N= 1.2; (Dissolution coefficient of phosphorus in oxalic acid solution) determined in the experiment[25].

α = Final pH of the leaching solution at the time t when the concentration of dissolved phosphorus is evaluated.

Equation (11) is the derived model**.**

Table1: Variation of weight-input of iron oxide ore and final pH of leaching solution with concentration of phosphorus removed.[25]

M (g)	(α)	P (mg/Kg)
4	3.19	59.60
6	3.20	45.60
8	3.29	44.20
10	3.45	51.31
12	3.49	60.80
14	3.84	96.50

M = Mass of iron oxide ore used for the leaching process

Table2: Variation of lnP with Nα

lnP	Nα
4.0877	3.8280
3.8200	3.8400
3.7887	3.9480
3.9379	4.1400
4.1076	4.1880
4.5695	4.6080

3. Boundary and Initial Condition

Iron oxide ore was placed in cylindrical flask 30cm high containing leaching solution of oxalic acid. The leaching solution is non flowing (stationary). Before the start of the leaching process, the flask was assumed to be initially free of attached bacteria and other micro organism. Initially, the effect of oxygen on the process was assumed to be atmospheric. Range of weight of iron oxide ore used; 2-14g. Initial pH of leaching solution used; 2.5 and leaching time of 3 hrs were used for all samples. A constant leaching temperature of 25^{o}C was used. Oxalic acid concentration at 0.1mol/litre and average ore grain size;150µm were also used. Details of the experimental technique are as presented in the report [25].

The leaching process boundary conditions include: atmospheric levels of oxygen (considering that the cylinder was open at the top) at both the top and bottom of the ore particles in the gas and liquid phases respectively. A zero gradient was assumed for the liquid scalar at the bottom of the particles and for the gas phase at the top of the particles. The sides of the particles were assumed to be symmetries.

4. Model Validation

The formulated model was validated by calculating the deviation of the model-predicted concentration of phosphorus removed from the corresponding experimental values.

The deviation recorded is believed to be due to the fact that the surface properties of the ore and the physiochemical interactions between the ore and leaching solution which were found to play vital roles during the leaching process [25] were not considered during the model formulation. It is expected that introduction of correction factor to the predicted concentrations of P, gives exactly the experimental values of P.

Deviation (Dv) (%) of model- predicted P values from experimental P values is given by

$$Dv = \left(\frac{P_P - P_E}{P_E} \right) x\ 100 \qquad (12)$$

Where Pp = Predicted P values

P_E = Experimental P values

Since correction factor (Cr) is the negative of the deviation,

$$Cr = - Dv \qquad (13)$$

Substituting equation (12) into equation (13) for Dv,

$$Cr = -100\left(\frac{P_P - P_E}{P_E} \right) \qquad (14)$$

It was observed that addition of the corresponding values of Cr from equation (14) to the model-predicted concentrations of P gave exactly the corresponding experimental P values.[25]

5. Results and Discussion

The derived model is equation (11).

Dissolution of phosphorus per unit mass of iron oxide ore added during the leaching process was determined following comparison of the dissolved phosphorus per unit mass of iron oxide ore obtained by calculations involving experimental results, and that obtained directly from the model.

Dissolution of phosphorus per unit mass of iron oxide ore added, D_i (mg/kg/g) was calculated from the equation;

$$D_i = D/\mu \qquad (15)$$

Therefore, a plot of concentration of dissolved phosphorus against the mass of iron oxide ore added, as in Fig. 1 using experimental results in Table 1, gives a slope, S at points (6, 45.6) and (14, 96.5) following their substitution into the mathematical expression;

$$S = \Delta D/\Delta\mu \qquad (16)$$

Eqn. (16) is detailed as

$$S = D_2 - D_1/ \mu_2 - \mu_1 \qquad (17)$$

Where

ΔE = Change in the concentrations of iron dissolved D_2, D_1 at two different weight-input values μ_2, μ_1. Considering the points (6, 45.6) and (14, 96.5) for (μ_1, D_1) and (μ_2, D_2,) respectively, and substituting them into eqn. (17), gives the slope as 6.3625mg/kg/g which is the concentration of dissolved phosphorus per unit mass of iron oxide ore used during the actual experimental leaching process. Also similar plot (as in Fig. 2) using model-predicted results gives a slope. Considering points (6, 46.53) and (14, 100.28) for (μ_1, D_1) and (μ_2, D_2,) respectively and substituting them into eqn. (17) gives the value of slope, S as 6.7188mg/kg/g. This is the model-predicted concentration of dissolved phosphorus per unit mass of iron oxide ore used for the leaching process. A comparison of these two values of dissolved phosphorus concentrations per unit mass of iron oxide ore used shows proximate agreement. This indicates a very high degree of validity for the model. An ideal comparison of the concentration of dissolved phosphorus per unit mass of iron oxide ore used as obtained from experiment and as predicted by the model for the purpose of testing the validity of the model is achieved by considering the R^2 values.

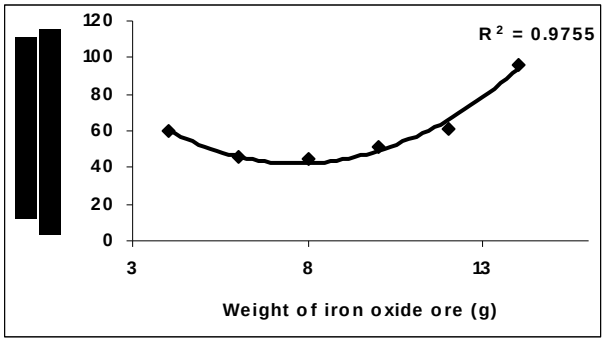

Fig.1-Effect of weight-input of iron oxide ore on the concentration of dissolved phosphorus as obtained from experiment [25]

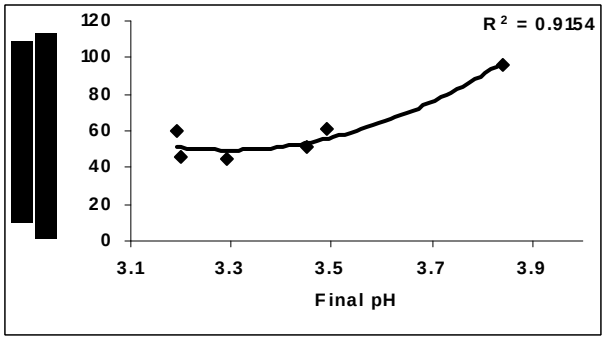

Fig.2-Effect of final pH on the concentration of dissolved phosphorus as obtained from experiment [25]

The values of the correlation coefficient, R calculated from the equation;

$$R = \sqrt{R^2} \qquad (18)$$

using the r-squared values (coefficient of determination) from Figs.1-4 show a very close correlation;(0.9877),(0.9568) and (0.8226),(0.9554) between values of the concentration of dissolved phosphorus obtained from experiment[25] and derived model respectively. This also shows that the model-predicted concentrations of dissolved phosphorus are very much in proximate agreement with the corresponding dissolved phosphorus concentration obtained from experiment [25]. Fig.4 shows that final pH contributed more significantly to the validity of the model compared with the weight-input of iron oxide ore (Fig.3). This is shown in their respective R^2 values.

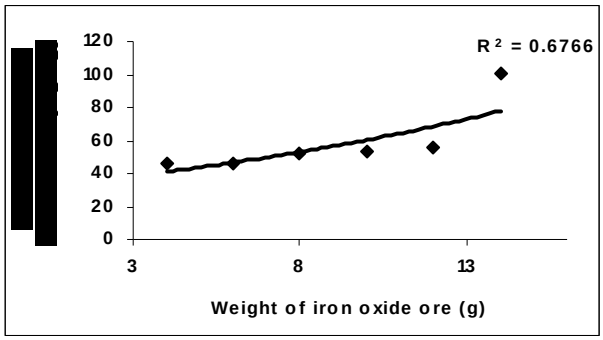

Fig.3-Effect of weight-input of iron oxide ore on the concentration of dissolved phosphorus as predicted by derived model

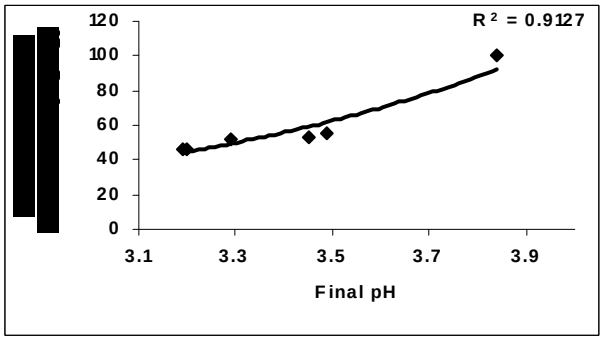

Fig.4-Effect of final pH on the concentration of dissolved phosphorus as predicted by derived model

Comparison of Figs. 5 and 6 show that both values of the dissolved phosphorus concentration obtained from the experiment [25] (line ExD) and the derived model (line MoD) in relation to both the weight-input of iron oxide ore and final solution pH are generally quite close hence depicting proximate agreement and validity of the model. Moreover, both Fig.5 and 6 show direct relationship in agreement with Table 1 which is made up of data from the experiment [25].

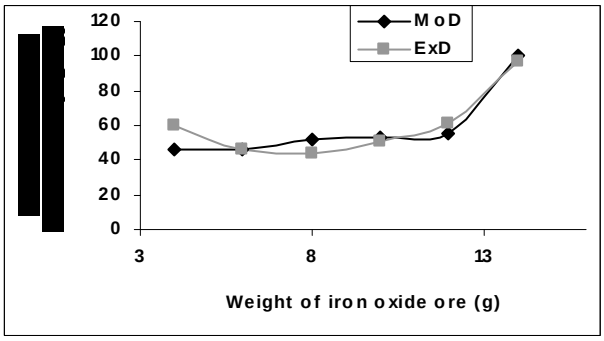

Fig.5-Comparison of the concentrations of dissolved phosphorus in relation to weight of iron oxide ore as obtained from experiment [25] and derived model

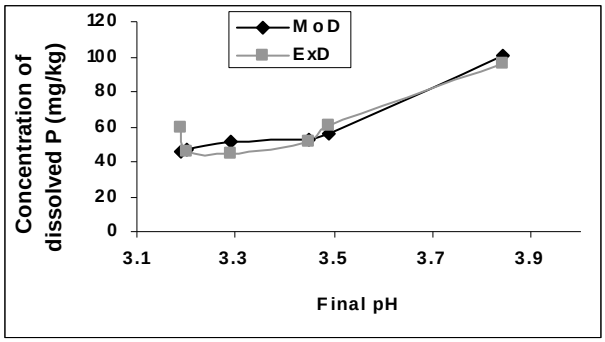

Fig.6-Comparison of the concentrations of dissolved phosphorus in relation to final pH as obtained from experiment [25] and derived model

Effect of final solution pH and weight-input of iron oxide ore on the deviation (from experimental values) of model-predicted concentration of dissolved phosphorus

It was found that the validity of the model is rooted in the expression $\ln P = N\alpha$, where both sides of the expression are correspondingly approximately equal 4. Table 2 also agrees with equation (9) following the values of $\ln P = N\alpha$ evaluated from Table 1 as a result of the corresponding computational analysis. The maximum deviation of the model-predicted concentration of dissolved phosphorus from the corresponding experimental value is 22.87% which is quite within the acceptable deviation range of experimental results, hence depicting the usefulness of the model. The positive and negative deviations (of the model-predicted concentration of dissolved phosphorus) from actual experimental values show an undulating relationship with the final solution pH, the weight-input of iron oxide ore and the actual concentration of dissolved phosphorus (Figs.7- 9).

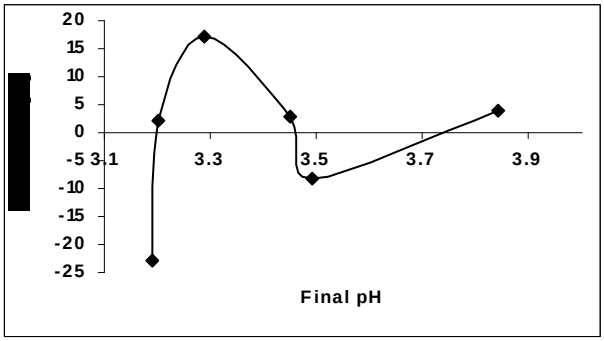

Fig.7-Variation of deviation (from experimental values [25]) of model-predicted concentrations of dissolved phosphorus with final pH

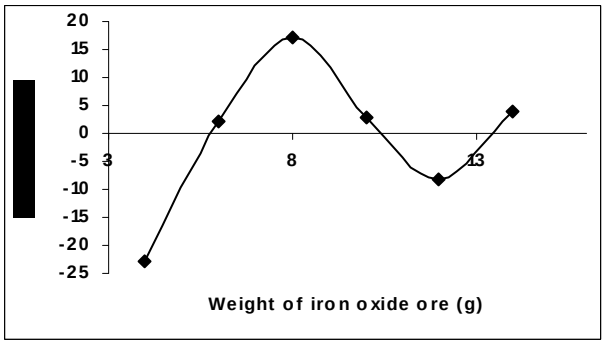

Fig.8-Variation of deviation (from experimental values [25]) of model-predicted concentration of dissolved phosphorus with weight-input of iron oxide ore

Figs.7-9 indicate that the highest and least deviations (-22.87 and 2.04%) which are same in relation to both the final solution pH obtained (at the end of the leaching process) and the weight-input of iron oxide ore corresponds to the model-predicted dissolved phosphorus concentrations 45.97 and 46.53mg/kg respectively. Comparison of Figs.7-8 shows that these percent deviations also correspond to the final solution pH; 3.19 and 3.20 and also iron oxide ore weight-input; 4 and 6g respectively.

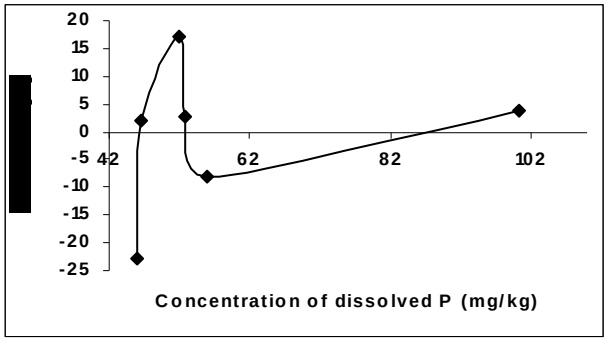

Fig.9-Variation of deviation (from experimental values [25]) of model-predicted concentrations of dissolved phosphorus with the actual model-predicted concentration of dissolved phosphorus

Effect of final solution pH and weight-input of iron oxide ore on the correction factor to the model-predicted concentration of dissolved phosphorus

Figs. 10 and 11 also show that correction factor to the model-predicted concentration of dissolved phosphorus depict an undulating relationship with the final solution pH and weight-input of iron oxide ore. Comparison of Figs.3, 4, 10 and 11 indicates that the highest and least correction factors (22.87 and -2.04%) which are same in relation to both the final solution pH obtained (at the end of the leaching process) and the weight-input of iron oxide ore also correspond to the model-predicted dissolved phosphorus concentrations 45.97 and 46.53 mg/kg respectively.

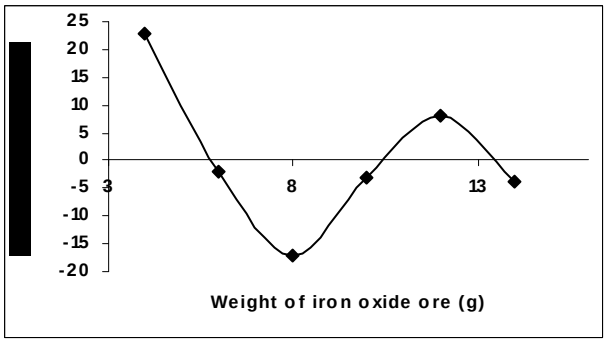

Fig.10-Variation of correction factor to model-predicted concentration of dissolved phosphorus with weight-input of iron oxide ore

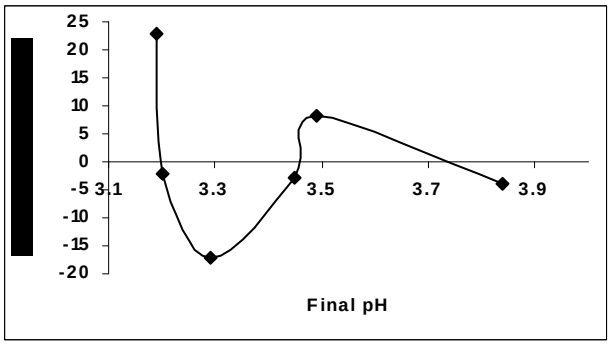

Fig.11-Variation of correction factor to model-predicted concentration of dissolved phosphorus with final pH

The percent correction factors also correspond to the final solution pH; 3.19 and 3.20 as well as iron oxide ore weight-input; 4 and 6g respectively. Comparison of Figs.7, 8, 10 and 11 shows that the orientation of the curves of the correction factor against final pH and weight-input of iron oxide ore are opposite that of the deviation against final pH and weight-input of iron oxide ore. This is attributed to the fact that correction factor is the negative of the deviation as shown in eqns. (13) and (14). It is believed that the correction factor takes care of the effects of the surface properties of the ore and the physiochemical interaction between the ore and the leaching solution which (affected experimental results) were not considered during the model formulation.

6. Conclusion

The model predicts the concentration of iron dissolved during leaching of iron oxide ore in nitric acid solution. The validity of the model is rooted on the expression $\ln P = N\alpha$ where both sides of the expression are correspondingly approximately equal to 4. The maximum deviation of the model-predicted P values from the corresponding experimental P values is 22.87% which is quite within the acceptable range of deviation limit of experimental results. The two values of the dissolved phosphorus concentrations per unit mass of iron oxide ore used; 6.3625mg/kg/g and 6.7188mg/kg/g as obtained from experiment and derived model respectively, show proximate agreement hence indicating a very high degree of validity for the model.

It is expected that more process parameters should be incorporated into the model in further works with the aim of reducing the deviations of the model-predicted P values from those of the experiment.

Acknowledgement

The authors thank Dr. Ekeme Udoh and Pearl Bassey, modelling experts at Linkwell Modelling Centre Calabar for his technical inputs. The management of SynchroWell Nig. Ltd. Enugu is also appreciated for permitting and providing the experimental data used in this work.

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Efficacy of Allium sativum (Garlic) Bulbs Extracts on Some Enteric (Pathogenic) Bacteria

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ABSTRACT: Ethanol and water extracts of *Allium sativum* (garlic) bulbs were made through cold extraction and then concentrated by refluxing in soxhlet apparatus. A crude (raw) extract of the bulbs was also obtained by blending and then using muslin cloth to squeeze the juice out. These extracts were tried at various concentrations on four species of enteric bacteria namely: *Salmonella typhi, Salmonella paratyphi, Pseudomonas aeruginosa* and *Klebsiella* to observe their efficacy on these pathogenic bacteria. Crude extract showed a highly positive result and the rest were negative. [New York Science Journal. 2009;2(6):24-28]. (ISSN: 1554-0200).

Key words: efficacy, *Allium sativum*, extracts, enteric, bacteria

INTRODUCTION

The majority of people in Nigeria and presumably Africa as a whole use plant based traditional medicines for their care. The Pharmaceutical potential of African medicinal plants is immense. Plants like Neem (*Azadirachta indica*), Sodom apple (*Calotropies spp.*), Papaw (*Carica papaya*), Mahogany (*Khaya sinegalensis*) and a host of other plants are used for the treatment of several illnesses like fever, pile, stomach ache and so on.

In Nigeria, traditional healers and remedies made from plants play an important role in the health of millions of people especially in the rural areas (Rukangira, 2001). If ratios were to be compared between traditional practitioners and university trained doctors being patronized by the Nigerian populace; it is sure that there will be a tilt in high numbers, towards the traditional healers. This consequently means that most of the populace are more exposed and disposed to taking traditional recipe as opposed to the Orthodox, refined medicine (Rukangira, 2001).

It is also a known fact that the Orthodox drugs are refined from extracts of many of these medicinal plants. This is why the traditional medicine has some success story. In all countries of the world, there exists traditional knowledge related to the health of humans and animals. The importance of traditional medicine as a source of primary health care was officially recognized by the World Health Organization (WHO) in the primary health care declaration of Alma Ata (1978) and has been globally addressed since 1976 by the traditional medicine programme of the WHO (Rukangira, 2001). The programme defined traditional medicine as: "the sum total of all the knowledge and practices, whether explicable or not, used in diagnosis, prevention and elimination of physical, mental or social imbalance and relying exclusive on practical experience and observation handed down from generation to generation, whether verbally or in writing" (Rukangira, 2001).

One disease aside malaria that has in recent times infected and affected people around our community is typhoid fever. Typhoid fever is said to be caused by bacteria of Salmonella species. There have been cases of prolonged sickness and even death due to this disease.

Common drugs like chloramphenicol, gentarnicin and ampiclox have always been used for treatment of typhoid fever. However, there have been rising cases of resistance of the pathogen to these drugs. It therefore behooves us to develop new therapies to counter the resistivity of the pathogen to already developed drugs.

In rural community, a traditional recipe is being used for the treatment of diagnosed typhoid cases. The recipe is a mixture of extract from bulbs of garlic (*Allium sativum)* and leaves of *Moringa oleifera* plant. These are washed, pounded and a glass of water added to it. This is sieved to give the filtrate. A glass full of the freshly prepared filtrate is taken first thing, every morning for five days. This application has shown some (though unrecorded) success story.

TYPHOID FEVER

The dictionary defines typhoid fever as an infectious fever caused by bacteria, resulting in red spots on the chest and abdomen and severe irritation of the intestines (Soanes, 2001).

Typhoid is an enteric fever which occurs only in man and is caused by a few *Salmonella* species and has a worldwide occurrence. Its occurrence and spread is encouraged by poor sanitary conditions. Strains resistant to recommended antibiotics have appeared in several areas of the world. Multi- resistant strains have been reported from Asia, the middles East and Latin America (Benson, 1990).

DESCRIPTION AND HISTORY OF GARLIC PLANT

The name is of Anglo-Saxon origin, derived from gar (a spear) and lac (plant), referring to the shape of its leaves. It belongs to the *liliaceae* family and genus *Allium*, which has more than six hundred (600) species. Included in this family are onions, shallots, leeks and bunching onions.

Garlic is believed to have originated in Western China from around the Tien Shan Mountains to Kazakhstan and kirgistan. Vvedensky proposed that garlic evolved from the wild species *Allium longicuspus* (Derrida, 2003). The spread of garlic probably was first to the old world and then to the new world. One herb that seems to be universally known is garlic. It is revered and despised; revered for its potent health benefits and despised for its odour. Garlic has been in use for so long that it is difficult to pinpoint its particular origin. It is known that garlic grew wild in Southwest Siberia and spread through Southern Europe down to Sicily (Derrida, 2003).

For its cultivation, it prefers a rich, moist, sandy soil that is somewhat alkaline and a sunny place. Each clove from a bulb of garlic may be planted separately to grow new bulbs. They are planted about two inches deep and six inches apart with a one foot space between rows, new bulbs may be dug up in early fall when the leaves begin to die. It is cultivated today in most parts of the world.

The leaves of garlic plant are long, narrow and flat like grass. The bulb (the only part eaten) is of a compound nature, consisting of many bulb lets, known as cloves, grouped together between the membranous scales and enclosed within a whitish or purplish skin, which holds them as in a sack. The flowers are placed at the end of a stalk rising directly from the bulb and are whitish, grouped together in globular head or umbel, with an enclosing type of leaf or spathae, and among them as small bulbils.

While garlic is primarily used as an herb to enhance many food dishes in various cultures, many compounds can be found in its bulbs. It contains vitamins A and C, Potassium, Phosphorus, Selenium and a number of amino acids (Derrida, 2003). Most important are the over 75 sulphur containing compounds including alum (S-allyl-Lcysteine sulphoxide). If the bulbs are grounded or crushed alliin is transformed into allicin (diallyl-disulphde Soxide) in which the typical garlic is attributed. A broad spectrum of antibacterial properties is associated with allicin (Derrida, 2003). Properties of the bulb include: adaptogen, alterative, antibiotic, anticoagulent, antifungal antineoplastic, antispasmodic, blood purifier, diaphoretic, digestive, expectorant, febrifuge, rebefacient and stirnilant (Derrida, 2003).

Phytochemicals common to bulb, flower, leaf and shoot are beta- carotene, niacin, riboflavin, and thiarnin. The bulb contains the following, gamma-L-glutarnyl-rnethionine; 1,2-(prop-2-enyl)-disuphane; 12- epithiopropane 1 ,2-dimercaptocyclopentane; 1,3 -dithiane; 1 -hexanol; 1- methy- 1 ,2-(prop-2-enyl)-disulphane; 1-methyl-2-(prop-2neyl)disulphane; 1-methy-3 -(prop-2-enyl)-tri-sulphane; 2,3 ,4—trithiapentane; 2,5 ,dirnethyltetrahydrothiophene; 2-rnethyl-benzaldehyde; 2 -propen- 1-01; 2- vinyl-4H- 1 ,3-dithiin; 3,5-diethyl—1 2,4,-trithiolane; 3-rnethyl-2- cyc lopentane- 1 -thione; 3—vinyl—4H— 1 ,2—dithiin; 4—methyl—5—vinylthiazole and many more (Derrida, 2003).

Garlic finds application in many areas today due to its high potency. Among the many areas are: Garlic (*Allium sativum*) serve as immune stimulator. It is able to stimulate the immune system's macrophages, white blood cells that destroy foreign organism. It also increases the activity of Helper cells, and can be used to treat upper respiratory viral infections because of its ability to clear mucus from lungs and help asthma patients (Derrida, 2003).

Garlic serves as a good natural antibiotic. It is effective against bacteria that may be resistant to other antibiotics, and it stimulates the lymphatic system to throw off waste material. Unlike other antibiotics, garlic does not destroy the body's natural flora instead; it has the ability to stimulate cell growth and activity, thus rejuvenating all body functions (Derrida, 2003). From research, Albert Schweitzer is reported to have used garlic when in Africa for treating amoebic dysentery and as an antiseptic in preventing infections. (Derrida, 2003). Garlic is known to be effective in inhibiting V bacterial growth and many different strains of mycobacteriurn, viruses, worms and fungi. A study with aqueous garlic extract demonstrated significant *in-vitro* inhibition of a number of drug-resistant bacterial strains, and promising *in-vivo* activity when tested against *Shigella flexineri* in rabbits. Other researchers screened 132 extracts of' plants used in folk medicine, and reported that *Allium sativum* extract was among those exhibiting the most

potent antibacterial activity (Derrida, 2003). Noteworthy is the performance of garlic extract against *Staphylococcus aureus*. The S. aureus strain used was resistant to both ampicillin and tetracycline, but 100% garlic was able to produce zones of inhibitions. *Allium Sativum* does display antimicrobial properties effective against a wide spectrum of pathogens (Derrida, 2003).

MATERIALS AND METHODS

COLLECTION OF BACTERIA SAMPLES

Stock culture of four bacteria samples viz *Salmonella paralyphi Pseudomonas aeruginosa* and *Kiebsiella pneumoniae* were collected from microbiology laboratory of Federal University of Technology, Minna. These cultures were used for analysis.

MEDIA PREPARATION

All anhydrous media which include Nutrient agar, Selenite F', Triple sugar iron agar, sugars, methyl red — Voges proskauer media were prepared according to the manufacturer's instruction. They were mixed and dissolved in distilled water, made up to the required volume, in some deserved cases, heated up to boil and then sterilized and poured into Petri dishes / test tubes.

GRAM STAINING

This divides bacteria into two categories, depending on whether they can be decolourized with acetone, alcohol or aniline oil after staining with dye of crystal violet, and treating with iodine. Those that resist decolourization remain blue or violet in colour, and are designated Gram + (positive); while those that are decolourised are termed Gram — (negative) (Baker et al., 2001).

BIOCHEMICAL TESTS

Respective isolated colonies of the four test organisms were inoculated into Triple Sugar Iron (TSI) agar and nutrient broth. Further tests including methyl red, Voges proskauer (VP), lndole, catalase, oxidase and sugar fermentation were carried out to confirm the identity of these micro organisms.

EXTRACTION FROM FRESH GARLIC BULBS

50g of fresh, peeled garlic bulbs were weighed in two places. These weighed bulbs were washed separately in clean water and pounded differently in a washed, dry and clean mortar. First part of the pounded (crushed) bulbs was soaked in 50m1 of distilled water and the second part in 50m1 of 98% ethanol in conical flasks which were covered tightly and left to stand for 48 hours. They were differently filtered using clean muslin cloth. About 3/4 of the filtrates were kept in the oven to evaporate.

CRUDE EXTRACTION FROM GARLIC BULBS

Some peeled garlic bulbs were blended, placed in a clean muslin cloth and the juice squeezed into a conical flask.

RECONSTITUTION OF EXTRACTS

For the extracts evaporated, they were reconstituted in the following manners:

a. 0.2g of extracts in ethanol were dissolved in 2m1 of ethanol and 8rn1 of glycerol added.
b. Various weights of the extracts were dissolved in the same 2ml of ethanol and 8m1 of glycerol with the highest weight being 5g of extracts.
c. 0.2g of extracts in water were dissolved in lOml of distilled water. Also various weights were used with the maximum at 5g/lOrnl of distilled water.

METHOD OF APPLICATION OF EXTRACTS

Basically two methods of application were used with a third type meant to verify or attest to the result obtained from the two methods.

a. AGAR PLUG HOLE METHOD

Sterile, molten nutrient agar was poured into petri dishes and allowed to solidify. Using sterile swab sticks, the test organisms were inoculated on the media by spreading. Holes were then drilled into the media using sterile cork borer (Ogechukwu, 2003). Various quantities of the extracts were introduced into the holes using sterile syringes with needles. The plates were then incubated at 37^0C for 24 hours. Zones of inhibition were determined by measuring with a ruler and the result recorded.

b. DISK DIFFUSION TECHNIQUE

Disks were prepared using punch and whatman filter paper. The disks were sterilized, soaked in various concentrations of the different extracts and dried aseptically. Sterilized molten nutrient agar (45^0C) was poured into sterile petri dishes and allowed to solidify. The plates were inoculated with test organisms by spread plate technique. The prepared disks were immediately placed at reasonable distances from each other on the inoculated plates having been previously soaked in the extracts and dried. These were incubated at 37^0C for 24 hours and the observations recorded.

c. AGAR DILUTION METHOD

The third method used was the agar dilution method. In this method, various quantities (concentrations) of the extracts were added to sterile petri dishes. Sterile molten nutrient agar was added to the petri dishes and the dishes swirled for the molten agar and the extracts to mix thoroughly. The media were allowed to solidify. The plates were then inoculated with the test organisms and incubated at 37^0C for 24 hours, observed and recorded.

RESULTS

Results of the biochemical tests on the microorganisms to verify their identification were obtained as in the table (Table 1) below.

Table 1: Biochemical tests on microorganisms

Test Organism	Gram Reaction	shape	Motility	TS						Methyl Red	Indole	Voges proskaeur	Citrate	Oxidase	Catalase
				Butt	Production H_2S	Glucose	Sucrose	Manitol	Lactose						
Salmonella typhi	-	R	+	A	+	A	-	A	-	+	-	-	V	-	+
Salmonella paratyphi	-	R	+	A G	-	A	-	AG	-	+	-	-	-		+
Pseudomonas aeruginosa	-	R	+	A	-	A	-	-	-	-	-	+	+	+	-
Klebsiella pneumoniae	-	R	-	A G	-	AG	AG	AG	AG	-	-	+	+		

KEY:

R = Rod A = Acid - = Negative G = Gas + = Positive
V = Variable AG= Acid and Gas

The result showed that all the extracts at their various concentrations did not have an effect on the four microorganisms except the crude garlic extract as seen on the table below.

Table 2: Result of Agar plug method

TEST ORGANISM	**RG**		**GW**		**GE**		**CG**		
	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2	**Concentration (m1)**
Salmonella typhi	NE	NE	NE	NE	NE	NE	12	16	ZONE OF INHIBITION (mm)
Salmonella paratyphi	NE	NE	NE	NE	NE	NE	13	19	
Pseudomonas aeruginosa	NE	NE	NE	NE	NE	NE	5	10	
Klebsiella pneumoniae	NE	NE	NE	NE	NE	NE	10	10	

KEY:
RG = Refluxed garlic extract GW = Cold garlic in water extract
GE = Cold garlic ethanol extract CG = Crude garlic extract.
NE = No effect mm = Millimetre ml = Mililtre.

Table 3: Result of disk diffusion technique

TEST ORGANISM	RG	GW	GE	CG
Salmonella typhi	NE	NE	NE	3mm
Salmonella paratyphi	NE	NE	NE	2mm
Pseudomonas aeruginosa	NE	NE	NE	2mm
Klebsiella pneumoniae	NE	NE	NE	NE

Similar result was obtained for the agar dilution method. Plates of all the extracts except for crude garlic extract showed a significant growth of the three microbes. No growth was seen on all plates of crude garlic extracts for the four microbes.

DISCUSSION

The result of this study revealed that garlic has some antimicrobial effect. The crude garlic extract showed a significant inhibition zone for all the bacteria samples, the ineffectiveness of extracts in water and ethanol could be due to denaturing of active ingredients resulting from the heat applied while refluxing and evaporating. This agrees with the findings of Derrida (2003) who stated that the constituents in garlic are protein, volatile oil, vitamins and other compounds. Probably the most beneficial compound is allicin, which is made by the enzyme alliinase breaking down alum to allicin. This process is essential to garlic's potency. Heating or cooking garlic inactivates the enzymes (Derrida, 2003). Cold, extraction on the other hand may not have succeeded in bringing out the active ingredients from the bulbs.

Garlic bulb extract is confirmed to have antimicrobial effect on *Salmonella typhi, Salmonella paratyphi, Pseudomonas aeruginosa* and *Klebsiella pneumoniae*.

RECOMMENDATION

More research work should be carried out on this plant *Allium sativum* (garlic) as regards its antimicrobial effects. However, particular attention should be paid to the methods of extraction that will extract out all the potent phytochernicals without denaturing them. The extracts should also be tried not only on enteric bacteria but on a variety of pathogens generally.

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An exploration on the phenology of different growth forms of an alpine expanse of North-West Himalaya, India

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Abstract: Phenological behavior of different growth forms was observed in an alpine pasture of North – West Himalaya (Tungnath), India. Total 103 species were identified which were categorized in 10 different growth forms. In the majority of the growth forms, growth initiation was recorded in May whereas senescence in October. Flowering occurred in July- August in most of the growth forms. In different growth forms, stoloniferous forbs exhibited maximum percent contribution in comparison to tussock graminoids and stoloniferous graminoids. On the basis of growth cycle pattern, long growth cycle plant species contributed maximum percentage in comparison to short growth cycle plant species. Phenological characters *viz*., initiation, flowering, fruiting etc. depends on the climate of the particular regions. Currently, most of the species initiate after snow melt in alpine regions (April – May) and in near future because of predicted global climate changes, phenology of many plant species may get altered which in turn will be the factor responsible for their acclimatization in changed environment. The present study deals with the phenological characters of different growth forms of an alpine expanse which will be fruitful in this respect. [New York Science Journal. 2009; 2(6):29-42]. (ISSN: 1554-0200).

Key words: Alpine, flowering, growth cycle, growth forms, phenology, Tungnath

Introduction: Phenology is the study of the timing of chronic biological events, the causes of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species (Leith, 1974). The word is derived from the Greek *phainomai* - to appear, come into view, and indicates that phenology has been principally concerned with the dates of first occurrence of natural events in their annual cycle. Examples include the date of emergence of leaves and flowers, the first flight of butterflies and the first appearance of migratory birds, the date of leaf coloring and fall in deciduous trees, the dates of egg-laying of birds and amphibia, or the timing of the developmental cycles of temperate-zone honey bee colonies. In the scientific literature on ecology, the term is used more generally to indicate the time frame for any seasonal phenomena, including the dates of last appearance (Mier, 2007 and Menzel *et al*., 2006). In arctic and alpine tundra, the growing season is extremely short, and its duration varies strongly among years (Molau, 1993; Tho´rhallsdo´ttir, 1998).

In this biome, the timing of the onset of flowering is crucial to the reproductive success of flowering plants. In late - flowering species, the entire seed production is often lost in summers colder or shorter than the average (Molau, 1993, Henry and Molau, 1997). In alpine habitat, seedlings are uncommon, though seedlings may be abundant in certain high favorable environmental conditions scattered randomly. However, it has been widely perceived that vegetative reproduction predominates by underground parts in an alpine biome (Bliss, 1971). Flowering time varies from species to species, because

photoperiodic and thermo periodic responses are different. At higher elevations, temperature is the most important factor in different phenological stages (Holway and Ward, 1965).

Dickinson and Dodd (1976) observed that although there is annual variation in phenological progression within a species in response to variation in weather, there appears to be little variation of the species sequence between growing seasons. Plant phenology in alpine region is strongly influenced by variation in microenvironments related to micro topography (Bliss, 1956, 1966; Pearcy and Ward, 1972 and Fareed and Caldwell, 1975). Phenological and phenomenological variations of the plants are the product of interaction between genotype and environment. The growth of a species during early and late growth season shows the ability of plants to absorb water at low temperature. The phenological pattern of the species within and among community may differ from each other (Mooney and Billings, 1960).

Methodology

Study area: The present study was carried out in Tungnath, situated at 30^0 14' N Latitude and 79^0 13' E Longitude and between altitudes of 3200 m and 3750 m above MSL (Figure 1). The present alpine region ends at two popular summits namely, Rawanshila (3400 m) and Chandrashila (3750 m). The timberline in this area reaches upto an elevation of 3200 m. The meadows here are gentle at the base, becoming gradually steeper until they form summits. Meadows with deep soil cover are seen in northern aspects, while the southern faces generally have large rock spurs and crevices are either barren or have a few lithophytes. Important species at the timber line are *Quercus semecarpifolia*, *Abies pindraw* and *Betula utilis* (Sundriyal and Bisht, 1988). *Rhododendron campanulatum*, *Sorbus* and *Berberis* are common shrub species at treeline. Above and beyond the tree line, most of the plants are small with a dwarf–rosette growth structure.

The study was conducted in the alpine garden of High Altitude Plant Physiology Research Centre (5 ha) and area adjacent (10 ha) to the field station was surveyed randomly from April – November, 2008. After species emergence, the species were identified and categorized into different growth forms on the basis of their growth behavior as per Körner (1999) *viz.,* tussock graminoids, stolonifeorus graminoids, mat forming forbs, rhizomatous forbs, stolonifeorus forbs, tuberous forbs, bulbous forbs, shrubs and under shrubs, creeping dwarf shrubs and prostrate creeping dwarf shrubs and, on account of the length of growth cycle as per Nautiyal *et al*. (2001) *viz*., short growth cycle (species completing their life cycle within two months), intermediate growth cycle (species with a span of 2-4 months) and long growth cycle (species completing their life cycle in more than 4 months). Monthly phenological observations were made for individual plant species.

Meteorological observations: Average maximum temperature was recorded in August (21.23 °C) wherein minimum in October (6.06 °C). Maximum rainfall was recorded in August (1550.31 mm) wherein minimum in May (139.81 mm). Likewise, maximum humidity was recorded in August (59.19 %) wherein lowest in May (48.22 %).

Results

Selection of growth forms: Total 103 species were identified in the study area and further were categorized into different growth forms. Out of 103 species, 3 species were identified as tussock graminoids, stoloniferous graminoids and creeping dwarf shrubs, 6 species as mat forming forbs, 25 species as rhizomatous forbs, 30 species as stoloniferous forbs, 11 as tuberous forbs, 7 species as bulbous and shrubs and under shrubs and 8 species as prostrate creeping dwarf shrubs.

Generally, growth initiation occurred in May wherein senescence in October in different plant species of different growth forms. In different growth forms maximum flowering was occurred in the month of July - August and minimum in the month of April - May. Dominant flower colour was observed as yellow followed by white, purple and blue whereas minimum as red color (Table 1 and Figure 2).

Table 2 depicts that percent contribution of different species on the basis of growth forms was recorded maximum for stoloniferous forbs (29.13 %) followed by rhizomatous forbs (24.27 %) wherein minimum for tussock graminoids, stoloniferous graminoids and creeping dwarf shrubs (2.91 %).

In tussock graminoids, stoloniferous graminoids and shrubs and under shrubs, all related species of these growth forms were identified as long growth cycle plant so that 100 % contribution was recorded for long growth cycle plants in these growth forms. In mat forming growth form 2 species were identified as short growth cycle, 4 species as long growth cycle. In rhizomatous forbs growth form 17 species were identified as long growth cycle, 1 as short growth cycle and 7 as intermediate growth cycle. In stoloniferous

forbs 14 species were identified as long growth cycle, 15 as intermediate and 1 as short growth cycle plant. In case of tuberous forbs 7 species were identified as long growth cycle, 3 as intermediate and 1 as short growth cycle plant. In bulbous growth form 3 species were identified as long and intermediate growth cycle and 1 species as short growth cycle. In creeping dwarf shrubs 2 species were identified as long growth cycle and 1 species as intermediate growth cycle. In prostrate creeping dwarf shrubs 4 species were identified as long growth cycle and 2 species as intermediate and short growth cycle plant. Overall in different growth forms maximum contribution was recorded for long growth cycle plant species and minimum for short growth cycle plant species (Table 3).

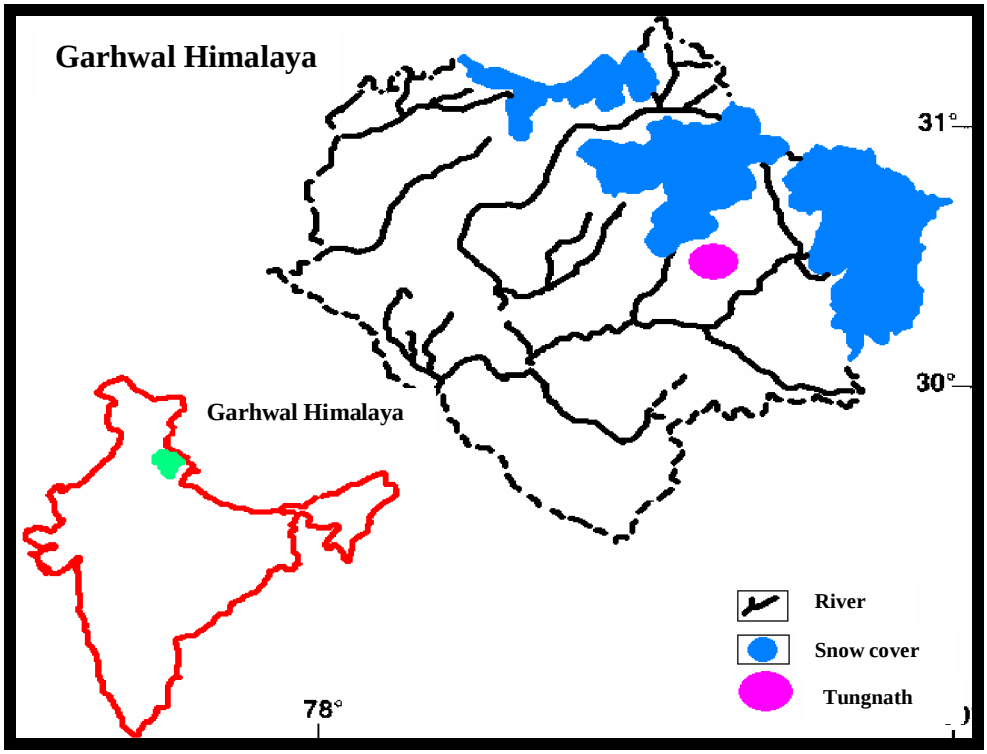
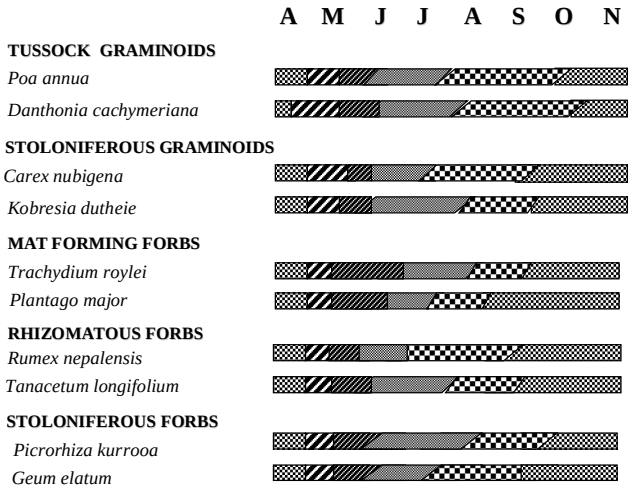


Figure 1. Location map of the study area



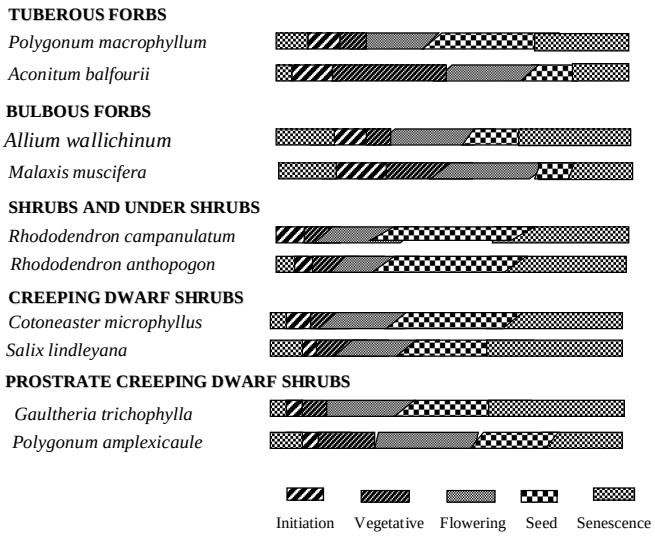


Figure 2. Phenophase spectra of dominant species in different growth forms

Table 1. Phenological observations of different growth forms

S. No.	Growth forms	Species	Growth initiation	Flowering	Flower color	Fruiting	Senescence
1	Tussock Graminoids	*Agrostis munroana Ait. Et Hemsl.*	May	August-September	Creamish	September-October	October-November
2		*Danthonia cachymeriana Jaub. & Spach.*	*May*	August-September	Creamish	September-October	October-November
3		*Poa annua* L.	*May*	June- July	White	August-September	October
1	Stoloniferous	*Carex nubigena D. Don*	May	June- July	Dark brown	July-August	October-November
2	graminoids	*Cyperus spp.*	May	July-August	Dark brown	August September	October-November
3		*Kobresia dutheie*	May	June - July	Brown-black	July-August	October
1	Mat forming forbs	*Gentiana argentia* (D. Don.) Cl.	May	May- June	Blue	July-August	September
2		*Plantago depressa*	May	June- July	Light brown	August-September	September
3		*Plantago major* non L.	May	June- July	Light brown	August-September	September
4		*Trachydium roylei* Lindl.	May	July-August	White	August-September	October
5		*Viola biflora* L.	May	May- June	Yellow	July - August	September
6		*Oxygraphis polypetala*	April	April-May	Whitish blue	June-July	July
1	Rhizomatus forbs	*Anemone obtusiloba* D. Don.	May	May- June	Light purple	July-August	August-September
2		*Anemone rivularis* Buch. - Ham. Ex DC.	May	May- June	White	July-August	August-September
3		*Anemone tetracephala*	June	May- June	White	July-August	August-September
4		*Angelica archangelica*	May	July - August	White	September-October	October-November
5		*Angelica glauca*	May	July - August	White	September-October	October-November
6		*Arnebia benthemi*	May	August-September	White	October	October
7		*Bergenia stracheyi*	May	July - August	Light pink	August-September	October
8		*Corydalis cashmeriana*	May	May- June	Blue	July-August	September
9		*Corydalis longipes*	May	June - July	Yellow	July - August	September
10		*Jurinia macrocephala*	*June*	August-September	Brown	October	October
11		*Ligularia amplexicaulis*	*June*	July - August	Yellow	September-October	October
12		*Ligularia arnicoides*	*June*	July -	Yellow	September-	October

				August		October	
13		*Morina longifolia*	*June*	July - August	Pinkish purple	August-September	October
14		*Nardostachys jatamansi*	*May*	July-August	Pink	September-October	October
15		*Podophyllum hexandrum*	*May*	May- June	White	July-August	October
16		*Polygonum affine* D. Don.	*June*	June- July	Purple	August-September	October
17		*Polygonum alpinum* All.	*June*	July-August	Pinkish white	September-October	October
18		*Polygonum rumicifolium* Royle ex Bab.	*June*	June- July	Reddish	August-September	September
19		*Rheum emodi*	*May*	June- July	White purple	August-September	October
20		*Rheum moorcroftianum*	*May*	June- July	White purple	August-September	October
21		*Rumex nepalensis* Spreng.	*May*	June- July	Reddish	August-September	October
22		*Selinum candolli* DC.	*May*	July-August	White	September-October	October
23		*Selinum vaginatum* (Edgew.) CLl.	*May*	July-August	White	September-October	October
24		*Tanacetum longifolium* Wall. ex DC.	*May*	July-August	White	September-October	October
25		*Taraxacum offcinale* (Weber) Wiggers	*May*	July-August	Yellow	August-September	September
1	Stoloniferous forbs	*Anaphalis cuneifolia* Hook f.	*May*	June- July	White	September-October	October
2		*Anaphalis margaritacea*	*May*	June- July	White	September-October	October
3		*Arenaria* spp. *L.*	*June*	June- July	White	July-August	September
4		*Caltha palustris* Linn.	*May*	May- June	Yellow	July-August	September
5		*Chrysanthemum spp.*	*June*	July-August	White	August September	September
6		*Doronicum roylei* DC.	*June*	August-September	Yellow	September-October	October
7		*Epilobium latifolium*	*June*	July - August	Dark mehroon	September-October	October
8		*Eregiron multiradiatus*	*June*	July-August	Light purple	August September	October
9		*Fragaria nubicola* Linn.	*May*	May- June	White	July-August	September
10		*Geranium wallichianum*	*May*	July-August	Purple	August-September	October
11		*Geum elatum* Linn.	*May*	June- July	Yellow	August-September	October
12		*Impatiens thomsonii*	*May*	July - August	Pink	August-September	September
13		*Inula grandiflora* Willd	*June*	August-	Yellow	October	October

				September			
14		*Juncus bracteatus* Buchen	*May*	June- July	White	July-August	September
15		*Meconopsis aculeata*	*May*	June- July	Blue	July-August	September
16		*Meconopsis robusta*	*May*	June- July	Yellow	July-August	September
17		*Oxyria digyna*	*June*	July - August	Reddish	September-October	October
18		*Parnassia nubicola* Wall. Ex Royle	*June*	July - August	White	August-September	September
19		*Phlomis bracteosa*	*May*	June - July	Mehroon	August-September	October
20		*Picrorhiza kurrooa* Royle ex Benth.	*May*	June- July	Light purple	September-October	October
21		*Potentilla atrosanguinea* Lodd.	*May*	May- June	Red	July-August	September
22		*Potentilla cuneata* Wall. ex Lehm.	*May*	June- July	Yellow	July-August	September
23		*Potentilla fulgens* Wall. ex Hook.	*May*	June- July	Yellow	July-August	September
24		*Ranunculus hirtellus* Royle, Bot.	*May*	May- June	Yellow	July-August	September
25		*Senecio alatus* Wall. ex DC.	*June*	July-August	Yellow	August-September	October
26		*Senecio chrysanthemoides* DC.	*June*	July-August	Yellow	August-September	October
27		*Swertia cuneata*	*June*	July - August	Creamish	August-September	September
28		*Swertia speciosa* D. Don.	*June*	July-August	White	September-October	October
29		*Thalictrum alpinum*	*May*	July-August	Yellow	September	October
30		*Rubus nepalensis*	*May*	June- July	Pinkish white	July-August	September
1	Tuberous forbs	*Aconitum balfourii*	*May*	August-September	Light Blue	October	October-November
2		*Aconitum heterophyllum*	*May*	August-September	Creamish	October	October-November
3		*Cypripedium himalaicum*	*May*	June - July	Pinkish-white	September-October	October
4		*Gymnedia spp.*	*May*	June - July	Purple	September-October	October
5		*Orchis chusua*	*June*	July - August	Purple	September	September
6		*Orchis latifolia*	*May*	June - July	Purple	September-October	October
7		*Polygonatum cirrhifolium*	*May*	July - August	Yellowish-white	September-October	October
8		*Polygonatum geminiflorum* Decne.	*June*	June- July	Yellowish white	August-September	October
9		*Polygonatum verticilatum*	*May*	July - August	Yellowish-white	September-October	October

10		*Polygonum macrophyllum* D. Don.	*May*	June- July	Light magenta	August-September	September
11		*Roscoea purpurea* J. C. Sm.	*May*	June- July	Purple	August-September	October
1	Bulbous forbs	*Allium stracheyi*	*July*	July-August	White	September	October
2		*Allium wallichinum*	*June*	July-August	Light purple	September	October
3		*Fritillaria roylei*	*May*	May- June	Cree mish	September-October	October
4		*Iris kumaonensis*	*June*	August-September	Purple	September-October	October-November
5		*Malaxis muscifera*	*June*	August-September	White	October	October
6		*Nomacharis oxypetala*	*June*	June- July	Light yellow	July-August	September
7		*Trillium govianum*	*May*	June - July	White	July - August	September
1	Shrubs and	*Berberris lonicera*	*April*	July-August	Yellow	September-October	October-November
2	under shrubs	*Piptenthus*	*April*	June- July	Yellow	August-September	October
3		*Potentilla polyphylla*	*April*	July - August	Yellow	August-September	October
4		*Rhododendron anthopogon*	*May*	May- June	Creamish	July-August	October
5		*Rhododendron campanulatum* D. Don.	*April*	April-May	Pinkish white	July-August	October
6		*Rhododendron lepidotum*	*April*	May- June	Light pink	July-August	October
7		*Rosa brunonii*	*April*	July-August	White	August September	October-November
1	Creeping	*Cotoneaster microphyllus*	*May*	May- June	White	July-August	October-November
2	dwarf shrubs	*Euphorbia stracheyi*	*June*	June - July	Light pink	July - August	September
3		*Salix lindleyana*	*May*	June - July	Creamish	July - August	September
1	Prostrate creeping	*Gaultheria tricophylla* Royle	*May*	May- June	Pinkish white	July-August	September
2	dwarf shrubs	*Hypericum spp*	*June*	July-August	Yellow	August-September	October
3		*Pedicularis gracilis* Wall. ex Benth.	*May*	June- July	Dark purple	July-August	September
4		*Pedicularis pectinata*	*May*	June- July	Purple	July-August	September
5		*Polygonum amplexicaule* D. Don.	*May*	July-August	Dark purple	September-October	October
6		*Polygonum vaccinifoila*	*June*	July - August	Pinkish-white	August-September	October

7		*Primula denticulata* Sm	*April*	April-May	Dark pink	June- July	August-September
8		*Primula radii*	*April*	May- June	Light yellow	June- July	August-September

Table 2. Percentage contribution of different species on the basis of growth forms

Growth forms	% contribution
Tussock graminoids	2.91
Stoloniferous graminoids	2.91
Mat-forming forbs	5.83
Rhizomatous forbs	24.27
Stoloniferous forbs	29.13
Tuberous forbs	10.68
Bulbous forbs	6.80
Shrubs and under shrubs	6.80
Creeping dwarf shrubs	2.91
Prostrate creeping dwarf shrubs	7.77

Table 3. Percentage contribution of different species on the basis of growth cycle

Growth forms	Growth cycle	% contribution
Tussock graminoids	3 L	100
Stoloniferous graminoids	3L	100
Mat-forming forbs	4 L	66.67
	2 S	33.33
Rhizomatous forbs	17 L	68.00
	7 I	28.00
	1S	4.00
Stoloniferous forbs	14L	46.67
	15 I	50.00
	1S	3.33
Tuberous forbs	7 L	63.64
	3 I	27.27
	1 S	9.09
Bulbous forbs	3L	42.86
	3 I	42.86
	1 S	14.29
Shrubs and under shrubs	7L	100
Creeping dwarf shrubs	2L	66.67
	1I	33.33
Prostrate creeping dwarf shrubs	4 L	50
	2 I	25
	2S	25

Discussion

Phenology is the study of periodically occurring natural phenomenon and their relation to climate and changes in season is a central focus of several aspects of ecology (Wieder *et al*., 1984). Seasonal timing events can be critical for survival of life and reproduction. Phenology of different populations of the same species is determined by environmental parameters and allowed for genetic exchange (Ratchke and

Lacey, 1985). Phenological observations also provide a background to functional rhythms of plant communities (Rawal *et al*., 1991).

Plant Phenology in alpine region is strongly influenced by variation in microenvironments related to micro topography Bliss, (1956, 1966), Pearcy and Ward (1972) and Fareed and Caldwell (1975). Sorenson (1941) and Mooney and Billings (1961) described the phenology of Tundra vegetation. Phenological and phenomenological variations of the plants are the product of interaction between genotype and environment. However, these modifications in plants may be reversible when plants are grown under diverse climatic conditions (Bhatt and Purohit, 1984). Ram *et al*. (1988) studied the community level phenology of grassland above tree line in Rudranath in the central Himalayan region. They observed the developmental stages of about 142 plant species. Their study simply adds to the fact that in the unfavorable environment of the high elevations the primary plant strategy is to complete the growth cycle rapidly in order to assure species survival.

Among the ecological studies phenological studies are important to understand the plant responses as affected by competition *e.g.* for light or topographic position. The climate, topography, weather of an area and the intensity of biotic interference are the most important ecological factors determining the type of plants that could occur there. Plants of alpine regions have various morphological and physiological means of adaptations against adverse climatic conditions. Each plant initiates and completes its vegetative phases with the commencement of favorable temperature and soil water accessibility. Accordingly, phenology is associated with plant growth rate (Taylor, 1972), nutrient transfer (Sosebee and Wiebe, 1973), thermal requirement (Ram *et al*., 1988; Negi *et al*., 1992), plant water relationship (Blaisdell, 1958) and evolutionary change (Kikuzawa, 1995).

In the present investigation total 103 species were identified out of which, 3 species were identified as tussock graminoids, stoloniferous graminoids and creeping dwarf shrubs, 6 species as mat forming forbs, 25 species as rhizomatous forbs, 30 species as stoloniferous forbs, 11 as tuberous forbs, 7 species as bulbous and shrubs and under shrubs and 8 species as prostrate creeping dwarf shrubs. Depending on the heterogeneity of the environmental gradients, the pattern of phenological stages between communities and within a community can vary from species to species. Dickinson and Dodd (1976) have stated that, although annual variations occurs in phenological progression within a species in response to variation in regional weather, there appears to be little variation of the species sequence between growing season.

Growth initiation occurred in May wherein senescence in October in different plant species of different growth forms, respectively. In different growth forms maximum flowering was occurred in the month of July - August and minimum the month of April - May. Dominant flower color was observed as yellow followed by white, purple and blue and minimum as red color. The early availability of moisture, a great majority of the species at the alpine site initiate growth and do not wait for the onset of the monsoon. The factor which decides growth initiation is snow melt, which not only supplies soil water but also indicates rise in temperature (Ram *et al*., 1988). In response to early growth initiation, the species number for vegetative phase is in the alpine area peaked in June compared to August in the herbaceous communities of the lower ranges (Rana, 1985). The species of smaller forms generally began to grow earlier than the larger forms. This also has in avoiding competition for resources, particularly for light and possibly for available nutrients. Consequently, in all growth forms, flowering and seed setting peaks occurred over a relatively short period of time compared to this, in the vegetation of lower elevations these Phenophases are spread over most of the year. Interestingly, the peak for flowering in alpine plants occurred during the wet period of the year (July - August). In contrast to the trees and shrubs of the lower elevations, which show peak flowering during the dry summer season (Ralhan *et al*., 1985).

The early growing species (cushion form) can have an unusual water absorbing ability at low soil temperatures, which is perhaps related to high levels of soluble carbohydrates in root stocks. In the study area, more abundant roots occurred in the upper soil layers, where temperatures were relatively higher or where the water requirement for early growth was low. The shallow root system of some species *viz*., *Oxygraphis polypetala*, *Gentiana argentia*, *Primula denticulata* etc. also favor early growth because they restrict water use in the upper soil layer, moreover, they need little water because of their small size (Oberbauer and Billings, 1991). Flowering time varies from species to species because photoperiodic and thermoperiodic responses are different. At higher elevations, temperature is the most important factor in different phenological stages (Howlay and Ward, 1965).

Percent contribution of different species on the basis of growth forms was recorded maximum for stoloniferous forbs wherein minimum for tussock graminoids, stoloniferous graminoids and creeping dwarf

shrubs which could be accredited to the type of perennating organs and adaptation features of particular species. Underground parts accumulate more biomass and secondary metabolites, resulting in greater production. Harvesting after seed shedding provide opportunities to grow new plants of the same species and to maintain the species population, many of these species are threatened because of overexploitation and illegal exploitation. Different phenophase time will provide information about morphological and functional attributes that is useful in understanding adaptation features. After a long period of winter dormancy, alpine plants initiate their growth as soon as air temperature becomes favorable and soil begin to thaw, however the pattern of growth varies with life form and micro-environment (Billings and Mooney, 1968). Billings *et al.* (1965) showed that long photoperiod with high temperature was responsible for breaking dormancy in perennating buds of alpine plants.

Among different growth forms long growth cycle plant species contributed maximum proportion wherein minimum proportion was contributed by short growth cycle plant species. Nautiyal *et al*. (2001) also had reported that short growth cycle plants contributed minimum percentage to total species wherein maximum was reported for intermediate growth cycle. Similar observations were reported by Ram *et al.* (1988). Körner (2003) also has focused on such type of studies on growth forms with reference to perennating organs.

Phenophases of species provides information about morphological and functional attributes, which are useful to understand adaptation features (Nautiyal *et al*., 2001). While, phenophases of the same species may vary from one region to another and yet in different macro - habitats because of environmental factors, the required germplasm can be collected from unapproachable areas in the Himalaya in accordance with the developmental stages of these species. Present study demonstrates the value of comparing and synthesizing results of multiple field methods within a single study. This also highlights the robust community wide trends, species specific responses of phenology to climate change and temperature related aspects of climate change which lead to long - term irregularities in interspecific interactions which in turn potentially alters the population and evolutionary dynamics, community structure and ecosystem functioning.

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Evaluation of the Biological Effects of a Chayotte Extracts: an Experimental Analysis on *Wistar* Rats.

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Abstract: Vegetal products have formed the basis of traditional medicine systems for thousands of years. Modern medicine improves on this process by extracting and concentrating the active compound from the natural product. An inherent problem with the widespread use of many natural products, however, lies with harvesting and processing products that have low concentrations of active principles however even though the concentration is low some active molecules are able to induce effects in the organism. The labeling of blood constituents with technetium-99m (99mTc) has been influenced by the presence of natural products. We evaluated the influence of a chayotte (*Sechium edule*) extracts (macerated and decoct) (i) on the labeling of blood elements with 99mTc, (ii) on biochemistry of blood (iii) and on the gauging of tail pressure in *Wistar* rats. In our study, the animals were treated with chayotte macerated and decoct extracts (100% v/v), as drinking water (15 days) and samples of blood were withdrawn. The blood samples were incubated with stannous chloride and with 99mTc. Plasma (P) and blood cells (BC) were isolated, also precipitated with trichloroacetic acid (TCA 5%) and soluble (SF) and insoluble fractions (IF) separated. There was a decrease in the radioactivity on the labeling of blood elements. Samples of blood from the animals which were treated with chayotte extracts were carried out with specific biochemistry kits and the blood biochemistry analysis compounds was done. It was analyzed the level of uric acid, albumin, cholesterol, creatinine, glucose, high density lipoprotein (HDL), globulin and trigliceridics. It was noticed that the extracts were capable of altering the levels of the non electrolytic substances in the blood. The gauging of the blood pressure of the animals was taken. Our results showed a reduction in the diastolic pressure. Concerning to the results we suggest that the effect of chayotte may be influenced by the warmness. The effect of chayotte extracts probably, could be explained by the metabolization of the chayotte that could be capable of inducing the generation of active metabolites with oxidant property. [New York Science Journal. 2009;2(6):43-48]. (ISSN: 1554-0200).

Keywords: chayotte, red blood cells, plasma proteins, technetium-99m, blood biochemistry.

Introduction

Many authors related the effect of natural and synthetic drugs concerning to the fact of them be capable of altering the labeling of blood elements with 99mTc (Early & Sodee, 1995; Hesslewood & Leug, 1994). *Sechium edule* (chayotte), a subtropical vegetable with potent diuretic action, is a cucurbitaceus specie which is used as food or as medication in popular medicine. It was reported a case of severe hypokalemia pregnancy and that a chayotte preparation was implicated, as the potassium level returned to normal, without recurrence of hypokalemia, once the ingestion of this vegetable was stopped (Jensen & Lai, 1986; Flores, 1989). Gordon (2000) described the antihypertensive effect of chayotte. Diré et al (2001) have noticed that chayotte extract (macerated) was capable of altering the biodistribution of sodium

pertechnetate ($NATcO_4$). It is related by different researchers that many natural products are able to alter the labeling of blood constituents with Technetium-99m (99mTc) (Olievira et al, 1997; Vidal et al, 1998; Reiniger et al, 1999; Braga et al, 2000; Oliveira et al, 2000; Lima et al, 2002; Oliveira et al, 2002; Oliveira et al, 2003). 99mTc has been the most utilized radionuclide in nuclear medicine procedures (Oliveira et al, 1997; Vidal et al, 1998) and it has also been used in basic research (Gutfilen et al, 1996). The wide use 99mTc in nuclear medicine is due to its optimal physical characteristics (half-life of 6h, gamma rays energy of 140 keV and minimal dose to the patients, convenient availability from 99Mo/99mTc generator and negligible environmental impact). Nearly almost all scanning devices currently in use are optimized for detecting the eletromagnetic emission from this radionuclide (Saha, 1998). It is known many applications of 99mTc-labeled red blood cells (99mTc-RBC), as in cardiovascular evaluations, in the detection of gastrointestinal bleeding and in the determination of the RBC mass in patients. RBC have been labeled with 99mTc through of *in vitro, in vivo* or *in vivo*/*in vitro* techniques (Srivastava et al, 1992; Early & Sodee, 1995). In spite of that, there is not a well established model to evaluate the effects of drugs (synthetic or natural) on the radiolabeling of blood components. In this study, we have evaluated the influence of a chayotte extracts (i) on the labeling of blood constituents with 99mTc using an *in vitro* technique; (ii) on the biochemistry of the blood of the animals treated with the referred vegetable extract and (iii) on the gauging blood pressure from the animals treated with chayotte extract.

Material and Methods:

Characterization of the chayotte sample

Chayotte was purchased from a local market in Rio de Janeiro city, RJ, Brazil. To prepare the decoct of chayotte, 50 g of skin of this fruit was put in an Erlenmeyer with 500 mL of saline solution (0.9% NaCl) and it was boiled on slow heat for tem minutes. After that, the solution was filtered and the watery extract was obtained.

To prepare the macerated of the referred fruit, 50g of the skin of the chayotte was also used with 500 mL of saline solution 0.9%. The skin was triturated with a domestic electric extractor. This macerated was filtered and a watery extract was obtained.

The presence of toxic compounds was evaluated and we did not find them in the extracts of chayotte used in our experiments. The method to verify the presence of these toxic products is based on inhibition of acethylcholinesterase in the presence of the pesticides (Cunha Bastos et al, 1991). In this method, brain acethylcholinestarase is utilized as an *in vitro* detector of organophosphorus and carbamate insectides. Briefly, a preparation of acethylcholinesterase was obtained after extraction of a rat brain microsomal fraction with Triton X-100 and was incubated with the extract of chayotte. Enzyme assay was performed by a potentiometric method based on the formation of acetic acid in the incubation mixture (preparation of acethylcholinesterase and extract of chayotte)

Radiolabeling and blood biochemistry:

The animals were treated during 15 days with chayotte extracts. After that, samples of 4.0 mL of blood of each animal were withdrawn. Assays to evaluate the level of blood compounds were performed through of a biochemistry test using specific kits. The level of glucose, uric acid and creatinine and total proteins was available by Dried Chemistry Method in a Vitros machine from Johnson, USA. The level of albumin and globulin was available by Bromocresol Green Method in a Mega machine from Merck, USA. The level of cholesterol and trigliceridics was utilized the Cholesterol oxidize Method in a Mega machine from Merck and the level from HDL was determined by the Direct Method without desproteinization in a Integra machine from Switzerland. The experiments were performed with the chayotte extract administrated to the animals. Whole blood was withdrawn from animals that received water or chayotte extracts, as drinking water, for 15 days. The vegetable extracts were prepared in the concentration of 0.1 g/mL and it was used the skin of the chayotte. Then, 0.5 mL of stannous chloride (1.2 μg/mL), as $SnCl_2.2H_2O$ was added and the incubation continued for another 1 hour. After this period of time, 99mTc (0.1 mL), as sodium pertechnetate, was added and the incubation continued for another 10 min. These samples were centrifuged and plasma (P) and blood cells (BC) were separated. Samples (20 μL) of P and BC were also precipitated with 1 mL of trichloroacetic acid (TCA) 5% and soluble (SF) and insoluble fractions (IF) were separated. The radioactivity in P, BC, IF-P, SF-P, IF-BC and SF-BC were determined in

a well counter. After that, the % of radioactivity (%ATI) was calculated. Statistical analysis (Mann-Whitney test) was utilized to compare the experimental data.

Gauging blood Pressure:

It was analyzed the blood pressure in the animals treated with the referred extracts during 15 days. The tails of the rats were warmed under glowing light during 10 min to hit the swelling of tail artery. The gauging of tail pressure was done by the use of a special apparatus of gauging of tail pressure in rats (LE 5002 Storage Pressure Meter, EUA). To each animal (n=10) it was taken twice the BPM (beating per minute), systolic, diastolic and the mean were analyzed to the end of the procedure to obtain the relative means due to the systolic and diastolic pressures (mm/Hg).

Results:

Table 1 has shown the level of the blood compounds of *wistar* rats treated with chayotte extract and treated with water during 15 days. The analysis of the results indicates that there is a significant decrease ($p<0.05$) in the level of glucose (from 118.40 mg/dL ± 10.69 to 97.20 mg/dL ± 4.32) and globulin (from 3.52 g/dL ± 0.13 to 3.08 g/dL ± 0.19) to the treatment with macerated extract. The analysis of the results to the treatment with the decoct extract revealed that there was an increase in the level of albumin (from 3.30 g/dL ± 0.07 to 3.46 g/dL to 0.11), cholesterol (from 70.20 mg/dL ± 7.79 to 86.60 mg/dL ± 8.08), glucose (from 118.40 mg/dL ± 10.69 to 150 mg/dL ± 10.58) and HDL (from 25,40 UI ± 2.30 to 32.60 UI ± 4.09) and a decrease in the level of creatinina (from 0.44 mg/dL ± 0.05 to 0.29 mg/dL ± 0.01).

Figure 1 has shown the percentages of the radioactivity on the blood cells and in the insoluble fractions of plasma and blood cells isolated from whole blood withdrawn from animals that have received chayotte (15 days), as drinking water. The analysis of the results indicates that the macerated extract was capable of entailing a slight decrease ($p<0.05$) in the uptake of 99mTc by the RBC (from 98.16 %ATI ± 1.57 to 90.35 %ATI ± 5.04) and a strong decrease in the fixation of the radioactivity in the insoluble fraction of the plasma (from 83. 96 %ATI ± 4.28 to 53.26 %ATI ± 6.69). In the analysis of the effect of decoct extract it was noticed that there is only a slight, but significant decrease ($p<0.05$) in the uptake of 99mTc by the red blood cells (from 98.16 %ATI ± 1.57 to 93.98 %ATI ± 0.93) and in fixation of radioactivity in the insoluble fraction of the cell (from 89.23 %ATI ± 2.68 to 83.34 %ATI ± 1.75) and by the insoluble fraction of plasma (from 83.96 %ATI ± 4.28 to 72.21 %ATI ± 2.69).

Table 2 has shown the effect of the extracts on the gauging of blood pressure. Concerning to the results obtained it was eyed a reducing in the diastolic pressure to the both extracts studied. To the treatment with macerated it was noticed a decreased in the minimum pressure (from 123.80 mmHg ± 9.12 to 84.40 mmHg ± 3.85) as well as it was observed to the treatment with decoct extract (121.75mmHg ± 7.61 to 79.52mm Hg ± 2.33).

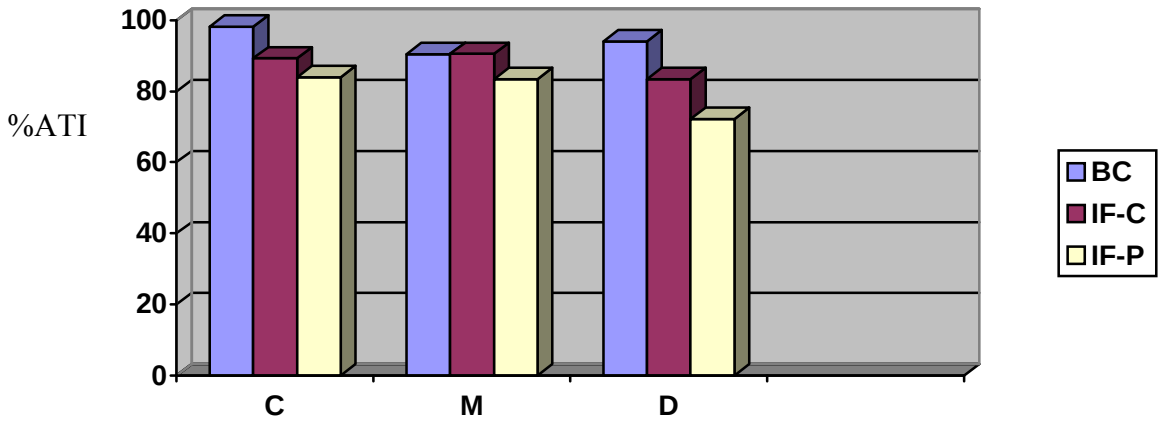
Table 1 - Effect of cayotte extract on the biochemistry of blood

Compostos	Control	Treated (macerated)	Treated (decoct)
Uric acid (mg/dL)	1.80 ± 0.45	1.50 ± 0.29	2.12 ± 0.50
Albumin (g/dL)	3.30 ± 0.07	3.30 ± 0.20	3.46 ± 0.11
Cholesterol (mg/dL)	70.20 ± 7.79	71.80 ± 4.14	86.60 ± 8.80
Creatinine (mg/dL)	0.44 ± 0.05	0.34 ± 0.05	0.29 ± 0.01
Glucose (mg/dL)	118.40 ± 10.69	97.20 ± 4.32	150.00 ± 10.58
Globulin (g/dL)	3.52 ± 0.13	3.08 ± 0.19	3.32 ± 0.27
HDL (UI)	25.40 ± 2.30	27.20 ± 3.56	32.60 ± 4.09
Triglicerídics (mg/dL)	50.40 ± 6.06	42.60 ± 8.90	44. 80 ± 8.04

In these samples of blood (n=10) were determined the concentrations of the blood compounds. The animals were treated during 15 days with chayotte extracts. The animals of control group received water. The blood was withdrawn in the morning period after a break of 8 hour on an empty stomach.

Table 2- Effect of the chayotte extract on the labeling of blood elements with 99mTc.

Animals have received water (control- C) or chayotte extracts (macerated- M or decoct- D) for 15 days.



Samples of whole blood were withdrawn from the animals and incubated stannous chloride. After that, 99mTc was added. The ATI% was calculated to blood cells (BC), insoluble fraction (IF) of plasma (P) and (C).

Table 2 - Effect of chayotte extract (100%) in the gauging of tail pressure in rats treated during 15 days.

Groups	Pressure Systolic (mmHg)	Pressure Diastolic (mmHg)
Control	204.75 ± 7.88	123.80 ± 9.12
Treated (macerated)	217.57 ± 9.11	84.40 ± 3.85
Treated (decoct)	121.75 ± 7.61	79.52 ± 2.33

The results were obtained by the gauging of tail pressure of rats which were treated and no treated with chayotte extracts.

Discussion:

A therapeutic drug is capable of modifying the nature/amount of the 99mTc-radiopharmaceutical bound to the blood elements and this may result in unexpected behavior of the radiopharmaceutical. Therapeutic drugs and extracts of medicinal can also alter the labeling of blood elements with technetium-99m (Reiniger et al, 1999; Sampson, 1996). We agree with Hesslewood & Leung (1994) that many reports on drug interactions with radiopharmaceuticals are anecdotal and in some instances a direct cause and effect relationship has not been unequivocally established. This fact could be diminished with the development of *in vitro* tests to evaluate the drug/radiopharmaceuticals interactions and the consequence for the bioavailability of the radiopharmaceuticals and the labeling of blood constituents (Srivastava et al, 1992; Nigri et al, 2002; Gomes et al, 2002).

Sechium edule macerated and decoct extracts (100% v/v) were administrated orally to the animals during 15 days. It was observed an alteration on the labeling of blood constituents with 99mTc as well as in the levels of non electrolytic components of blood and in the diastolic blood pressure. Lima et al (2001) described that a leaf extract isolated from cauliflower (*Brassica oleracea*) which was administrated to the animals during the same time was not capable of altering the radiolabeling of blood elements. Braga et al (2000), described that *Peumus boldus* showed a rapid uptake of the radioactivity by blood cells in whereas there was a slight decrease in the amount of 99mTc radioactivity in the insoluble fraction of plasma. In the labeling process of blood elements with 99mTc needs a reducing agent, and probably the stannous ion would be oxidized. In *in vitro* studies was verified that extracts of *Thuya ocidentallis* (Oliveira et al, 1997), *Nicotiana tabacum* (Vidal et al, 1998), *Maytenus ilicifolia* (Oliveira et al, 2000), *Syzygium jambolanum*

(Santos et al, 2002), *Stryphnodendron adstringens* (Costa et al, 2002), *Mentha crispa L.*(Santos-Filho et al, 2002), *Ginkgo biloba* (Moreno et al, 2002), *Paullinia cupana* (Oliveira et al, 2002), *Solanum melongena* (Capriles et al, 2002), *Fucus vesiculosus* (Oliveira et al, 2003) possibly, would have oxidants compounds, and the labeling of blood elements decreased in the presence of these extracts.

The decrease of diastolic pressure observed by Gordon et al (2000), could be due to the action of metabolites which were produced by the possible metabolism of chayotte in liver. The diuretic effect described by Jensen & Lai (1986) have encouraged us to gauging the tail pressure of the animals treated during 15 days with chayotte extracts. The results obtained are according with the ones described by Gordon et al (2000). We observed a decrease in the diastolic pressure in the animals treated with both extracts (table 3).

The genotoxic effect of *Paullinia cupana* (Fonseca et al, 1995) and *Brassica oleracea* (cauliflower) (Lima et al, 2001), a natural products, could be associated to the generation of reactive oxygen species (ROS) that are oxidant agents. It was reported that *Sechium edule* extract was capable of altering the biodistribution of 99m-Tc-radiopharmaceutical as well as to alter the morphology of red blood cells (Diré et al, 2001). Then, we can speculate that this fact could be associated with the decrease on the labeling of blood elements with 99mTc and with the results observed in the blood biochemistry analysis. On the labeling of red blood cells is important to consider the homeostasis of the membrane for if the architecture of the membrane is changed the labeling pattern could be modified (Ammus & Yunis, 1989). Alterations on the shape of the red blood cells were found with blood treated with *Thuya occidentalis* (Oliveira et al, 1997), *Nicotiana tabacum* (Vidal et al, 1998), *Maytenus ilicifolia* (Oliveira et al, 2000), *Sechium edule* (Diré et al, 2001), *Mentha crispa L* (Santos-Filho et al, 2002), *Ginkgo biloba* (Moreno et al, 2002), *Paullinia cupana* (Oliveira et al, 2002) and *Fucus vesiculosus* (Oliveira et al, 2003). Mongelli et al (1997) have showed that *Bolax gummifera* extract was used as a treatment of wounds probably due its properties related to the stabilizing activity of the red blood cell membrane.

There is not a well established model to study the interaction of therapeutic drugs (natural or synthetic) with radiopharmaceuticals (Santos et al, 1995). Much discussion has centered on the fact that many reports are individual case studies and are rarely reported in the nuclear medicine literature. In order to make an accurate assessment of the impact of the studied natural product and other factors on cell labeling to nuclear medicine procedures, additional data would be required (Hladik et al, 1987; Hesslewood and Leug, 1994; Sampson, 1996).

Conclusion:

Concerning to the analysis of the results we suggest that *Sechium edule* extracts are capable of altering the labeling of blood elements with 99mTc as well as to induce the decrease of diastolic blood pressure and to alter the levels of non electrolytic components of blood. In this case, we suggest that these effects can be due to the generation of active metabolites *in vivo* with oxidant properties.

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Biomass and Carbon Allocation in 8-year-old Poplar (*Populus deltoides* Marsh) Plantation in Tarai Agroforestry Systems of Central Himalaya, India

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ABSTRACT: Carbon management in forests is the global concern to mitigate the increased concentration of green house gases in the atmosphere. Reviving forest cover and finding low cost methods to sequester carbon is emerging as a major international policy goal. However the global forest cover is dwindling fast in view of great biotic pressure, industrialization, urbanization, land use changes and conversion of forests to agricultural land. Agroforestry systems can play an important role in carbon mitigation programmes through carbon sequestration and can reduce the pressure on existing natural forests by providing fuel, fodder, timber and wood products to the farmers. Biomass and carbon allocation in Poplar agroforestry plantation in the Tarai region of central Himalaya, India have been studied and it is found that the Poplar agroforestry plantation in the Tarai region of central Himalaya had a significant amount of biomass and carbon, which acts as an additional carbon sink in the region. [New York Science Journal. 2009;2(6):49-53]. (ISSN: 1554-0200).

KEY WORDS: Biomass, Carbon, Agroforestry, *Populus deltoides*, Central Himalaya

INTRODUCTION

Carbon management in forests is the global concern to mitigate the increased concentration of green house gases in the atmosphere. It is estimated that the world's forests store 283 Gt of carbon in their biomass alone (FRA, 2005). However the global forest cover is dwindling fast in view of great biotic pressure, industrialization, urbanization, land use changes for developmental activities and conversion of forests to agricultural land. Reviving forest cover and finding low cost methods to sequester carbon is emerging as a major international policy goal (Shively *et. al*. 2004). Agroforestry is widely considered as a potential way of improving environmental and socioeconomic sustainability (Alavalapati and Nair, 2001). Agroforestry systems can play an important role in carbon mitigation programmes through carbon sequestration and can reduce the pressure on existing natural forests by providing fuel, fodder, timber and wood products directly to the farmers on the on hand and on the other it may provide many indirect environmental benefits such as soil and water conservation, biodiversity conservation, soil nutrients enrichment etc.

India has a long tradition of agroforestry, several indigenous agroforestry systems, based on peoples needs and site-specific characteristics have been developed over the years. Agroforestry research was initiated in the country about three decades ago and several agroforestry technologies have been developed and tried on farmer's lands (Chinnamani, 1993). Poplar (*Populus deltoides)* has gained considerable importance in agroforestry plantations of Western Uttar Pradesh, Uttarakhand, Haryana, Punjab, and Jammu & Kashmir states of India, mainly due to its deciduous nature, fast growing habit and high industrial requirement (Chandra *et. al*., 2001). It has been estimated that 60,000 hectares equivalent plantations of *P.deltoides* exists in India. In the Tarai region of Indian central Himalaya Poplar was introduced on trail in 1960, and at present there are more than 16000 hectares of Poplar plantations exists in the Tarai agroforestry systems (Lodhiyal and Lodhiyal, 1997). *P.deltoides* is known for its fast growth, easy vegetative propagation and soil enrichment quality. It can be economically harvested in 6-8 years thus provide substantial wood over a short rotation. It provides valuable raw material for plywood, paper pulp, furniture, fiber board, veneer, sports goods, news print, fine paper, packing paper and match-splint industries thus makes an extra source of income to the farmers.

Comprehensive reports on biomass, productivity, structure and functioning of *P.deltoides* Tarai agroforestry platations are available (Lodhiyal *et. al*., 1992, 1995; Lodhiyal and Lodhiyal 1995, 1997). However information on carbon allocation in *P.deltoides* agroforestry plantations in this region is quite

meager. Therefore the present study was designed to estimate biomass and carbon allocation in different components of 8-year-old *P. deltoides* agroforestry plantation in the Tarai region of central Himalaya.

MATERIAL AND METHODS

The present study site is located between $29^0$3'-$29^0$12' N latitude and $79^0$20'-$79^0$23' E longitude at an elevation of 280-300 amsl in the Tarai region of central Himalaya, India. The climate of Tarai region is sub-tropical monsoon, with a long dry season from early October to mid June. The year can be divided broadly into three seasons as summer from April to mid June, rainy from mid June to mid September, and winter from November to February. Soil is deep fertile and due to water seepage from the higher elevations the water table is high, soil moisture content is high and higher productivity (Burfal *et. al.*, 2001). The Sal mixed broad-leaved forests were the natural vegetation of Tarai region (Champion and Seth, 1968). Most of these forests were converted into agricultural lands during the period of 1960s to 1980s and during this period fast growing tree species like Poplars and Eucalyptus were planted extensively in the region (Lodhiyal and Lodhiyal, 1995). The present study was conducted in a private farm at village Jawahernager in the UdhamSingh Nagar district of Uttarakhand state. At the time of present study the Poplar plantation was 8 year old and well managed under agroforestry system. To assess biomass and carbon allocation in this poplar plantation we measured trees within a sample plot of 0.25 ha and within this sample plot, diameter of all trees at breast height was measured and recorded. Mean diameter was than calculated and used in regression equation to assess tree biomass.

In order to assess the tree biomass the regression equations developed by L.S. Lodhiyal (1992) for *P.deltoides* plantation have been used. The regression equation was used in the form of:

$$Y = a + bx$$

Where, Y = Dry weight of components
x = Mean diameter at breast height (1.37 m) above the ground level (cm)
a = intercept and
b = slope

The carbon content of vegetation is surprisingly constant across a wide variety of species. Most of the information for carbon estimation described in the literature suggests that carbon constitutes between 45 to 50 percent of dry matter (Schlesinger, 1991; Chan, 1982), and it can be estimated by simply taking a fraction of biomass as (Magnussen and Reed, 2004):

$$C = 0.475 \times B$$

Where C is the carbon content and B is oven dry biomass.
In the present study we follow the above equation to assess the carbon content in different components of *P. deltoides* plantation.

RESULTS

Biomass and carbon allocation

Tree density of 8-year-old *P.deltoides* plantation was 500 trees ha^{-1} and the total tree basal area was 30.1 m^2ha^{-1}. The 8-year-old *P.deltoides* plantation had a mean dbh (diameter at breast height) of 27.69 cm. The total biomass of 8-year-old *P.deltoides* plantation was calculated 202.59 t ha^{-1}, and a single tree accounts about 0.405 t biomass. The above ground components were contributed 78.68% and below ground components were contributed 21.32% biomass to the total biomass (Table 1, Fig. 1). A total of 96.230 t C ha^{-1} was stored in the 8-year-old, short rotation *P.deltoides* plantation and by an average, a single tree accounts about 0.192 t C. Of the total carbon stored in the 8-year-old Poplar plantation, 78.68% carbon was allocated in the above ground components whereas 21.32 % carbon was allocated in the below ground components of the trees (Table 1, Fig. 2).

Table 1. Biomass and carbon allocation in different components of 8-year-old *P. deltoides* agroforestry plantation.

S.No	Components	Biomass	Carbon	Percent contribution
		t ha^{-1}	t ha^{-1}	
1	Bole wood	100.75	47.85625	49.73%
2	Bole bark	14.19	6.74025	7.00%
3	Branch	21.50	10.2125	10.61%
4	Twig	9.17	4.35575	4.53%
5	Leaf	13.80	6.555	6.81%
6	Stump root	26.18	12.4355	12.92%
7	Lateral root	14.72	6.992	7.27%
8	Fine root	2.28	1.083	1.13%
	Total	**202.59**	**96.23**	**100.00%**

DISCUSSION

The level of atmospheric CO_2 is increasing rapidly due to expanding use of fossil fuel, land use changes, deforestation and conversion of forest lands to other activities. Atmospheric level of CO_2 has increased from pre-industrial level of 280 ppm to present level of 375 ppm (Ramachandran *et. al.* 2007). Deforestation is a major anthropogenic cause of net carbon release to the atmosphere, next only to fossil fuel related emissions (Pandey, 2002). The forest ecosystems are the major biological scrubber of atmospheric CO_2 that can be significantly increased by careful management practices. However the global forest cover is declining at an alarming rate as about 13 million hectares of global forests are lost annually (FRA, 2005). In such situation of increasing atmospheric level of CO_2 and continued accelerative rate of deforestation, finding low cost methodologies to sequester increased level of atmospheric carbon into terrestrial ecosystems is a major strategy of most of the developing countries. In the Indian central Himalayan region where people's dependence on forest resources is high, agroforestry systems can play an important role in environmental and ecological sustainability. Agroforestry systems in this region can reduce the pressure on natural forests by providing the much needed fuel and fodder requirements of the peoples and can reduce a significant amount of atmospheric carbon through carbon sequestration in the standing biomass. The carbon allocation in different components of seven dominant forest types of Himalayan region have been studied by Rana *et. al.* (1989), and they have concluded that the carbon allocation in seven dominant forest types of the region ranges from 166.8 t C ha^{-1} to 440.1 t C ha^{-1}. However information on carbon allocation in *P. deltoides* agroforestry plantation in the region is not available. Our study reveals that a considerable amount of carbon allocated in 8-year-old *P.deltoides* agroforestry plantation, which acts as an additional carbon sink in the region, as there are more than 16000 hectares of Poplar plantations exits in the Tarai region of central Himalaya.

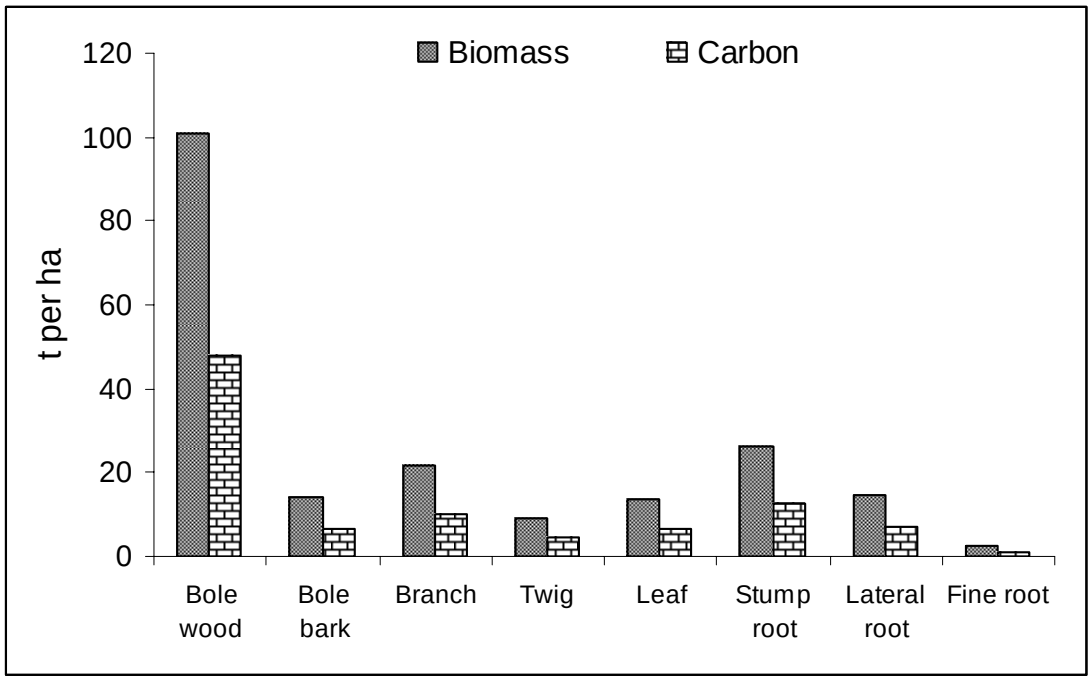

Fig 1. Biomass and carbon allocation in 8-year-old *Populus deltoides* plantation

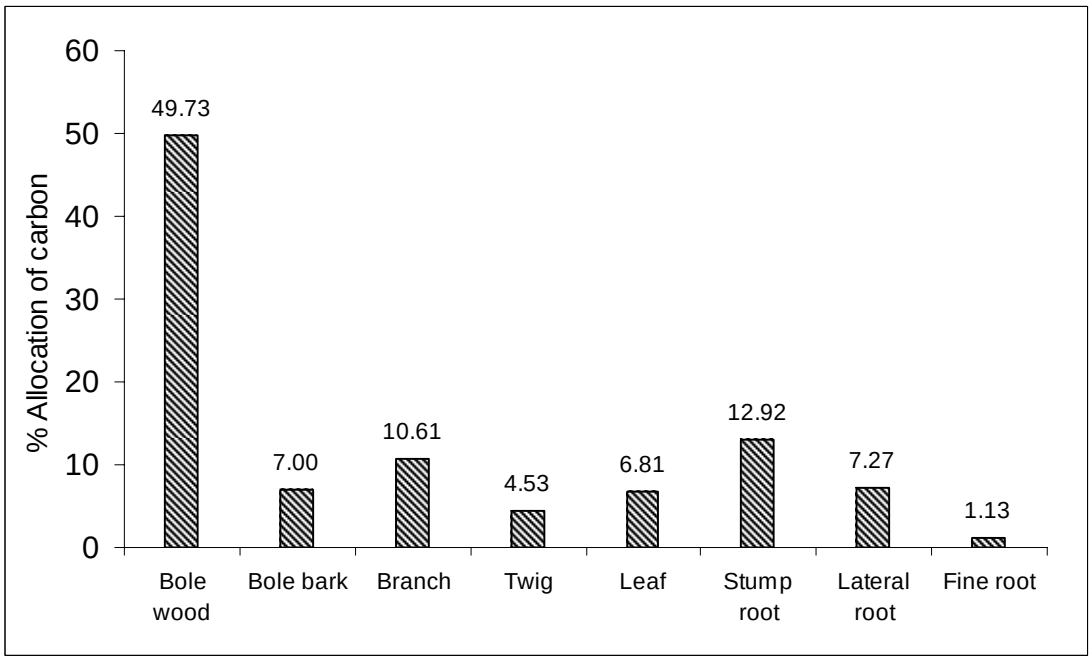

Fig 2. Percent allocation of carbon in different components of *P. deltoides* plantation.

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Litter production pattern and nutrients discharge from decomposing litter in an Himalayan alpine ecosystem

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Abstract: The amount of standing litter biomass varied both in the protected and unprotected sites and was maximum in the protected area. The mineral nutrients concentration *viz*., organic carbon, total nitrogen, total potassium and total phosphorus was also found maximum in the protected area compared to the unprotected area. Also, total nutrient concentration released to soil was also maximum by the protected sites than the unprotected sites. In the present communication, an attempt has been made to study the litter production pattern and nutrients discharge from decomposing litter in an Himalayan alpine ecosystem. [New York Science Journal. 2009;2(6):54-67]. (ISSN: 1554-0200).

Keywords: Alpine, litter, nutrient concentration, nutrient discharge, PRs (protected sites), UNPRs (unprotected sites).

Introduction:

The importance of forest floor components to productivity is well known. The dead organic matter (litter) is one of the most important pathways for the nutrients to the soil surface. Agren and Bosatta (1996) described litter as 'the bridge between plant and soil'. It represents an energy source of heterotrophic organisms, a nutrient reservoir for cycling and a factor influencing hydrology (Christensen, 1975; Chapman *et al*., 1975). Litter on the soil surface intercepts and stores a certain amount of precipitation thus reduce run - off and soil erosion. On the forest floor, it is the imperative link between the autotrophs and heterotrophs (Bray and Gorham, 1964), reduces bulk density, increase water holding and cation - exchange capacity of soil and serves as reserve store of plant nutrients (Hoyle, 1973). Forests litter is an important stage in habitat conservation providing nutrient return and organic matter replenishment (Ashton, 1975). The standing state of litter provides an estimate of the net production of the vegetation (Golly, 1978). Besides having enormous utilities to the ecosystem, the litter paradox yet needs to be explored.

Litter production varies with climate, season, substrate quality and type of vegetation (Hobbie, 1992; Melillo *et al*., 1982; Upadhyay *et al*., 1989; Vitousek *et al*., 1994). Chemical composition of litter, which changes with type of plant community, influences structure and activity of microbial communities inhabiting soils (Kutsch & Dilly, 1999), and biological and physico - chemical properties of topsoil (Heal

& Dighton, 1986). Knowledge of litter production is important when estimating nutrient turnover, C and N fluxes, and C and N pools in different ecosystems.

Litterfall production is related to environmental factors (Finer, 1996; Florence and Lamb, 1975; Kozlowski *et al*., 1990; Hart *et al*., 1992), the vegetation biomass and plant community composition (Pedersen and Hansen, 1999; Hosking, 2003). Because litterfall production reflects the interactions between biological heredity of plants and the influence of environmental fluctuations, litterfall production can be perceived as an indicator of forest condition (Pedersen and Hansen, 1999). Evaluation of litterfall production is also important for understanding nutrient cycling, carbon fluxes and disturbance ecology. For example, significant accumulation or reduction of litterfall amount in some forest communities can cause changes in frequencies of wildfire disturbance (Edmonds *et al*., 2000). The main emphasis in earlier litterfall studies was placed on the amount, composition (Chandler, 1943; Viro, 1955) and distribution (Kittredge, 1948) (summarized by Pedersen and Hansen, 1999). More recently, this literature has shifted to evaluating the ecological role of litterfall in nutrient cycling in forests (Bringmark, 1977; Waring and Schlesinger, 1985; Stevens *et al*., 1989; Haase, 1999; Gordon *et al*., 2000; Zimmermann *et al*., 2002) and its interactions with biotic and non - biotic variables (Prescott *et al*., 2000; Ca´rcamo *et al*., 2000; Trofymow *et al*., 2002; Prescott *et al*., 2004). This shift is important for understanding litterfall production patterns along forest development stages and environmental gradients. For example, based on numerous studies in litter production from world forests, Bray and Gorham (1964) and Albrektson (1988) found that annual litterfall production increased rapidly during stand development until canopy closure, and then remained relatively constant over a long period of time before decreased in old stands. In another study Xiao *et al*. (1998) used data on litterfall and its relationship to environmental variables to calibrate the Terrestrial Ecosystem Model for assessing the sensitivity of net ecosystem production of the terrestrial biosphere to transient changes in atmospheric CO_2 concentrations and climate. The monthly litterfall production pattern is mainly controlled by community characteristics and environmental factors (Huebschmann *et al*., 1999; Sundarapandian and Swamy, 1999; Lu and Liu, 1988; Kavvadias *et al*., 2001; Pedersen and Hansen, 1999). Finer (1996) reported that litterfall in September was 41% of the annual total due to high effective temperature totals. Our results show that litterfall production amounts were much higher in hot and wet months (from April to September) than the rest of year for all studied forests, which is also consistent with studies of similar vegetation types and nearby areas (Chen *et al*., 1992; Tu *et al*., 1993; Weng *et al*., 1993).

Litter production and nutrient release are controlled by a wide variety of chemical properties of the litter, including nitrogen (N) concentration, C : N ratio, phosphorus (P) concentrations or C : P ratio, phenolics concentration and phenolics to N or P ratio and lignin concentration or lignin to N ratio (Coulson and Butterfield, 1978; Meentemeyer, 1978; Schlesinger and Hasey, 1981; Mellilo *et al*., 1982; Berg, 1984; Taylor *et al*., 1989; Van Vuuren *et al*., 1993; Vitousek *et al*., 1994; Aerts and De Caluwe, 1997a; Shaw and Harte a & b, 2001). Litter nutrients release not only depends upon litter composition but also upon soil type, microbial communities and soil properties (Kutsch& Dilly, 1999; Scholes & Walker, 1993; Vitousek & Matson, 1984).

Several studies have been carried out on various aspects of litter in various forest types throughout the world and in India by several workers *viz*., George and Varghese (1990), Gupta and Rout (1992), Pant and Tiwari (1992), Shaver *et al.* (1992), Khiewtam and Ramakrishnan (1993), Pande and Sharma (1993), Das *et al.* (1993), Upadhyay (1993), Visalakshi (1993), Vitousek *et al*. (1994), Woodwell (1994), Chapin *et al*. (1995), Hobbie (1996), Nautiyal (1996), Cadish and Giller (1997), Aerts (1997), Singh and Upadhyay (1997), Singh, Srivastava and Singh (1997), Aerts and Chapin (2000), Gopikumar (2000), Pande *et al.* (2000), Hobbie and Vitousek (2000), Harmon *et al*. (2000), Shaw and Harte a & b (2001), Bahar *et al.* (2001), Lodhiyal *et al.* (2002), Loranger *et al.* (2002) and Aerts *et al.* (2003). Some studies on litter nutrients have been carried out by Venkataramanan *et al*. (1983) and George and Varghese (1990) in India. However, information on litterfall patterns and nutrient release from forests of Garhwal Himalaya, especially from the alpine Himalaya is still in small pockets.

Material and Methods

1. **Field inventory**: We conducted our study in Tungnath, Garhwal Himalaya, Uttarakhand, India. The area lies between 30°14’ N Latitudes and 79°13’ E Longitudes of Western Himalaya and at altitudes between 3400 m and 3750 masl forming two well famed summits *viz*., Rawanshila (3500 m) and Chandrashila (3750 m). Like other alpine and arctic zones of the globe, the climate of this alpine zone is cold, with

intense irradiance and low partial gas pressure. Heavy frost, blizzards and hailstorms prevail throughout the year except for a few months of summer. The timberline in this area reaches upto 3200 m altitude especially on west and north aspects. The meadows here are gentle at the base, becoming gradually steeper until they form summits. Meadows with deep soil cover are seen in northern aspects, while the southern faces generally have large rock spurs and crevices are either barren or have a few lithophytes. The important species of timber line are *Quercus semecarpifolia*, *Abies pindrow*, *Betula alnoidis* and *Rhododendron campanulatum* (Sundriyal and Joshi, 1990; 1992). Above and beyond the tree line, the region is predominated by herbaceous cushion plants. A total of 280 species with 157 genera and 50 families have been reported from this alpine zone (Semwal and Gaur, 1981; Nautiyal *et al*., 2001).

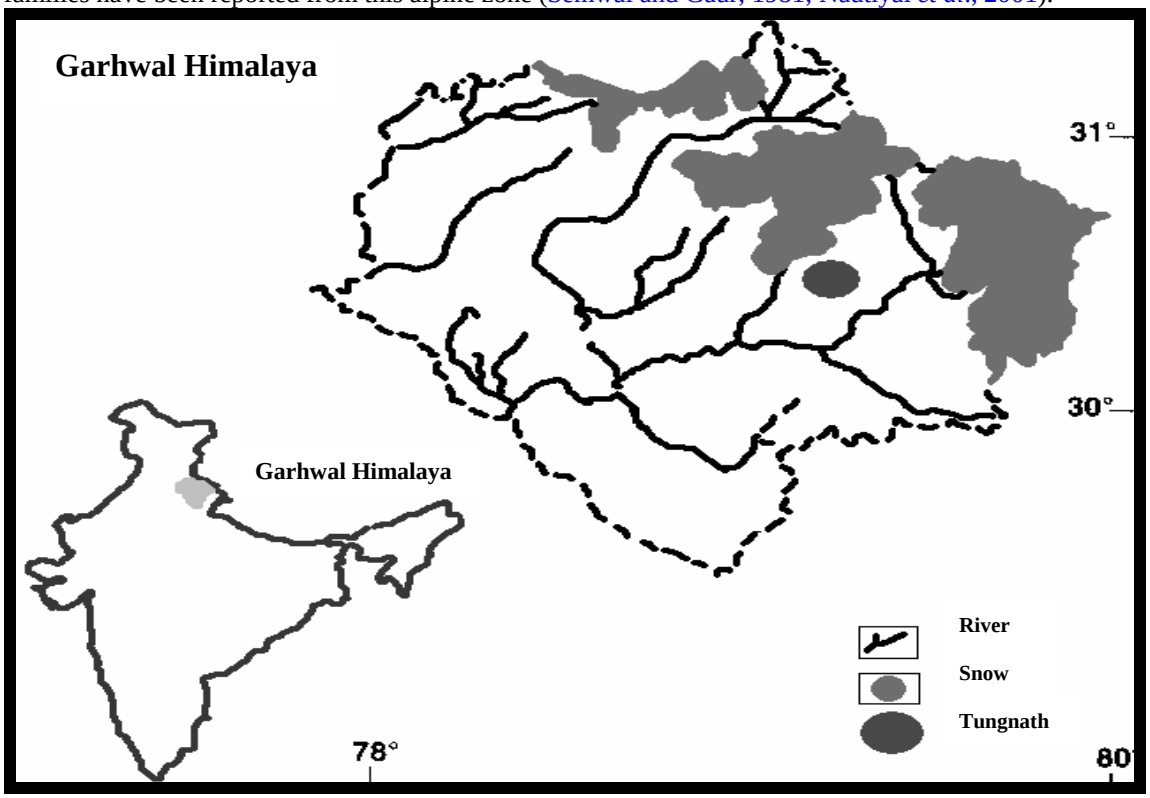

Figure 1. Location map of the study area

2. **Climatological features**: Climatological observations are being presented in Figure 2 - 4. Maximum temperature was recorded in June (26.65 ^{0}C) wherein minimum in October (3.37 ^{0}C). Highest humidity was recorded in August (81.42 %) wherein lowest in June (50.23 %). Maximum rainfall was recorded in July (700.80 mm) wherein minimum in October (88.00 mm). Likewise, number of rainy days were again recorded highest in July (28.00) wherein lowest in October (9.00).

3. **Site description**: The investigations were carried during the growth period (May – October, 2005). Six sites located on different topographical positions were selected. The sites were marked as protected (PR 1, PR 2, PR 3) and unprotected (UNPR 1, UNPR 2, UNPR 3).

Sites	Site characteristics		
	Global position	Altitude (masl)	Aspect
PR 1	N 30^0 29.509' E O79^0 13.110'	3279	North East
PR 2	N 300 29.524' E O79^0 13.090'	3256	North East
PR 3	N 30^0 29.542' E O79^0 13.077'	3243	North East
UNPR 1	N 30^0 29.488' E O79^0 13.081'	3262	North East
UNPR 2	N 30^0 29.467' E O79^o 13.061'	3268	North East
UNPR 3	N 30^0 29.455' E O79^0 12.999'	3259	North East

4. **Experimental methodology**: The litter input was measured from 10 random quadrats laid on the floor of the protected and unprotected areas of the present alpine region. Each quadrat was of 25*25 cm^2 size. Standing litter samples were collected monthly during whole growth period (May – October, 2005). All the litter samples were brought to the laboratory and were accounted for their dry weight (oven dried, 80^0C). Thenafter, the samples from the protected and unprotected areas were grounded separately and analyzed for the macro – nutrients *viz*., organic carbon, total nitrogen, total potassium and total phosphorus. The nutrient concentration was multiplied by the weight of annual litter fall to compute the amounts of nutrients transferred to the forest floor.

5. **Standard methods opted for nutrients analysis**: Following methods were employed for nutrient analysis,
Organic carbon - Okalebo *et al*. (1993),
Total nitrogen - Allen (1974),
Total potassium and total phosphorus - Mahapatra *et al*. (1999).

Results

1. **Monthly variation in the amount of standing litter biomass (gm^{-2})**: Amount of standing litter varied from 22.50 gm^{-2} to 632.50 gm^{-2} in protected sites and from 20.00 gm^{-2} to 167.50 gm^{-2} in unprotected sites. Maximum standing litter was recorded in PR 1 (632.50 gm^{-2}) in October wherein minimum in UNPR 1 (20.00 gm^{-2}) in June (Table 1).

2. **Monthly variation in organic carbon content of standing litter (%)**: Organic carbon content of standing litter varied from 1.83±0.06 % to 4.75±0.06 % in protected sites and from 1.05±0.03 % to 3.60±0.26 % in unprotected sites. Maximum organic carbon content was recorded in PR 3 (4.75±0.06 %) in September wherein minimum in UNPR 1 (1.05±0.03 %) in October. Variation on account of ANOVA (among months in individual site and between sites in each month) was found significant at $p<0.001$ (Table 2).

3. **Monthly variation in total nitrogen content of standing litter (%)**: It is evident from Table 3 that total nitrogen content of standing litter varied from 0.08±0.03 % to 0.36±0.04 % in protected sites and from 0.05±0.01 % to 0.25±0.04 % in unprotected sites. Maximum total nitrogen was recorded in PR 3 (0.36±0.04 %) in October wherein minimum in UNPR 2 (0.05±0.01 %) in May. Variation on account of ANOVA, among months in individual site was found significant at $p<0.001$ except UNPR 3 ($p<0.01$) and between sites in each month was also found significant at $p<0.001$ except September ($p<0.01$).

4. **Monthly variation in total potassium content of standing litter (%)**: Total potassium content of standing litter varied from 2.54±0.08 % to 7.17±0.22 % in protected sites and from 1.53±0.42 % to 5.28±0.15 % in unprotected sites. Maximum total potassium was recorded in PR 3 (7.17±0.22 %) in October wherein minimum in UNPR 3 (1.53±0.09 %) in May. Variation on account of ANOVA (among months in individual site and between sites in each month) was found significant at $p<0.001$ (Table 4).

5. **Monthly variation in total phosphorus content of standing litter (%)**: It is evident from Table 5 that total phosphorus content of standing litter varied from 0.0082±0.0011 % to 0.0173±0.0015 % in protected sites and from 0.0037±0.0021 % to 0.0157±0.0031 % in unprotected sites. Maximum total phosphorus was recorded in PR 2 (0.0173±0.0015 %) in October wherein minimum in UNPR 3 (0.0037±0.0021 %) in July. Variation on account of ANOVA, among months in individual site was found significant at $p<0.01$ (PR 2, PR 3, UNPR 2) and at $p<0.001$ (UNPR 3) wherein rest of the sites, variation was observed as non – significant. Variation among sites in each month was found significant at $p<0.001$ except May ($p<0.05$).

6. **Monthly variation in C: N ratio of standing litter**: Table 6 displays that C: N ratio of standing litter varied from 7.20 to 35.00 in protected sites and from 4.20 to 45.00 in unprotected sites. Maximum C: N ratio was recorded in UNPR 2 (45.00) in September wherein minimum in UNPR 1 (4.20) in October.

7. **Monthly variation in total nutrient concentration (gm^{-2}) released into the soil**: Table 7 executes that maximum nutrient concentration was released by the protected sites compared to the unprotected sites.

Total organic carbon content of standing litter released into the soil varied from 6095.72 gm^{-2} (PR 1) to 127.41 gm^{-2} (UNPR 2). Total nitrogen content of standing litter released into the soil varied from 830.16 gm^{-2} (PR 1) to 4.22 gm^{-2} (UNPR 2). Total potassium content of standing litter released into the soil varied from 11954.25 gm^{-2} (PR 1) to 129.09 gm^{-2} (UNPR 2). Total phosphorus content of standing litter released into the soil varied from 35.10 gm^{-2} (PR 1) to 0.69 gm^{-2} (UNPR 3)

Table 1. Monthly variation in the amount of standing litter biomass (gm^{-2})

Months	Standing litter biomass (gm^{-2})					
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3
May	37.50	60.00	45.00	52.50	22.50	42.50
June	102.50	22.50	180.00	20.00	22.50	55.00
July	150.00	70.00	87.50	45.00	30.00	97.50
Aug.	122.50	72.50	87.50	95.00	87.50	42.50
Sep.	223.50	105.80	98.99	101.30	99.75	78.89
Oct.	632.50	246.63	220.00	167.50	120.00	147.50

Table 2. Monthly variation in organic carbon content of standing litter (%)

Months	Organic Carbon content (%)						P value
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3	
May	2.23±0.10	2.46±0.09	2.73±0.12	1.31±0.07	1.51±0.04	2.04±0.04	*
June	3.34±0.15	3.33±0.24	3.69±0.36	2.70±0.23	2.61±0.37	2.08±0.07	*
July	3.44±0.05	3.70±0.10	3.47±0.12	2.38±0.18	2.44±0.05	2.17±0.03	*
Aug.	2.80±0.10	2.60±0.10	1.83±0.06	1.18±0.08	1.08±0.02	1.45±0.06	*
Sep.	3.88±0.10	4.55±0.06	4.75±0.06	3.20±0.10	3.60±0.26	3.04±0.04	*
Oct.	2.57±0.21	2.52±0.26	2.67±0.11	1.05±0.03	1.20±0.09	1.84±0.05	*
P value	*	*	*	*	*	*	

* Significant at p<0.001

Table 3. Monthly variation in total nitrogen content of standing litter (%)

Months	Total Nitrogen content (%)						P value
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3	
May	0.17±0.02	0.11±0.01	0.15±0.04	0.07±0.02	0.05±0.01	0.08±0.01	*
June	0.23±0.01	0.22±0.05	0.20±0.03	0.09±0.03	0.11±0.03	0.15±0.03	*
July	0.24±0.04	0.22±0.04	0.25±0.04	0.11±0.02	0.14±0.03	0.09±0.03	*
Aug.	0.08±0.03	0.15±0.03	0.16±0.03	0.09±0.01	0.05±0.03	0.07±0.03	*
Sep.	0.27±0.02	0.22±0.05	0.20±0.06	0.17±0.03	0.08±0.04	0.17±0.02	**
Oct.	0.35±0.04	0.35±0.04	0.36±0.04	0.25±0.04	0.19±0.03	0.14±0.05	*
P value	*	*	*	*	*	**	

* Significant at p<0.001, ** p<0.01

Table 4. Monthly variation in total potassium content of standing litter (%)

Months	Total Potassium content (%)						P value
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3	
May	2.54±0.08	3.24±0.25	3.85±0.05	2.09±0.09	1.53±0.42	1.53±0.09	*
June	2.98±0.02	3.75±0.07	3.98±0.02	3.12±0.09	2.53±0.07	2.44±0.05	*
July	5.02±0.14	5.13±0.07	5.22±0.22	4.13±0.05	4.39±0.32	3.08±0.09	*
Aug.	5.44±0.10	5.38±0.11	6.89±0.17	4.10±0.10	4.17±0.34	3.74±0.22	*
Sep.	5.35±0.21	5.75±0.14	6.38±0.14	5.10±0.06	4.58±0.27	3.97±0.31	*
Oct.	5.04±0.10	6.61±0.08	7.17±0.22	5.28±0.15	4.65±0.34	4.10±0.05	*
P value	*	*	*	*	*	*	

* Significant at p<0.001

Table 5. Monthly variation in total phosphorus content of standing litter (%)

Months	Total Phosphorus content (%)						P
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3	
May	0.0153±0.0025	0.0167±0.0025	0.0153±0.0015	0.0100±0.0010	0.0143±0.0025	0.0157±0.0031	***
June	0.0128±0.0016	0.0142±0.0016	0.0170±0.0010	0.0087±0.0015	0.0100±0.0026	0.0061±0.0021	*
July	0.0147±0.0030	0.0082±0.0011	0.0110±0.0010	0.0063±0.0031	0.0075±0.0022	0.0037±0.0021	*
Aug.	0.0133±0.0016	0.0160±0.0026	0.0127±0.0021	0.0053±0.0042	0.0073±0.0015	0.0043±0.0025	*
Sep.	0.0146±0.0022	0.0148±0.0023	0.0167±0.0015	0.0047±0.0047	0.0047±0.0031	0.0060±0.0020	*
Oct.	0.0148±0.0023	0.0173±0.0015	0.0127±0.0015	0.0043±0.0025	0.0067±0.0025	0.0047±0.0021	*
P value	NS	**	**	NS	**	*	

* Significant at p<0.001, ** p<0.01, *** p<0.05, NS = Non - significant

Table 6. Monthly variation in C:N ratio of standing litter

Months	C:N ratio					
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3
May	13.12	22.36	18.20	18.71	30.20	25.50
June	14.52	15.14	18.45	30.00	23.73	13.87
July	14.33	16.82	13.88	21.64	17.43	24.11
Aug.	35.00	17.33	11.44	13.11	21.60	20.71
Sep.	14.37	20.68	23.75	18.82	45.00	17.88
Oct.	7.34	7.20	7.63	4.20	6.32	13.14

Table 7. Monthly variation in total nutrients concentration (gm^{-2}) released into the soil

Months	Total nutrient concentration (gm^{-2}) released into the soil					
	Organic carbon					
	PR 1	PR 2	PR 3	UNPR 1	UNPR 2	UNPR 3
May	313.59	553.50	460.69	257.91	127.41	325.13
June	1283.81	280.97	2490.75	202.50	220.22	429.00
July	1935.00	971.25	1138.59	401.63	274.50	793.41
Aug.	1286.25	706.88	600.47	420.38	354.38	231.09
Sep.	3251.93	1805.21	1763.26	1215.60	1346.63	899.35
Oct.	6095.72	2330.65	2202.75	659.53	540.00	1017.75
	Total nitrogen					
May	23.91	24.75	25.31	13.78	4.22	12.75
June	88.41	18.56	135.00	6.75	9.28	30.94
July	135.00	57.75	82.03	18.56	15.75	32.91
Aug.	36.75	40.78	52.50	32.06	16.41	11.16
Sep.	226.29	87.29	74.24	64.58	29.93	50.29
Oct.	830.16	323.70	297.00	157.03	85.50	77.44
	Total potassium					
May	357.19	729.00	649.69	411.47	129.09	243.84
June	1145.44	316.41	2686.50	234.00	213.47	503.25
July	2823.75	1346.63	1712.81	696.94	493.88	1126.13
Aug.	2499.00	1462.69	2260.78	1460.63	1368.28	596.06
Sep.	4483.97	2281.31	2368.34	1937.36	1713.21	1174.47
Oct.	11954.25	6113.34	5915.25	3316.50	2092.50	2267.81
	Total phosphorus					
May	2.15	3.76	2.58	1.97	1.21	2.50
June	4.92	1.20	11.48	0.65	0.84	1.26
July	8.27	2.15	3.61	1.06	0.84	1.35
Aug.	6.11	4.35	4.17	1.89	2.40	0.69
Sep.	12.24	5.87	6.20	1.79	1.76	1.78
Oct.	35.10	16.00	10.48	2.70	3.02	2.60

Table 8. Relationship between temperature and monthly nutrient concentration of different sites

Sites	OC		TN		TK		TP	
	r	r^2	r	r^2	r	r^2	r	r^2
PR 1	0.61	0.37	-0.32	0.10	0.72	0.52	-0.59	0.35
PR 2	0.42	0.18	0.01	0.00	0.43	0.18	-0.35	0.12
PR 3	0.05	0.00	-0.12	0.01	0.51	0.26	-0.22	0.05
UNPR 1	0.32	0.10	-0.06	0.00	0.49	0.24	-0.58	0.34
UNPR 2	0.23	0.05	-0.13	0.02	0.64	0.42	-0.72	0.51
UNPR 3	-0.02	0.00	0.00	0.00	0.62	0.39	-0.79	0.63

Table 9. Relationship between rainfall and monthly nutrient concentration of different sites

Sites	OC		TN		TK		TP	
	r	r^2	r	r^2	r	r^2	r	r^2
PR 1	-0.09	0.01	-0.76	0.57	0.52	0.27	-0.24	0.06
PR 2	-0.20	0.04	-0.43	0.18	0.19	0.04	-0.08	0.01
PR 3	-0.58	0.33	-0.37	0.14	0.43	0.19	-0.52	0.27
UNPR 1	-0.35	0.12	-0.33	0.11	0.09	0.01	-0.31	0.09
UNPR 2	-0.40	0.16	-0.45	0.21	0.31	0.09	-0.21	0.05
UNPR 3	-0.49	0.24	-0.69	0.47	0.28	0.08	-0.29	0.08

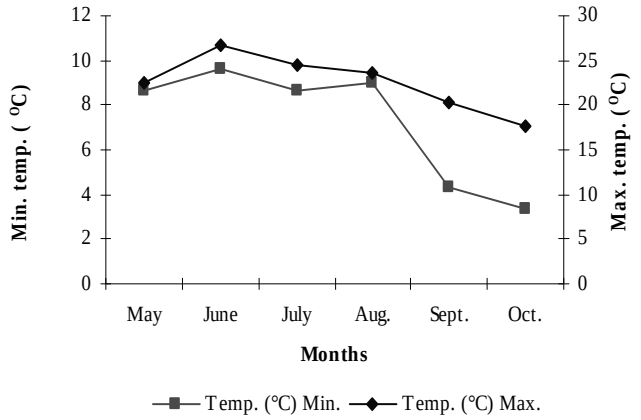

Figure 2. Monthly variation in min./max. temperature (^{0}C)

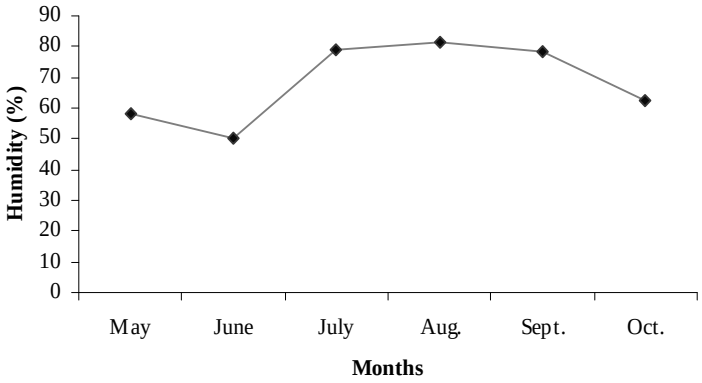

Figure 3. Monthly variation in humidity (%)

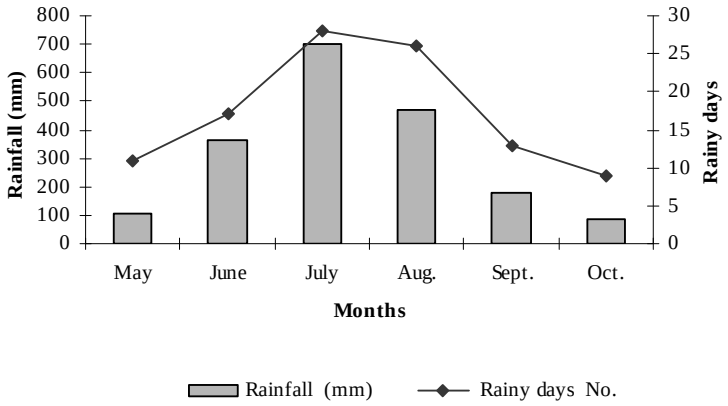

Figure 4. Monthly variation in rain fall (mm) and No. of rainy days

Discussion

The relocate of matter and energy between autotrophs, heterotrophs and decomposers maintains the reliability of an ecosystem. A major part of the annual gain of energy and matter by plants is shed as litter, which enters into decomposition subsystem as detritus and plays a key role in the ecosystem structure and function (Christensen, 1975).

Evaluation of litterfall production is important for understanding nutrient cycling, forest growth, successional pathways and interactions with environmental variables in forest ecosystems (Zhou *et al*., 2007). Litter production varies with climate, season, substrate quality and type of vegetation (Hobbie, 1992; Melillo *et al*., 1982; Upadhyay *et al*., 1989; Vitousek *et al*., 1994). Chemical composition of litter, which changes with type of plant community, influences structure and activity of microbial communities inhabiting soils (Kutsch & Dilly, 1999), and biological and physicochemical properties of topsoil (Heal & Dighton, 1986). Knowledge of litter production is important when estimating nutrient turnover, C and N fluxes, and C and N pools in different ecosystems. Release of nutrients not only depends upon litter composition but also upon soil type, microbial communities and soil properties (Kutsch & Dilly, 1999; Scholes & Walker, 1993; Vitousek & Matson, 1984).

In the present study, amount of standing litter was found maximum in the protected sites compared to the unprotected sites which could be accredited to the rich vegetation cover of the particular area. Also, the topographic, biotic and anthropogenic pressures are not much more pronounced in the protected area. Grazing pressure, types of interactions, seasonal invading by localites and tribes, unusual curiosity of the tourists, mythological believes, the trend of flower offering in temples, illegal harvesting from wild and natural calamities are some of the factors which directly or indirectly affect the vegetation cover and same is true for the present study area (Rawat, N. - Personal observations). Sundriyal (1994) has also reported some of the abovementioned factors as important in maintaining the vegetational outlook of an area. Nautiyal (1996), Nautiyal *et al.* (2001), Semwal (2006) and Anthwal (2006) had also pointed out the abovmentioned factors responsible for variation in the structural composition of an area which in turn are responsible for the litter production and nutrient release patterns.

Amount of all the four macro – nutrients, was recorded maximum in the protected sites compared to the unprotected sites. Number of possible reasons could be attributed, but through the present annotations, it appears that high turnover rate (TR), low atmospheric and soil temperatures (Cadisch and Giller, 1997; Sangha *et al*., 2006) in the unprotected area compared to protected one are the doable reasons. Other litter parameters such as toughness and lignin content including cellulose and hemicellulose have been reported as factors which affect the nutrient release patterns (Taylor *et al*., 1989) and yet, also needs to be investigated in detail. Another probable reason is poor documentation of the litterfall production patterns and nutrient release, especially, from the belowground compartment in alpine ecosystems which needs immediate attention in order to understand the role of plant species completely in releasing nutrients.

C: N ratio was found maximum in the unprotected site compared to the protected site. This variation could be attributed to the mode of organic matter which the unprotected area receives through uniform distribution of animal feces/excreta, trampling and human influenced land disturbance. The most commonly mentioned factors that may regulate the litter decay are related with litter quality including N

elemental concentrations and ratios such as C: N and C: P (Berg *et al.*, 1982; Berg and Ekbohm, 1983; Berg and McClaugherty, 1989); organic matter fractions such as lignin (Meentemeyer, 1978; Taylor *et al*., 1989), ligno - cellulose index (Berg *et al*., 1984), lignin: N index (Berg and Ekbohm, 1983; Taylor *et al*., 1989), alkyl C content of waxes and cutin (Trofymow *et al*., 1995), elevated CO_2 concentration.(De Angelis *et al*., 2000) and tannin contents (Mesquita *et al*., 1998). These considerations are more important under litter diversity conditions. However, when the substrate is the same, the chemical composition cannot be correlated to the decomposition rate.

When monthly organic carbon content of each site was co – related with temperature, positive correlation was recorded mostly at all sites (r = 0.61, 0.42, 0.05, 0.32, 0.23) and there was 0.37, 0.18, 0.00, 0.10 and 0.05 percent variation. Only, the organic carbon content of UNPR 3 was found negatively co – related with temperature (r = 0.02) and there was negligible percent variation. Likewise, monthly total nitrogen content of each site was co – related with temperature, negative correlation was recorded mostly at all sites (r = 0.32, 0.12, 0.06, 0.13) and there was 0.10, 0.01, 0.00 and 0.02 percent variation. Only, the organic carbon content of PR 2 and UNPR 3 was found positively co – related with temperature (r = 0.02) and there was 0.01 and 0.00 percent variation. Monthly total potassium content of each site when, was co – related with temperature, positive correlation was recorded for all sites (r = 0.72, 0.43, 0.51, 0.49, 0.64 and 0.62) and there was 0.52, 0.18, 0.26, 0.24, 0.42 and 0.39 percent variation. Similarly, monthly total phosphorus content of each site when, was co – related with temperature, negative correlation was recorded for all sites (r = 0.59, 0.35, 0.22, 0.58, 0.72 and 0.79) and there was 0.35, 0.12, 0.05, 0.34, 0.51 and 0.63 percent variation (Table 8).

When monthly organic carbon content of each site was co – related with rainfall, negative correlation was recorded mostly at all sites (r = 0.09, 0.20, 0.58, 0.35, 0.40 and 0.49) and there was 0.01, 0.04, 0.33, 0.12, 0.16 and 0.24 percent variation. Likewise, monthly total nitrogen content of each site was co – related with temperature, negative correlation was recorded mostly at all sites (r = 0.76, 0.43, 0.37, 0.33, 0.45 and 0.69) and there was 0.57, 0.18, 0.14, 0.11, 0.21 and 0.47 percent variation. Monthly total potassium content of each site when, was co – related with temperature, positive correlation was recorded for all sites (r = 0.52, 0.19, 0.43, 0.09, 0.31 and 0.28) and there was 0.27, 0.04, 0.19, 0.01, 0.09 and 0.08 percent variation. Similarly, monthly total phosphorus content of each site when, was co – related with temperature, negative correlation was recorded for all sites (r = 0.24, 0.08, 0.52, 0.31, 0.21 and 0.29) and there was 0.06, 0.01, 0.27, 0.09, 0.05 and 0.08 percent variation (Table 9).

Release of nutrients not only depends upon litter composition but also upon soil type, microbial communities and soil properties (Kutsch & Dilly, 1999; Scholes & Walker, 1993; Vitousek & Matson, 1984). Plant chemical composition significantly impacts on (e.g. microbial immobilization and nitrification) nutrient cycling, as these ecosystem functions improve with increased plant diversity (Hooper, 1996; Hooper & Vitousek, 1998). Also, high stocking rates lead to reduced litter production and root biomass (Cantarutti *et al*., 2002; Christie, 1979). From an ecological perspective, Grubb (1989) explained with examples from different ecosystems that poor soils support vegetation communities which are adapted to poor nutrient status. There is a two - way relationship between structure or type of vegetation communities and soils, and it is still not clear which plays a greater role in determining the other (Grubb, 1989).

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Comparative Analysis of Poverty Status of Community Participation in Rural Development Projects of Akwa Ibom State, Nigeria

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ABSTRACT: The study was designed to comparatively analyze the poverty status of community participation in selected rural development projects of Ini and Abak Local Government Areas (LGA's) of Akwa Ibom State, Nigeria. It was as a result of the observation that systematic research aimed at understanding factors influencing poverty status through community participation in the two L.G.A's seemed to be lacking despite the presence of many development projects in these communities. The selected development projects included-electricity, pipe borne water, school blocks, and road rehabilitation. The multi-stage sampling technique was adopted. Ini and Abak LGA's were purposively selected on the basis of their proximity to the state capital, Uyo. A total of 200 community members were randomly sampled from ten households in five villages, in two wards, within two autonomous communities of the study areas. However, only 161 respondents who completed all the questionnaire items were actually used for data analysis. Descriptive statistics and the Maximum Likelihood Probit Regression Analysis were used in the analyses. Results revealed that more males (78.6%) than females participated in Ini LGA, while in Abak, more females (57.14%) participated in the development projects. In comparison, the maximum probit analysis revealed that communities in Ini L.G.A, participated more in self-help project than Abak Communities. Perhaps, this could be explained by the proximity of Ini to the state capital. The L.G.A was almost neglected in development projects resulting from its location which is about 66km from the state capital. The communities in Ini L.G.A, struggled on their own to provide the needed infrastructure for development purposes. On the other hand, Abak L.G.A is closely located to the state capital, and the communities thereof expected the state government to provide most of the needed infrastructures. There were low level of education in the study areas. Other obstacles to participation included: lack of economic power, high cost of living, inadequate monitoring of projects, and embezzlement of funds. Based on the above findings, the following were recommended: formal and informal education should be emphasized to create awareness of development projects. Governments should improve road networks to enable farmers sell their farm produce to other communities and beyond, profitable time management strategy is equally necessary for those employed in formal occupation in order to participate in the development of their communities. Wealthy individuals and groups in these communities should assist in the rehabilitation of projects in their communities. [New York Science Journal. 2009;2(6):68-75]. (ISSN: 1554-0200).

Keywords: Community participation, Rural development, Projects, Comparative analysis

Introduction

According to Imoh (2002) study on Family size and participation of women in the Socio-economic Development of Mbaise, observed that forty-two years after Nigeria's independence, most rural areas in Nigeria demonstrate characteristics that indicate lack of prosperity. This situation has not changed much even today. Participatory rural development seeks to improve the social, economic, political, and capacities of the rural people. Unless rural people are given the opportunity and means to fully participate in development projects, they will continue to be excluded from its benefits. However, many governments, non-governmental organizations, and development agencies have recognized that the top-down approach which is characteristic of the traditional development strategies has largely failed to reach and actually benefit the rural poor.

It is on record that inspite of various efforts at developing rural areas, poverty, ignorance and disease are still very prevalent in Nigerias rural areas. Chigbo (2001) opined that most of the rural development projects failed because of faulty goal specification, fraud, and inadequate funding. In the same vein, most of these projects were either borrowed or merely forced on the people, without due consideration of the political and cultural norms, which of course resulted in failure (Adagba, 2002).

To overcome this ugly situation, a new approach has evolved. This is called "popular participation" whereby local people take initiatives or influence their own development. It implies the active involvement of the rural people, particularly the dis-advantaged groups that form the mass of the rural population. The philosophy guiding this approach is that the resources of the community are mobilized by the community for the good of the community. It should be anchored on the cooperative efforts of the people with or without any external stimuli (FAO 1996; Ikeji 2003). Such participation is essential at all stages of the project – from conception, through planning, implementing, to monitoring and evaluation.

Problem Statement

It has been observed that inspite of abundant natural, physical and human resources that Nigeria is endowned with, there is still high incidence rate of poverty in Nigeria especially in the rural areas. In Akwa Ibom State, majority of the people live in the rural areas and they depend mainly on agriculture. They operate fragmented and maginal holdings while some others concentrate on artisanal fishing. Despite the obvious role of farming and artisanal fishing in the economy of the state, rural people tend to remain poor. In general they share several characteristics such as low levels of educational attainment, a relatively large number of children, relatively low access to material resources, physical and social infrastructures, higher susceptibility to community-wide exogenous shocks such as weather induced crop losses and natural disasters. However, it must be noted that rural communities also vary greatly with regard to the condition of their rural economies and rural development needs.

Communities in Ini and Abak Local Government Areas of Akwa Ibom State, Nigeria have been involved in community development projects over the years, but their participation output seemed not to have yielded any dividends of prosperity. It was further observed that systematic research aimed at understanding factors influencing poverty status of the above named communities through participation in community development projects seemed to be lacking. These communities need improvement in the quality of their living standards. This, therefore, was of great concern, hence the decision to investigate the status of the communities in these two L.G.A's through their participation in community development projects. At this juncture, it became pertinent to ask a series of questions to which this work intended to address. What were the on-going community development projects in Ini and Abak LGA's ? To what extent did the people of Ini and Abak participate in the development of their communities through development projects? What factors influenced peoples participation in community development projects? How did their participation affect their living standards? What were the major obstacles to effective participation in development projects in the study area?

Objective of the Study

The broad objective of the study was to comparatively analyze community participation in development projects of Ini and Abak LGA's . In order to achieve this objective, the following specific objectives were to:

1. identify the socio-economic characteristics of respondents in the study areas;
2. select relevant community development projects in the two study areas;
3. determine factors that influence participation of people in community development projects in the two areas;
4. compare community participation between the people of Ini and Abak LGA's;
5. determine obstacles militating against community participation in development projects.

Today, it is widely accepted that main (homo sapiens) is the central link and principal agent for development process (Imoh, 2002). If the above statement is correct, and if development has to do with improvement of the quality of life of the people, then community participation is very crucial to development. This study is therefore justified as it offers a scientific insight into the influence of development projects on living standards through participation.

Methodology

The study area comprised of Ini and Abak L.G.A's of Akwa Ibom State, Nigeria. Geographically, the state is one of the core Niger Delta States and is located in the south-south geopolitical zone. The state lies between latitudes $4^{o}31$" and $5^{o}31$" North, and Longitudes $7^{o}25$" and $8^{o}25$" East of the Equator. It has a

total land mass estimated at 7,245,935km^2. The state has common borders with Cross Rivers State to the East, Abia State to the North, Rivers state to the West, and Atlantic Ocean by the South (AKADEP, 2006). It is made up of 31 LGA's with Uyo as the state capital.

Akwa Ibom State had a population figure of 3,920,208 with 2,044,510 males and 1,875,698 females; and a population density of 587 people per km^2 (FRN, Gazette 2007). The climate of the state falls within the tropical rain forest zone. The annual rainfall is estimated at 2000mm in the hinterland and 2400 mm along the coast. The state is an agricultural state and is rich in culture with institutions like Ekpo, Eong, Akata, etc; which play positive roles in promoting social, economic, and political development of the area.

Ini LGA is located at about 66km away from the state capital, on the extreme north of the state. The 2006 population census gave a total population figure of 99,196 people of which 52,644 were males, and 46,552 were females (NPC, 2007). This L.G.A is generally regarded as the "food basket' of Akwa Ibom State. The people produce rice, cassava, plantain, maize, cocoyam, and vegetables. The area is also endowed with abundant natural resources such as petroleum, limestone, gold, copper, and lignite among others (Idachaba, 1991).

Abak L.G.A,on the other hand, is located at about 18km away from the state capital, Uyo. This L.G.A had a population figure of 139,090 people in 2006, which comprised 73,578 males and 65,512 females (NPC, 2007). The major occupation of the people is agriculture, especially in palm produce. Others include mineral resources.

The study population comprised of men and women who are aged 18 years and above in conformity with the national population policy on age irrespective of their occupation, literacy level and socio-economic status, participation was seen as a strategy for community development.

Sampling Procedure

The study adopted the multi-stage sampling technique. The two L.G.A's, Ini and Abak, were purposively selected out of 31 L.G.A's in the State, on the basis of their proximity to the state capital. While Abak is at the nucleus of the state capital, Ini is 66km away.

Then, two clans were randomly selected from each LGA, giving a total of four clans. In each clan, five villages were randomly selected, giving a total of 20 villages. Finally, ten household per village were also randomly selected which gave rise to a total number of two hundred households from the list of households in each village (sampling frame) where respondents were actually selected for the study. The sample size therefore, is 200.

Instruments/Data Collection Techniques

The major instrument used for this study was the questionnaire which sought information about the socio-economic and demographic characteristics of the respondents, and other general questions on community participation and development. The questionnaire items consisted of both open and fixed choice questions. They were administered as face-to-face interview to all respondents. This was to ensure uniformity in the interpretation of concepts, and to create room for possible clarification where necessary.

Trained enumerators were used to administer the questionnaire and to interprete in their local dialect where necessary. Data collected were those on awareness of development projects, level of participation, urban exposure and problems encountered,in addition to socio-economic characteristics.

Analytical Technique

Data generated were subjected to statistical analysis using both descriptive and inferential statistics. Objectives i, ii, and v were achieved using descriptive statistics while the Maximum Likelihood Probit analysis was employed to achieve the relationship between the dependent and independent variables.

Model Specification

The model is implicitly specified as follows:

$Y = f(X_1, X_2, X_3, X_4 \ldots\ldots\ldots\ldots X_n, e)$ ……. (1)

Where:

Y = Participation (participation = 1; no participation = 0)

X_1 = Sex (male = 1; Female = 0)

X_2 = Age (in years)
X_3 = Marital Status (married = 1; if otherwise = 0)
X_4 = Household size (2-6 = 1; 7 and above = 0)
X_5 = Occupation (formal = 1; informal = 0)
X_6 = Religion (christianity = 1; if otherwise = 0)
X_7 = Educational level (years of schooling)
X_8 = Years spent in the community (in years)
X_9 = Urban exposure (exposed = 1; not exposed = 0)
X_{10} = Awareness (aware = 1; not aware = 0)
e = error term.

Explicity, $Y = b_0 + b_1x_1 + b_2x_3 + b_4x_4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_{10}x_{10} + e$

Where Y = participation
b_0 = constant/intercept
b_1-b_{10} = regression parameters to be estimated
X's = as already defined above
e = error term

Result and Discussions

Major findings of this study are discussed according to the study objectives. The socio-economic characteristics of Ini and Abak respondents are presented in Table 1.

Table 1: Distribution of respondents according to socio-economic characteristics

	INI		ABAK	
Variables	**Frequency**	**%**	**Frequency**	**%**
Sex: Male	66	78.57	33	42.86
Female	18	21.43	44	57.14
Age: 18-27	10	11.90	45	58.44
28-37	37	44.05	20	25.97
38-47	29	34.52	07	09.09
48-57	06	7.14	02	02.60
58 and above	02	2.38	03	03.90
Marital Status: Married	66	78.57	32	41.56
Single	18	21.43	42	54.55
Household Size: 2-6	57	67.86	46	59.97
7 and above	29	32.14	31	40.26
Occupation: Formal	50	59.52	40	51.94
Informal	34	40.48	37	40.05
Religion: Christian	82	97.62	76	98.70
Muslim	01	01.19	01	01.30
Others	01	01.19	-	-
Education level: Primary	04	04.76	09	09.09
Secondary	36	42.86	22	28.57
Tertiary	44	52.38	48	62.33
Urban Exposure: < 5 years	06	07.14	07	09.09
5 years and above	78	92.85	70	90.90
Awareness: Aware	77	91.67	66	85.71
Not aware	07	08.33	11	14.29
Total (n) 161	**84**	**100**	**77**	**100**

Source: Survey data, 2008

The table shows that majority of the respondents (78.57%) in Ini were males, while (57.14%) in Abak were females. More males participated in Ini, and this could be as a result of the traditional male dominance in every sphere of human endeavour which renders women as mere housewives, firewood collectors, and homemakers. Abak on the other hand, is more urban-like and the cultural pattern of male

dominance is on the decrease because of the influence of the state capital in terms of civilization and enlightenment.

The table reveals that young people aged 18-37 years were found to have participated in development projects in the study area which were represented by 55.95% in Ini and 84.4% in Abak. The lower percentage in Ini when compared to Abak could be as a result of migration of able bodied young people to urban centers in search of better opportunities according to Imoh (2002). However, young people formed the preponderance of community participation in the two LGA's. Younger people tend to be more actively involved in development projects of their communities than older people.

The educational level of respondents was fairly high especially for those of Abak L.G.A. Majority of the respondents (62.33% had education at the tertiary level (i.e, OND – first degree). This also could be as a result of the nearness of Abak to the state capital where the University and other educational institutions are located.

Development Projects in Ini and Abak L.G.A's

At the time of this survey, three different major projects were going on in Ini and Abak Local government areas. These projects include water, electricity, school block, and road rehabilitation. Table 2 shows that about 73.8% of respondents in Ini L.G.A, participated in electricity project than other projects in the area. In Abak L.G.A, most of the respondents (61.3%) also participated in electricity project than others. These projects form the felt needs of community members. This agrees with Ekong (2003), who asserts that the community's "felt needs" must be met before tackling the "real needs". Community projects therefore, can only succeed and yield the expected dividends if the felt needs of the people are met.

Table 2: Distribution of Respondents According to On-going Projects

Projects	**INI**		**ABAK**	
	Frequency	**%**	**Frequency**	**%**
Electricity	62	73.8	47	61.3
Water	40	47.6	38	49.3
School Block	36	42.8	-	-
Road Rehabilitation	-	-	27	35.0
Total (multiple response)	84		77	

Source: Survey data, 2008

Determinants of Participation in Ini and Abak L.G.A's.

Table 3, shows the result of the Maximum Likelihood Probit analysis of the determinants of participation in community development projects of Ini and Abak Local gogernment areas. The result indicated that about 95% of the variables tested were significant at 1 and 5 per cent levels of significance.

Table 3: Determinants of Community Participation in Ini LGA

Variables	**Coefficients**	**Standard error**	**t-ratio**
Intercept	-1.7602	0.3849	4.5726***
Sex (X_1)	5193	0.0776	6.6810***
Age (X_2)	.0173	0.0039	4.4028***
Marital Status (X_3)	-.5598	0.2039	-2.7467**
Household Size (X_4)	-.0529	0.0143	-3.7143***
Occupation (X_5)	3574	0.1037	3.4461***
Religion (X_6)	3411	0.1568	2.1756**
Education (X_7)	.0422	0.0126	3.5219***
Yrs spent in Comm. (X_8)	-.0098	0.0038	-2.5907**
Urban Exposure (X_9)	-4375	0.1009	4.3373***
Awareness (X_{10})	-.1209	0.1069	-1.1320

Source: Survey data 2008. * significant at 1%, ** at 5%, * at 10%**

According to table 3, the coefficient for age is statistically significant and positive, implying that younger people participated more in community development projects of their communities than their older counterparts. This finding agrees with Ekong (2003) that older rural people tend to take less active part in the general social and economic activities.

Household size is statistically significant at 1%, but negative implying that as household size decreases, participation in community development increases. This conforms to *a priori* expectations that community members with small household size will participate more than large households because of the heavier burden of household sustenance. This finding agrees with Imoh (2004) study on family size and participation of women in socio-economic development which revealed that large family size did not permit women to participate due to routine burden of meeting the needs of many children.

Educational level is statistically significant at 1% and positive , this conforms to *a priori* expectation that the more an individual is educated, the more likely he would accept and participate in development projects. This agrees with the findings of Udoh 1999; Asiabaka 2002; Nwaru 2004, and Imoh 2006 who noted that education and training produce labour force that is mobilized, more skilled, amenable to risk taking, and adaptable to the needs of changing economy. Nwaru and Ekumakama (2002) further noted that this kind of labour force participates effectively in development projects. The coefficients of sex, marital status and occupation were significant statistically and positive, while others like years spent in the community, urban exposure were statistically significant but negative at either 1% or 5% level as the case may be in accordance with *a priori* expectations as determinants of community participation.

On the other hand, the result of the maximum Likelihood Probit Analysis for Abak L.G.A is shown on Table 4.The coefficient of these variables, age, sex, occupation, and household size were statistically significant and positive at 1% level of significance in Abak as they were in Ini L.G.A.

Table 4: Probit Regression Analysis for Abak Local Government Area

Variables		**Coefficients**		**Standard error**	**t-value**
Intercept	-1.9925	0.2039		-9.7709***	
Sex (X_1)	0.3176		0.0661	4.8031***	
Age (X_2)		0.0186		0.0040	4.6688***
Marital Status (X_3)		0.1923		0.0782	2.4604**
Household Size (X_4)		0.0583		0.0151	3.8756***
Occupation (X_5)	0.3019		0.0618	4.8820***	
Religion (X_6)		0.0026	0.0218	0.1175	
Education (X_7)	0.0120		0.0093	1.2980	
Yrs spent in Comm. (X_8)	-0.0146	0.0032		-4.6285	
Urban Exposure (X_9)		-0.1846	0.0635	-2.9085	
Awareness (X_{10})	0.1902		0.0851	2.2352**	

Source: Field Survey data 2008. significant at 1% *, 5%**, 10%*.**

In the same vain, marital status, awareness, and education were positive and statistically significant. This could perhaps imply that Abak is advantaged resulting from its close proximity with Uyo, the state capital, over Ini in receiving awareness through modern information and communication media. Other variables like years spent in the community and urban exposure were negative and statistically significant at one and five per cent respectively.

Comparative Analysis of Ini and Abak L.G.A Community Participation

According to table 5, all the respondents in both Ini and Abak Local government areas indicated membership of community participation. In Ini, about 65% made financial contributions towards the on-going projects, while in Abak, 56% made financial contributions. Majority of respondents (70%) each in the study areas indicated attendance at community meetings. Membership of committees and office holdings had the lowest participation rate. This finding is in agreement with Imoh (2002) which revealed that lack of meaningful education and urban exposure led to poor participation especially at the higher levels – committee membership and office holdings.

Table 5: Distribution of Respondents according to Components of Participation

Variable	INI Frequency	%	ABAK Frequency	%
Membership	84	100	77	100
Attendance at Meetings	59	70.24	54	70.13
Financial Contributions	54	64.29	43	55.84
Membership of committee	20	23.81	15	19.48
Office holding	12	14.29	12	15.58

Source: Field Survey, 2008

The higher participation in Ini, was a reflection of the acceptance of such development projects in the community for improved standard of living. It also demonstrated the tendency for project success and sustainability. Recent studies have shown an important link between participation and its contribution to poverty reduction (Oakley and Clayton, 2000; World Bank, 2001).

Similarly, considering the proximity of the two areas to the state capital, it was observed that Ini being far away from the capital, participated more than Abak. This perhaps may have resulted from the feeling that it was their responsibility rather than government to develop their communities. On the other hand, Abak may have felt that with the presence of the state capital, development projects should be the responsibility of government.

Hinderances to Active Participation

Table 6 revealed that 76.19% of respondents in Ini were high cost of living (82.14%) and lack of economic power as the a major hinderance to active participation in development projects of their communities. Whereas in Abak, lack of time (72.72%) and high cost of living (75.32%) were the major problems that militated against participation in development projects in their communities. Embezzlement of funds (21%) was also noted as a problem against participation in Ini L.G.A. Respondents reported that project implementation committee members embezzled funds meant for development projects. All these factors influenced active participation in the two local government areas in their order of magnitude. These factors have led to inactive participation and the ongoing of numerous development projects in the two areas of study.

Table 6: Distribution of Respondents According to Hinderances Against Active Participation in Community Development Projects

Variable	INI Frequency	%	ABAK Frequency	%
Lack of economic power	64	76.19	43	51.19
Lack of time	15	17.8	56	72.72
High cost of living	69	82.14	58	75.32
Inadequate monitoring	53	63.09	10	12.98
Embezzlement of funds	18	21.43	04	5.19

Source: Survey Data 2008.

Conclusion and Recommendations

Past attempts at national development ended up dividing Nigeria into two distinct socio-economic dichotomies – the urban and the rural. The urban-biased approach to development gave rise to decades of rural neglect because government programmes for rural development never succeeded. The main reason for programme failure was the non-inclusion of programme or project benefiting communities in the entire programme planning and execution. This study revealed that by improving participation of community members in the development process, then development projects will succeed in rural communities and poverty will subsequently be alleviated.

Lack of economic power was found to be the biggest obstacle to participation. The study recommends that opportunities should be created for rural people to be involved in profitable economic

activities that would enhance their livelihood. To achieve the above therefore, rural people should be encouraged through soft loans and training on the use of such laons to enhance their economic endeavours. Rural youths should be mobilized through economic empowerment programmes in order to position them for participation in development projects. This could be done by government through creation of employment opportunities such as regular supply of electricity in the rural areas. Quality education, both formal and informal, should be emphasized most especially in rural communities to create better awareness and profitable time management strategy.

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Development and Performance Evaluation of a Groundnut oil Expelling Machine

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Abstract: An expelling machine for extracting oil from groundnut seeds was designed and fabricated for market oriented production. The procedures employed include the design stage, construction and testing. The machine components are: the speed reduction gear, expellant unit, drains collector, driving and driven pulleys, and the hopper. The expelling unit consists of a screw expellant shaft with expellant barrel. The groundnut seeds were pre-heated by roasting before extraction of the oil in it. The machine gave a better performance at the speed of 60 revolutions per minute and improvement in the design can be achieved by incorporation a heating chamber along the expeller barrel. [New York Science Journal. 2009;2(6):76-79]. (ISSN: 1554-0200).

1. Introduction

Groundnut oil extraction in most developing nations such as those of the south Asia and Africa is usually done manually by hand, and like all other manual operations it is drudgery and time consuming.

The groundnut, *Arachis hypogaea*, also known as the peanut or earthnut, is botanically a member of the *Papilionaceae*, largest and most important member of the *Leguminosae* [1, 2]. It is a very important oil seed and food crop around the globe for its nutritional and trade values [2, 3]. Mainly native to warmer climates, groundnuts frequently provide food for humans or livestock, and in the absence of meat, form a valuable dietary protein component [4].

Groundnuts are almost exclusively processed in combination with the utilization of the residue for human consumption. In fact often the bye-product, a kind of a snack called *Kulikuli* in Nigeria and some other African countries, is usually the main product and the processing of the groundnut oil only as part of the process.

Groundnuts give edible and pleasant tasting oil for direct human consumption and are used as salad oil or for cooking. The oil is also further processed to margarine or *Vanaspati* in India, soaps, paints and cosmetics.

The oil content of groundnut can contain up to 50% oil (although the usual range is 40% to 45%) and 25 % to 30 % protein [1, 4]. Oil is extracted from groundnut through either traditional means (mostly dependent on human energy with about 20-30% of the oil extracted) or mechanical means (over 90% of the oil can be extracted) [3]. Most vegetable oils are recovered by grinding, cooking, expelling and pressing, or by solvent extraction of the raw materials [5].

The most common method of extracting edible oil from oilseeds is mechanical pressing of oilseeds [6, 7]. This method ensures extraction of a non-contaminated, protein-rich low fat cake at a relatively low-cost [7].

Traditionally, oil is extracted from groundnuts by roasting and crushing to as fine as possible (i.e. first by pounding, followed by crushing between stones or a stone and an iron bar). Afterward, the crushed mass is mixed with water, and the oil is obtained by cooking the mixture, causing the oil to float. The oil is finally skimmed off and dried by heating [1].

The weak points of these processes are the grating or crushing steps. They are time consuming and drudgery, yet crushing is generally not fine enough. Thorough crushing can improve the oil recovery considerably.

Traditional processes are very labour intensive and labour saving changes seem apt, at least for any kind of market oriented production-small (or domestic), medium or large scale. The potential for improvements would best be tapped by a simplified reproducible version of the modern technologies: Crushing the seed in a roller mill, heating in a directly fired pan and pressing with a spindle press, a hydraulic press or an engine driven oil expeller.

2. Design Considerations

Groundnut oil expelling machine is an important device for oil recovery from groundnut seeds by crushing seed in a roller mill, direct firing of barrel and pressing with an engine driven oil expeller.

Generally, the barrel behaves like a simple pressure vessel – the cylindrical shell, computed on the assumption that the stress is uniform throughout the wall thickness. Thus, circumferential or hoop stress σ_h and longitudinal stress σ_l is given by:

$$\sigma_h = \frac{f}{tl} = \frac{\mathrm{Pr}\,l}{tl} = \frac{\mathrm{Pr}}{t} \quad (1)$$

and $$\sigma_l = \frac{\pi r^2 P}{2\pi r t} = \frac{\mathrm{Pr}}{2t} \quad (2)$$

where f = Hoop force (N), t = Thickness of the cylindrical wall (m), l = Length of the cylindrical wall (m), P = Intensity of the internal pressure $\left(N/m^2\right)$, r = Internal radius of the cylindrical wall (m).

The torque T (in Nm) transmitted by worm action and the angular speed ω (in rad/s) is given by

$$\omega = \frac{2\pi N_w}{60} \quad (3)$$

and $$T = \frac{P}{\omega} = \frac{60P}{2\pi N_w} \quad (4)$$

where P = Power transmitted by the worm action (W), N_w = No. of Rev/min of worm action (rev/min).

The pulley was designed by considering the power to be transmitted between the electric motor and the screw expellant shaft. The ratio of the pulley for the electric motor to that of the expellant shaft was 1:2 and the allowable diameter of the pulleys were calculated as given by Olaomi [3] as:

$$N_1D_1=N_2D_2 \quad (5)$$

where, N_1 = Speed of the driving motor (rev/min), N_2 = Speed of the expellant shaft, D_1 = Diameter of driving pulley (m), D_2 = Diameter of driven pulley (m)

The belt speed V (m/s^2) and its total length L (m) were calculated as given by Khurmi et al. [8] respectively as:

$$V = \pi N_1 D_1 \quad (6)$$

and $$L = 2C + \frac{\pi}{2}\left(D_1 + D_2\right) - \frac{D_2 - D_1}{4C} \quad (7)$$

where C = Center diameter (m)

For the center diameter,

$$C = \left(\frac{D_2 + D_1}{2}\right) + D_1 \quad (8)$$

The shaft, made from wrought iron carried combined load of bending moment and torque is given as:

$$\tau_{\max} = \frac{16}{\pi d^3}\sqrt{\left(M^2 + T^2\right)} \quad (9)$$

where $\tau_{\max}$ = Maximum shear stress (N/m), T = Torque (Nm), M = Bending moment of shaft (Nm), d = Shaft diameter of the machine (m).

3. Principles of Operation of the Oil Expelling Machine

The machine component parts include speed reduction gear, drain collector, driver and driven pulleys, and the hopper. The expeller is driven by a 3HP electric motor via a reduction gear. The expelling unit consists of a screw expellant shaft, shown in Figure 1 below. The heating of groundnut seeds is achieved by generated heat, which heats the surrounding of seeds passage.

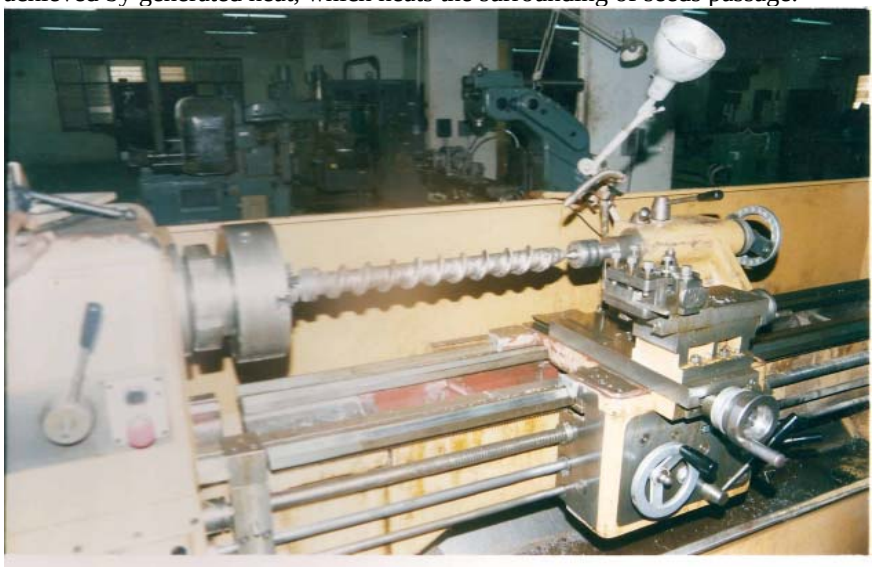

Figure 1. Lathe machining of Screw Expellant Shaft

4. Results and Discussion

Oil is a valuable product with universal demand, and the possible income from oil extraction is therefore often enough to justify the relatively high cost of setting up and running a small scale oil milling business.

The cell walls of oil seeds encapsulating the oil are characterized by cellulosic and non-cellulosic materials like hemicelluloses, pectin etc. They in general protect the constituents of the cell. In the extraction process the cell wall is ruptured by grinding in order to release oil. Incomplete rupture due to process constraints results in reduced yield.

The testing result suggests that the performance of the machine is highly depended on the speed of the electric motor and the quantity of material passing through the machine with expelling operation probably better at around 60 revolutions per minute.

Preliminary test carried out on the machine without heating of the groundnut gave no oil yield and only paste was observed passing through the cake outlets. This implies that for oil to be extracted from groundnut heating is necessary. However, when the groundnut was roasted before extracting oil from it, oil was produced because of the breaking of oil bearing cells during heating. The fabricated groundnut oil expelling machine and its schematic diagram is shown in Figure 2 below.

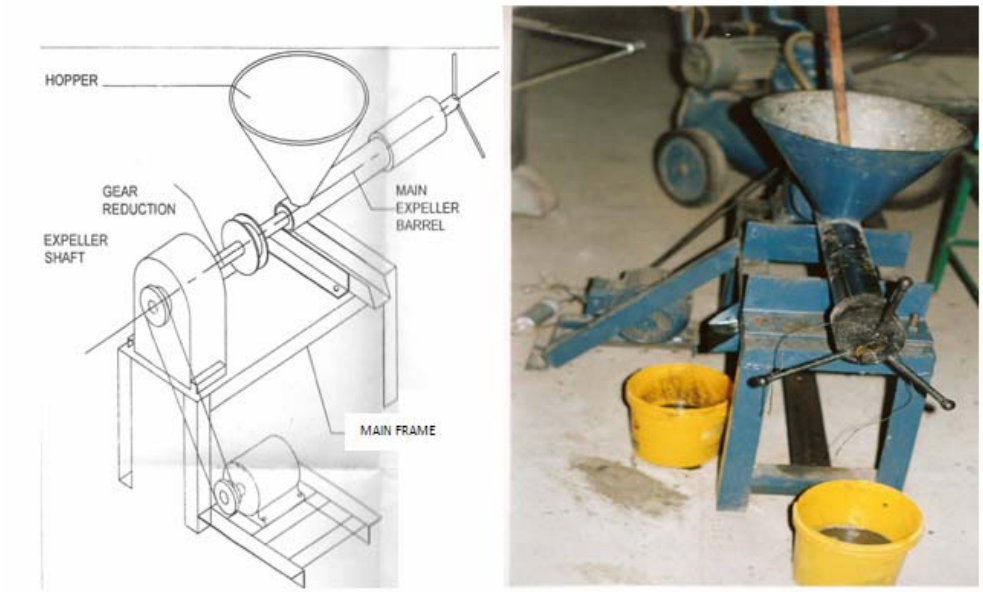

Figure 2. Groundnut Oil Expelling Machine and the Schematic Diagram

5. Conclusion

A groundnut oil expeller was developed. Preliminary evaluation of the machine gave a better performance at the speed of 60 revolutions per minute. Without heating of the groundnut no oil yield was observed with only paste observed through the cake outlet.

When the groundnut seeds were roasted before extraction of oil, reasonable oil was extracted. However, improvement in the design by incorporation a heating chamber along the Expeller barrel is expected to greatly improve the performance efficiency of the machine.

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Effect of *Alternaria* on Some Members of Family *Brassicaceae* of Garhwal Himalaya

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Abstract: In the present study a survey of disease caused by genus *Alternaria* on plants of *Brassicae f*amily was carried out and demonstrated the different sp. of *Alternaria* and their causing affect in Brassica family. Four species of Brassica family was taken, witch were infected by different species of pathogens of *Alternaria* family: (1) *Brassica compestris* infected by *Alternaria brassicae* and *A. brassicicola*, (2) *Brassica oleraceae* was infected by *Alternaria brassicae, A. brassicicola* and *A. raphani*, (3) *Brassica nigra* was infected by *Alternaria brassicae, A. brassicicola*, (4) *Raphanus sativus* was infected by *Alternaria brassicae, A. brassicicola, A. rapani*. The best time for the diseased sample collection was January to April. Infected leaf samples were collected in cellophane bag. Samples were collected from the different sites of Srinagar Garhwal and brought to the laboratory for further studies. In laboratory the aseptic conditions was maintained to isolate the pathogen on potato dextrose agar media and as well as in blotter papers. After incubation shape and size of conidiospores of different spp. of *Alternaria* were studied. [New York Science Journal. 2009;2(6):80-85]. (ISSN: 1554-0200).

Introduction:

Brassicaceae plays an important role for its uses as vegetable as well as oil yielding seed. Most of the plants of the family contain plenty of sulphur compounds. These crops are cultivated in farm in leafy form and/or to produce in seed form. It is a large family contains 350 genera and about 2500 species. This family is cultivated in whole India, but in specially Garhwal region, peoples are cultivating *Brassica compestris, Brassica nigra, Brassica oleraceae L, Brassica juncea, Raphanus sativus L, Iberis amara* in large area.

The leaf spot & seed disease caused by various species of *Alternaria* occur abundantly in some region of Garhwal Himalayas. This disease is so prevalent that most of the plants of the area were found to be infected by this disease. The disease of then become so severe that growth & yield of the crop decreased considerably. Species of *Alternaria* which is a member of Deuteromycetes are facultative parasite causing disease on most of the common and economical important crop plant. It is very common fungi often found on plant debris and on living plant parts. It produces very distinct symptoms on foliar parts of the plant (Agarawal and Hasija, 1967). The fungal genus *Alternaria* is comprised of many saprophytic and endophytic species, but is most well known as containing many notoriously destructive plant pathogens. There are over 4,000 *Alternaria*/host associations recorded in the USDA Fungal Host Index ranking the genus 10th among nearly 2,000 fungal genera based on the total number of host records. While few *Alternaria* species appear to have a sexual stage to their life cycles, the majority lack sexuality altogether. Many pathogenic species of *Alternaria* are prolific toxin producers, which facilitates their necrotrophic lifestyle (Christopher, 2008). *Alternaria* produces toxin(s) which are responsible for these lesions. Understanding the mechanism of action, particularly, host specific toxins (HSTs) provide a better appreciation of host pathogen interactions and resistance mechanisms. Two approaches have been used to study the mode of action of HSTs. One is the study on the molecular level of host selectivity and the other at the cellular level. It causes amongst other aberrations in chloroplast and mitochondria. It cause sever infection on most of the family *Brassicaceae* viz. *Brassica nigra, Bressica campestris Linn, Brassica oleraceae, Raphanus sativus, Iberis amara* as a result of which the quality and quantity of crop decreases (Johnson et al., 2000).

Many unanswered questions regarding fungal pathogenicity, especially pertaining to *Alternaria* species, still remain. All of the plant pathogenic *Alternaria* species to date have been reported to produce host-specific toxins (HSTs) and/or nonhost specific toxic substances, both having very diverse biochemical structures (Rotem**,** 1994; Thomma, 2003).They affect the quantity as well as quality also. Thus it is necessary to study the details about the occurrence, symptomology and morphology of the pathogen.

Keeping above points on view the objectives of the present investigation was to study the symptoms, disease development, morphology and identification of the pathogen on various hosts.

Material & Methods:
The details of the material and methods used during the present investigation are as follows:

Collection of Plant Samples:

Infected samples of *Brassicaceae* were collected from Srinagar Garhwal and its adjoining areas. These localities were: Srinagar, Government nursery, Dang, Bhaktiyana, Shaktivihar, and Ghasiamahadev. The sites of collection include cultivated fields, kitchen garden, road sides etc. After collection of samples, these were carried out to the laboratory and isolated within two or three days after collection.

Isolation of Alternaria:

In order to study the disease of *Alternaria* in *Brassicacea*, the following experiments were performed by two methods:

The blotter test:

The blotter test is a combination of the *in vitro* and the *in vivo* principles of investigation. The basic principle in this method was to provide a high level of relative humidity, and optimum light and temperature those are conductive for fungal development. Usually three layers of blotter papers were provided enough moisture for duration of the test. Blotters were soaked in tape water and placed in culture plates after draining off the excess water. The thickness of filter paper in Petri dishes is having depth of 2.0 cm. The leaves samples were placed in to the Petri dishes. The samples were incubated for a fixed period of time, usually one week, at the fixed temperature that is 20± 2^0c. The fluorescent light used with a 12 hr. cycle of light and dark. The essence of recording in blotter test is quick identification of habit characters. *Alternaria* species displaying characteristic features such as the form, length and arrangement of conidiophores; the form size, septation, colour, chain formation, etc., of conidia and their arrangement on the conidiophores.

Incubation of samples in Petri dishes containing tap water agar. *(Agar, 15 gm; tap water 100 ml)**:***

Small pieces of samples were placed in each dish. Prior to plating, samples were treated with 1-2% sodium hypo chloride (NaOCl) solution to prevent saprophyte development. Malt extract agar or potato dextrose agar media most commonly applied. The samples were incubated at a fixed temperature, mostly about room temperature 20±2^0c for an incubation period of 5 to 8 days for the development of fungi. The principle of recording in the agar plate test is macroscopically examination of fungus colonies. Isolation of Alternaria species was made by direct transfer to suitable media by means of sterile inoculating needles or fine forceps. Potato dextrose (peeled potatoes 200gm; dextrose20gm; agar 20gm and water 100ml) (Ricker and Ricker 1936) was routinely used for isolation of such fungi.

Identification of Alternaria Species:

An attempt was made to identify all species of *Alternaria* which appear on infected plant parts. For identification, monograph of *Alternaria* was consulted. Microscopic observation was carried out using living specimens mounted and water and lactophenol cotton blue.

Results and Discussion:
***Alternaria brassicicola* on *Brassica oleraceae* (black leaf spots disease):**

The pathogen known to cause the most destructive and widespread *Alternaria* leaf spots, speckle disease, dark leaf spot or pod spots. This disease is attack mostly on *Brassica oleracae*. Infection of *Alternaria brasicicola* in seed resulted discoloration, shriveling and changes in seeds contents (Schimmer, 1953). Weakly discoloured and symptomless seeds revealed the mycelial fragments in outer seed coat layers. An early study in cabbage revealed Alternaria brassicicola restricted to seed coat only and spores on seed surface. Heavy aggregation of mycelium and in the vicinity of hilum suggests entry of pathogen through hilum. These confirm that mycelium was found aggregated in the cavities and folds of the tissue in the hilum region. The cells of palisade layer of seed coat showed reduced thickenings mycelial fragments.

This indicates that mycelium can also penetrate directly through the seed coat layer (Chahal *et al.*, 1979; Tonukari, 2000).

A brassicicola germinate *(in vitro)* at a higher temperature (tested at a temperature range of 7 to 31^0C). *A. brassicicola* begins to germinate 98% of its spores at 15^0C after 10 hrs. of incubation. Plants wound inoculated with *A. brassicicola* develop symptoms most quickly at 25^0C, while seedlings from infected seed develop symptoms most quickly at 30^0C. Free water or high humidity is required for germination and infection. Germination also requires the presence of moisture in the form of free water or high relative humidity (at least 95%). Seeds infected with *A. brassicicola* are known to have active surface spores for up to 2 years when the seeds are stored at 10^0C with 50% relative humidity. Internal mycelium can remain viable for upto 12 years. *A. brassicicola* also survive in the form of microsclerotia and chlamydospores which appear after infected leaves have partially decayed. Microsclerotia and chlamydospores of both pathogens can be formed within conidial cells. Both microsclerotia and chlamydospores develop best at low temperature (3^0C) and are resistant to freezing and dessication (in vitro). Chlamydospores also can develop in conidial cells on natural soil at room temperature (Neergaard, 1945).

The symptoms were appeared as dark colored necrotic spots on the leaves, spreading rapidly and forming circular concentric rings/lesions up to one cm in diameter, black sporulation was also seen on the spot (Plate-1). Conidiophores amphigenous arising singly or in group of 2-13 or more through the stomata 0-4 septate with the basal cell sometimes slightly swollen olivaceous merely branched straight and upright when solitary, often curled when fasiculate not markedly geniculate usually with a single terminal scar sometimes with lateral spores also 20 – 60 x 4 – 9 µm. Conidia born in chain of up to 20 or more. The conidia spread to siliqua , the germ tube penetrate through the pericarp in to the seed coat of maturing seed and hyphae establish as dormant mycelium (Riker *et al.*, 1936).

***Alternaria alternate on Brassica campestris* (Leaf spot disease):**

It causes leaf spot on rape and mustard and has been found to be associated with rape. In rape the dark thick knotty mycelium was limited to seed coat layers in bold symptom less and weakly discolored seeds. Heavy inoculum at hilum reason and weakened radical thickening of palisade layer in seed coat suggested mode of penetration and ways similar to *Alternaria brassicicola* (Jain *et al.*, 1970).

The disease makes its appearance brown nacrotic spots on cotyledonary leaves and brown streaks on hypocotyl in seedlings leading to post emergence losses. At maturity, it naturally infected and inoculated plants, it cause dark brown necrotic spot on stem and ashy brown oval to irregular spots on pods. In leaves the spot becomes circular to irregular and shape with dirty grey center and dark brown margins and sometimes coalesce to form irregular patches. Germinated conidia of pathogen secrete cytokinins which lead to the formation of Green Island below the germinating conidia on senescing tissues (Chaturvedi, 1972; Zheng, 2006).

***Alternaria raphani* on *Brassica nigra* (Leaf spot disease)**

The initially appear as small scattered grey spot on leaf lamina. Later these, spread rapidly to form almost circular spot 3-8 mm in diameter, brown to dark with raised yellow margins and distinct zonations. Formation of chlamydospore on hypocotyle, stem and seeds with finally get killed. Necrotic spot on cotyledonary leaves and hypocotyls were also observed. A. raphani chlamydospore are considerd important for overwintering in nature and also the longer survival up to 15 years of the fungus in soil culture is attribute to formation of chlamydospore (Kothari *et al.*, 1970).

The pathogen may survive as dormant mycelium or spores on seeds as it has been reported on rape and mustard plants.After the study of mycelium it is observed that the mycelium is septate, branched, whitish to greenish, gray, aging to dark olive 3.5-7.5µm in width.Conidiophores are simple cylindrical erect or somewhat curved septate (3-7), grayish olive and 3.0-6.5µm in size. Conidia produced singly or in short chain of 2-3 are irregular oval, light grayish olive to grayish olive and smooth with 3-10, constricted at septa. The conidia measures 20-60*11.5-26 µm in size (Thomma, 2000).

Epidemiology:

Infected seeds, with spores on the seed coat or mycelium under the seed coat, are likely the main source of transport of these pathogens. Spores are disseminated by wind, water, tools and animals. The fungus can survive in susceptible weed or perennial crops. Infected crops left on the ground after harvest

also serve as a source of infection for *Alternaria brassicae* and *A. brassicicola*. In one study, Infected leaves of oilseed rap and cabbage placed out doors on soil, produced viable spores for as long as leaf tissues remained intact. For oilseed rape this was up to 8 weeks and for cabbage up to 12 weeks. This type of spread is likely to occur in seedling beds as well, and seedling from infected seed beds can carry the inoculum to the field (Sreekanthian *et al.*, 1973).

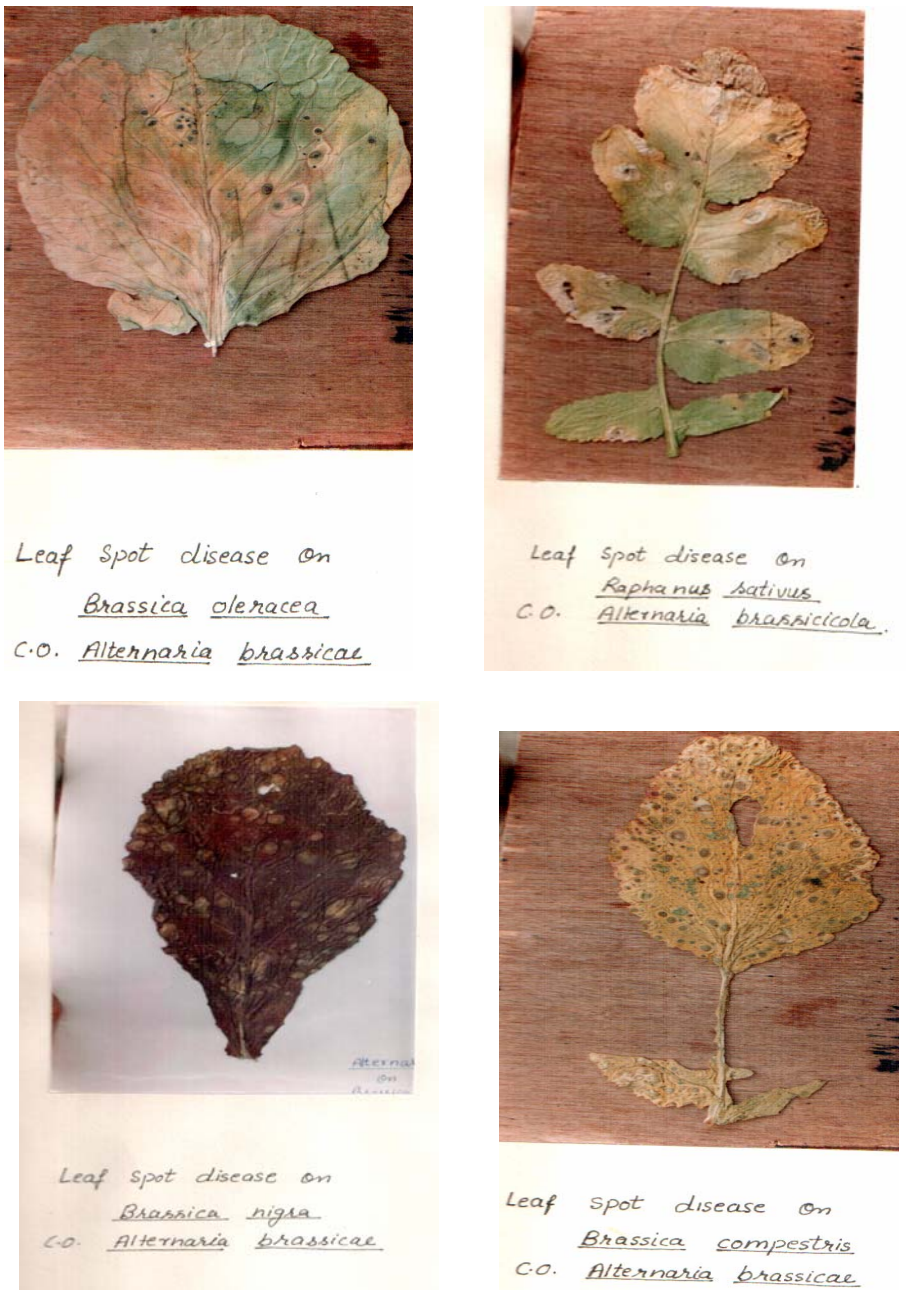

Plate-1 Leaf Spot Diseases on different Species of *Brassica*

Symptomology:

After disease attack of *Altenaria* there occurs several symptoms on the plant of Brasicca family. The physiological changes occur in the plant after infection of Alternaria. There occur several anatomical

and morphological changes which are expressed externally in form of visible symptoms. Wadhwani and Dudeja (1982) have described the development of the disease in three phases.

1. On leaves in contact with soil when relative humidity was high.
2. After pollination (early fruit set stage) when there were heavy rains.
3. On fruit.

When the host plant has passed the seedling stage, infections generally become confined to superficial, scarcely visible necroses, often located at the soil level. Later infections may spread to weakened parts of the host such as dying leaves and petals or any has tissues losing vitality as they do during the maturation of seed. These conditions give an opportunity for the pathogen to get a foothold in the developing seeds, thus determining the rate of seed infection. The fungus of *Alternaria brassicae, A. brassicicola* may penetrate the pod at different times during its development and directly invade the maturing seeds. *Alternaria brassicae* first appear on the cotyledonary leaves as small light brown spots, later turning black due to sporulation of the pathogen and as necrotic streaks of hypocotyls. On leaves, the infection starts as brown to blackish point which enlarges becoming entirely black or dark bordered with a gray centre. The spots spread rapidly on the stem and pods and become more or less circular (0.5 to 10 mm in diameter), slightly raised above leaf surface. Linear spots have also been reported on stem. In severely infected plants, the stem is so heavily attacked that it undergoes defoliation even before the pods reach maturity. The pathogen penetrates into the pods and infects the seeds which may show gray to brown discoloration. *Alternaria brassicicola* caused dark coloured necrotic spots on leaves spreading rapidly and forming circular concentric rings/lesions upto one cm in diameter. In humid weather the fungus may produce bluish tinge in the centre of these spots. Dark discoloration at the base of hypocotyl, sometimes extending on stem as streaks and dark spots on cotyledons were observed. The pathogen harboured as dormant mycelium in the seed coat or as condial contamination is carried on the cotyledons and in the seed coat and transmitted to young plants by air currents and/or rain splashes (Kaul and Narain, 1981.).

Scarcely visible necrotic symptoms on the stem at the ground level or in weakened leaves are often located. *Altenaria raphani* shows formation of chlamydospores on hypocotyls, stem and seeds which finally get killed. Nectotic spots on cotyledonary leaves and hypocotyls were also observed. The chlamydospores of A. raphani are considered important for overwintering in nature and also the longer survival upto 15 years of the fungus in soil cultures is attributed to formation of chlamydospores. The pathogen may survive as dormant mycelium or spores on seeds.

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Improvement of the Mechanical Properties of Pb-Sb Alloy System Through its Microstructural Modification by Copper Powder Dispersion during Casting

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Abstract: An attempt has been made to improve the mechanical properties; impact strength, energy absorbance and hardness of Pb-Sb alloy system through its microstructural modification by copper powder dispersion during casting. The Pb-Sb-Cu alloy was formed through casting by simultaneous addition of Cu powder and pouring of the molten Pb-Sb into the mould. Results of this study show that impact strength, energy absorbance and hardness of the cast Pb-Sb-Cu alloy increased as a result of increase in Cu addition (up to 6.54%) due to decrease in the grain size of Pb-Sb-Cu alloy occasioned by increased uniform distribution of the Cu powder within the Pb-Sb matrix. [New York Science Journal. 2009;2(6):86-92]. (ISSN: 1554-0200).

Keywords: Improvement, Mechanical Properties, Pb-Sb-Cu Alloy, Microstructural Modification.

1. Introduction

Abrikosov [1] has studied the effect of tellurium on the mechanical properties of Pb-Sb alloy. The results of the investigation indicate that impact strength, tensile strength and hardness of the alloy is enhanced with addition of Te. He however, stated that the durability of the components made with this alloy cannot be guaranteed since Te is very radioactive. Several studies [2,3] have been carried out on lead-antimony alloy by addition of Sn to improve its mechanical properties and corrosion resistance. Results of the investigation indicate that addition of Sn to the Pb-Sb matrix increases both the tensile strength, hardness and corrosion resistance of the alloy. This makes Pb-Sb-Sn alloy suitable for coating tanks and pipes. Nwoye [4] reported that dispersion of Cu powder in Pb-Sb melt increases the impact strength and hardness of the alloy when cooled. He stated that the higher values of these mechanical properties (relative to those of Pb-Sb alloy) obtained is believed to be jointly as a result of Cu dispersion in the Pb-Sb matrix and the high level of purity (99.8%) of the copper powder used. This is in accordance with studies [5] which show that impurities in metals and alloys affect negatively their mechanical properties. It has been reported [5] that the effect of oxygen addition on Pb-Sb alloy is improvement in the corrosion resistance of the alloy due to the formation of transient oxide film as oxygen diffuses into the alloy. However, the alloy does not find wide industrial application due to the low mechanical properties attributed to it which includes tensile strength, impact strength and hardness. It has been reported [6] that addition of indium to Pb-Sb alloy increases the corrosion resistance of the alloy. Indium is added to the Pb-Sb alloy by ionic exchange through electrolytic process where indium is the anode and Pb-Sb, the cathode. Addition of 0.7% Al and 0.23% Bi to Pb-Sb alloy was found to increase the hardness, tensile strength, ductility and corrosion resistance of the alloy [7]. Arsenic addition to Pb-Sb-Sn alloy has been found to increase the corrosion resistance of the alloy due to its ability to reduce oxidation during service by formation of oxide film on the matrix [8]. However, this alloy has not found application in pipes and tanks because of its poisonous nature. Ackerrmann [9] reported, following characterization of Pb-Sb-Sn-Ni alloy, that addition of 0.25% Ni imparts good casting properties to Pb-Sb-Sn alloy. He also found that presence of Ni in the alloy increases the tensile and impact strength of Pb-Sb-Sn particularly at high temperature. He further stated that the hardness and corrosion resistance of the alloy is tremendously improved with addition of 0.25% Ni. Several research works [4,10,11] have been carried out to improve the electrical conductivity of Pb-Sb alloy used as wet cell battery heads. Blumenthal [10] discovered that addition of cadmium enhances the electrical conductivity of Pb-Sb alloy tremendously. He however, stated that the alloy cannot find application in battery heads and plates because Cd is very radioactive and causes a volatile and explosive reaction when in contact with sulphuric acid for a long time. Rollason and Hysel [11] reported that addition of silver to Pb-Sb alloy increases very significantly the electrical conductivity of the alloy. He however, stated that this increase does not give a stable value due to impurities in the Ag. He stated that these

impurities are Au, As, Sn, Cu and S. He further posited that these impurities create an unstable electrical field in the alloy of Pb-Sb-Ag. It is believed that this short coming has made the use of this alloy for battery heads and plates impossible since it obscures the precise electromotive force of the electrolyte in the battery. Nwoye [4] found that addition of copper powder by dispersion to Pb-Sb alloy improves the electrical conductivity of alloy greatly. It is believed that this breakthrough was possible because Cu used, had high purity level (99.8%). It is widely accepted that the mechanical properties of cast alloys and metals depend significantly on the chemical compositions of the material, casting temperature, casting technique, mould material, cooling medium and cooling rate. Studies [4,12,13] have shown that amongst cooling media such as water, air and furnace, water gives the highest cooling rate followed by air and then furnace. They posited that furnace cooling imparts better impact strength, ductility and tensile strength to cast metals and alloys followed by air cooling and then water cooling. They however, stated that water cooling imparts greater hardness to these materials followed by air cooling and then furnace cooling. Nwajagu [12] found that cooling an alloy from a higher temperature widens the temperature gradient and hence increases the hardness in the case of water cooling. It was therefore concluded that increased cooling time increases the tensile and impact strength.

The aim of this research work is to improve the mechanical properties; impact strength, energy absorbance and hardness of Pb-Sb alloy system through its microstructural modification by copper powder dispersion during casting.

2. Materials and methods

ALLOY PREPARATION:

The materials used are antimonial lead scraps and electrolytic copper powder (200 mesh to dust type). They antimonial lead collected were melted together in order to obtain a fairly uniform composition of lead antimonial alloy, in case of any variation in antimony content. The melting operation was carried out at the forge, followed by casting of the alloys in sand mould and cutting to various sizes for use in the actual alloying. They melting crucible was of 260mm long, 200mm wide mild steel of about 100mm breadth with handle for carriage.

MOULD PREPARATION:

The preparation of the mould was done by first sieving the sand for aeration and mixing 6% moisture to give good green strength. The mould box of dimension 300mm wide, 100mm breadth and 500mm long was made from cast metal frame. A long hollow cylindrical pipe of 85mm long and 9mm diameter was used as the pattern for the cast. The mould was allowed to dry before use following its preparation.

CASTING TECHNIQUES:

A weighed quantity of lead antimony alloy (500g) was placed on the crucible and then placed inside the furnace. At 420^0C, the melt was slagged (since the whole constituent of the crucible have melted). Various quantities of Cu were added simultaneously with pouring of molten Pb-Sb into the mould.

HEAT TREATMENT

The cast alloys were heat treated at a temperature of 180^0C to relieve stresses incurred during solidification of the alloys. The heat treatment was also carried out to homogenize the microstructure of the alloys prior to the testing of their mechanical properties.

IMPACT STRENGTH AND HARDNESS TEST

Following the heat treatment process, impact strength, energy absorbance and hardness tests were carried out on the cast alloys (applying British standard procedures) using impact strength testing machine and Vickers hardness testing machine respectively from the Mechanical Engineering Workshop of University of Nigeria, Nsukka. They energy absorbed by the alloy before fracture was calculated from the values of the impact strength by considering the cross-sectional area of the alloy sample.

CALCULATION OF IMPACT STRENGTH AND ENERGY ABSORBANCE OF Pb-Sb-Cu ALLOYS:
The striking energy of the impact strength testing machine is given by the equation [14];

$$S_E = M \times g \times H \quad (1)$$

Where

S_E = Striking energy of the impact strength machine (Kg/Fm)
M = Mass of hammer from the machine (g)
g = Acceleration due to gravity (m/s^2)
H = Height of hammer (rad.)

M = 3941Kg, g = $10m/s^2$, H = 90^0 ($\Pi/2$) (by conversion to radian) and $\Pi = 22/7$. Substituting these values into equation (1) gives;

S_E = 619300J (61930 KgFm)

Where 1Nm = 1J and 1KgF = 10N

Cross-sectional area, A (cm^2) of the alloy sample is given by the equation;

$$A = \Pi D^2/4 \quad (2)$$

Where D = 0.9cm; (Diameter of cross- section of the sample)

Substituting the of D into equation (2)

$$A = 0.6364cm^2$$

Energy absorbed at fracture, E_B (KgFm) is given by the equation [14];

$$E_B = I_M \times A \quad (3)$$

Where

I_M = Impact strength of the alloy sample before fracture ($KgFm/cm^2$)

3. Results and discussion

Results of chemical analysis carried out on the materials used (as shown in Table 1) indicate that antimonial lead contains about 3.3% Cu in addition to Pb and Sb present. The percentage composition of the powdered Cu used is as received.

Table 1: Chemical composition of materials used

Material	Pb (%)	Sb (%)	Cu(%)
Antimonial lead	92	4.7	3.3
Copper powder	-	-	99.80

Effect of microstructural modification of Pb-Sb alloy system on the impact strength of Pb-Sb-Cu alloy formed

The result of impact strength tests (Tables 2 and 3) carried out on Pb-Sb-Cu alloys shows that the impact strength of the alloy increases with increase in the weight of Cu added (up to 6.54%) to the molten Pb-Sb alloy system. Micrographs in Figs. 1-8 show decrease in the grain size of the Pb-Sb-Cu alloy formed as the weight of Cu added increases. Figs.1-8 also shows increasing degree of uniform distribution of Cu as the weight of Cu added increases. It is therefore believed that increased uniform distribution of the Cu powder resulted to the decrease in the grain size of the Pb-Sb-Cu alloy formed. Comparison of Table 3 and Fig.8 shows that the highest impact strength ($13.4KgFm/Cm^2$) is associated with the greatest weight-input of Cu powder (6.54%). Fig.8 also indicates the most uniform distribution of Cu within the Pb-Sb matrix. Based on the foregoing, impact strength increased as a result of increase in Cu addition due to decrease in the grain size of Pb-Sb-Cu alloy formed occasioned by increased uniform distribution of the Cu powder within the Pb-Sb matrix. This agrees with past studies [12] where decrease in the grain size of alloys resulted to increased tensile strength, impact strength and hardness.

Effect of microstructural modification of Pb-Sb alloy system on energy absorbance of Pb-Sb-Cu alloy formed

Energy absorbed by Pb-Sb-Cu alloys prior to fracture was calculated from the values of the impact strength using equation (3) following the calculation of the cross-sectional area of the alloy sample using equation (2). Comparison of Tables 2 and 3 show that energy absorbance increases with increase in the weight of Cu added (up to 6.54%) to the molten Pb-Sb alloy system. it is strongly believed that since energy absorbed by the alloys is a derivative of the impact strength, increased energy absorbed by the Pb-Sb-Cu alloys also resulted from increase in Cu addition (up to 6.54%) due to decrease in the grain size of Pb-Sb-Cu alloy formed occasioned by increased uniform distribution of the Cu powder within the Pb-Sb matrix. Table 3 and Fig. 8 show that the highest value of energy absorbed by the Pb-Sb-Cu alloy (8.40KgFm) is associated with the greatest weight-input (up to 6.54%) of the Cu powder.

Effect of microstructural modification of Pb-Sb alloy system on the hardness of Pb-Sb-Cu alloy formed

Comparison of Tables 2 and 3 show that the hardness of Pb-Sb-Cu alloy was also found to increase with the weight of Cu added (up to 6.54%) to the molten Pb-Sb alloy system. Figs. 1-8 show decrease in the grain size of the Pb-Sb-Cu alloy formed as the weight of Cu added increases with Fig.8 depicting the smallest grain size. Comparison of Figs.1-8 also shows increasing degree of uniform distribution of Cu as the weight of Cu added with Fig. 8 depicting the most uniform distribution of Cu in the Pb-Sb matrix. It is therefore believed that increased uniform distribution of the Cu powder resulted to the decrease in the grain size of the Pb-Sb-Cu alloy formed. Fig.8 and Table 3 is also associated with the highest hardness value (17.80VPN) resulting from the greatest weight-input of Cu powder (6.54%). It is therefore also believed that the hardness of Pb-Sb-Cu alloy increased as a result of increase in Cu addition due to decrease in the grain size of Pb-Sb-Cu alloy formed occasioned by increased uniform distribution of the Cu powder within the Pb-Sb matrix. This also agrees with past studies [12] where decrease in the grain size of alloys resulted to increased tensile strength, impact strength and hardness.

Conclusion

Based on the foregoing, impact strength, energy absorbance and hardness of Pb-Sb-Cu alloy increased as a result of increase in Cu addition due to decrease in the grain size of Pb-Sb-Cu alloy occasioned by increased uniform distribution of the Cu powder within the Pb-Sb matrix.

Table 2: Mechanical properties of Pb-Sb alloy (Alloy control of melting temperature 425^0C) cooled in furnace

Mechanical Property	Values
Impact strength	1.26 KgFm/Cm^2
Energy absorbed	0.80 KgFm
Hardness	14.40 VPN

Table 3: Effect of copper addition (to Pb-Sb matrix) on the impact strength, energy absorbance and hardness of Pb-Sb-Cu alloy cooled in furnace

Cu (%)	Hardness (VPN)	Energy absorbance (KgFm)	Impact Strength (KgFm/cm^2)
0.99	14.49	0.96	1.50
1.96	14.56	2.40	3.80
2.91	15.20	3.40	5.74
3.85	15.60	4.84	8.20
4.76	16.53	6.35	10.20
5.66	17.40	7.20	11.30
6.54	17.80	8.40	13.40

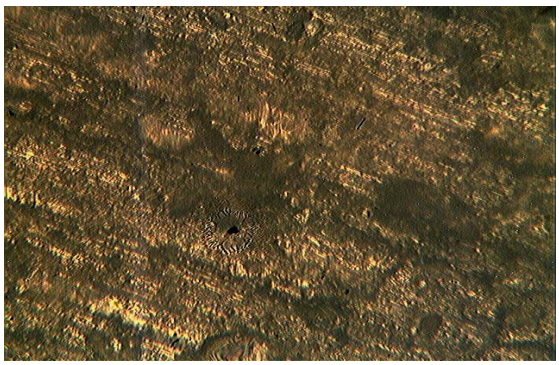

Fig.1-Microstructure of Pb-Sb matrix (Control) x400

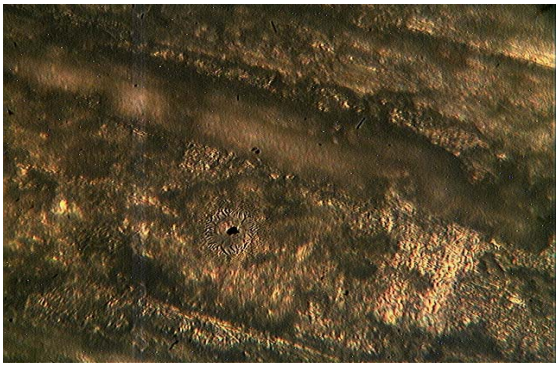

Fig.2-Microstructure of Pb-Sb matrix, 0.99%Cu x400

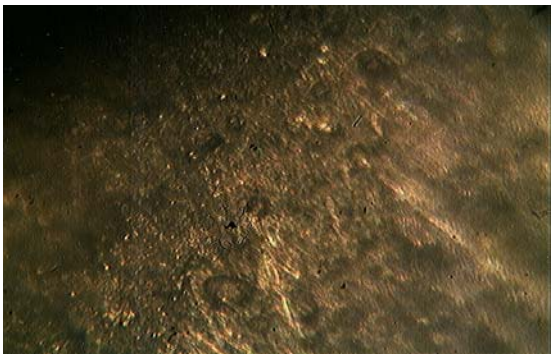

Fig.3-Microstructure of Pb-Sb matrix,1.96%Cu x400

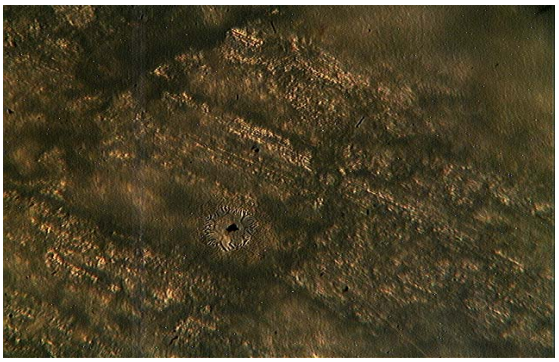

Fig.4-Microstructure of Pb-Sb matrix, 2.91%Cu x400

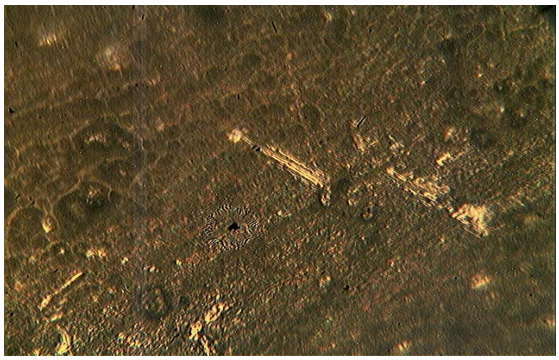

Fig.5-Microstructure of Pb-Sb matrix,3.85%Cu x400

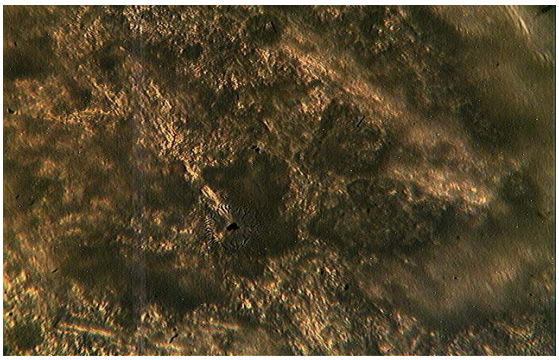

Fig.6-Microstructure of Pb-Sb matrix, 4.76%Cu x400

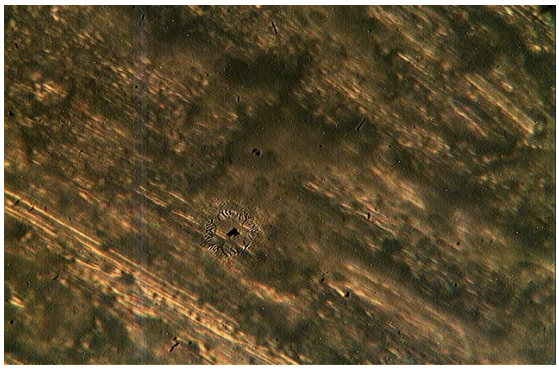

Fig.7-Microstructure of Pb-Sb matrix,5.66%Cu x400

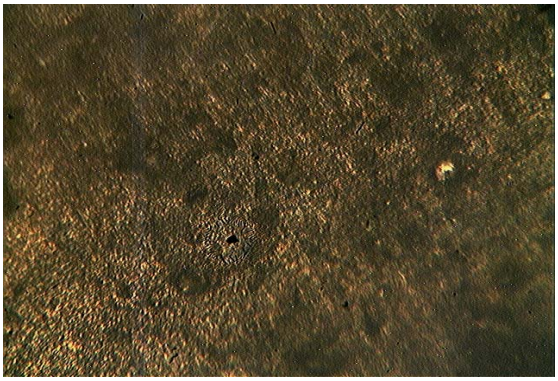

Fig.8-Microstructure of Pb-Sb matrix, 6.54%Cu x400

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Model for Predictive Analysis of Hardness of the Heat Affected Zone in Aluminum Weldment Cooled in Groundnut Oil Relative to HAZ Hardness of Mild Steel and Cast Iron Weldments Cooled in Same Media

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Abstract: Model for predictive analysis of hardness of the heat affected zone in aluminum weldment cooled in groundnut oil has been derived. The general model;

$$\beta = 0.5997\sqrt{(\gamma\alpha)}$$

is dependent on the hardness of the heat affected zone (HAZ) in mild steel and cast iron weldments cooled in same media. Furthermore, re-arrangement of these models could be done to evaluate the HAZ hardness of mild steel or cast iron respectively as in the case of aluminum. The respective deviations of the model-predicted HAZ hardness values β, γ and α from the corresponding experimental values was less 0.02% indicating the reliability and validity of the model. [New York Science Journal. 2009;2(6):93-98]. (ISSN: 1554-0200).

Keywords: Model, Hardness, Heat Affected Zone, Aluminum Weldments, Mild Steel, Cast Iron.

1. Introduction

Past reports [1,2] have shown that several processes and methods of arc welding exist, for example carbon-arc welding, atomic hydrogen welding, shielded metal arc welding, plasma arc welding, electroslag welding, etc. Arc welding involves a process where by the heat generated by the electric arc is maintained in most cases between the electrodes and the work piece [3]. The arc supplies enough heat to melt the base metal in the vicinity of the arc and also the electrode. In arc welding, some of the processes utilize consumable electrodes which serve to strike an arc onto the work pieces, and they melt to provide the weld metal. In recent times, advancement has been made in such joining processes as adhesives, mechanical fasteners, brazing soldering [4]. However, welding remains the most important metal joining process.

The most widely used fusion welding process is arc welding. It produces smooth welding surfaces and utilizes both direct and alternating current. Oxidation is minimal as weld metal is completely shielded from the atmosphere. The process is excellent welding low carbon, medium carbon and alloy steels. The arc is quiet, discomfort from glare or fume is minimal, and is applicable in fabricating vessels, boilers and pipes, etc. Disadvantages of the process include need for very high current for welding operations and formation of a crater in the molten metal of the work piece arising from the pressure produced by the stream of ions flowing from the cathode [2]. Electrodes are the elements of an arc lamp or furnace between which an arc is struck. They are filler materials which a joining engineer should be able to match with the parent material to avoid failure [1]. Uncoated electrodes produce an atmosphere of oxygen and nitrogen, so that the oxides and nitrides formed may be in the weld metal, thus impairing ductility and impact toughness in the weld. The situation is avoided by use of coated electrodes, which contains slag and so form a fluid covering over the weld [2]. In this case, stabilization of the arc is achieved by including materials which would produce ionization and consequently may be wielded by the metallic arc process. In welding carbon and low carbon steels, coated electrodes are used especially for low carbon steels but for alloy steels in which martensite occurrence is likely on cooling and formation of hydrogen embrittlement expected, the electrode coating must be free from hydrogen forming cellulose [5].

One of the causes of low mechanical properties such as hardness and impact strength in welded parts is weldment cracking. Adjacent to the immediate welded area or fusion zone is the heat affected zone [6]. The mechanical property of main importance in HAZ is the hardness since it gives an indication of the degree of embrittlement there. It was reported [7] that the heat affected zone hardness produced by any given welding operation depends on the cooling rate experienced by the HAZ. Too rapid rate of cooling favours

the formation of hard and brittle martensite in all the sub zones of the HAZ or increases the martensite region in size relative to the other regions. The presence of martensite in the HAZ results in a very high hardness value for the heat affected zone. Slow cooling favours a better microstructure needed for engineering applications. Also, the more rapid the quenching rate, the greater the HAZ hardness.

Although much has been done on different joining processes and methods, but no emphasis has been placed on evaluation of the hardness of HAZ cooled in a particular medium as a function of the hardness of HAZ from the same material but cooled in different media. Researches carried out on HAZ; its cooling and mechanical properties have not addressed the issue of predicting or evaluating the hardness of the HAZ of a material cooled in a particular medium by simple substitution of the value of the hardness of HAZ from the same material, but cooled in different media. The hardness of HAZ in aluminum, cast iron and mild steel cooled in kerosine was found to be exactly the same as the hardness value of the same materials cooled in groundnut oil [8]. This implies that

$$H_G = H_K \quad (1)$$

Where

H_G = Hardness of HAZ cooled in groundnut oil

H_K = Hardness of HAZ cooled kerosine

Nwoye [8] reported that 8-10% less hardness than that from water occurs when kerosine or groundnut oil is used as quenchant for HAZ. He discovered that quenching the HAZ with kerosine or groundnut oil gives approximately 8-10.7% more hardness than that from quenching with air. He found that palm oil gave the lowest hardness and cooling rate on the HAZ.

Nwoye [9] derived quadratic and linear models for predicting the HAZ hardness of air cooled cast iron weldment in relation to the combined and respective values of HAZ hardness of aluminum and mild steel welded and cooled under the same conditions. It was discovered that the general model;

$$\theta = \left(\frac{2.9774\beta - \gamma}{2}\right) + \sqrt{\left(\left(\frac{\gamma - 2.9774\beta}{2}\right)^2 - \gamma\beta\right)} \quad (2)$$

predicts the HAZ hardness of cast iron weldment cooled in air as a function of the HAZ hardness of both aluminum and mild steel welded and cooled under the same conditions. The linear models; $\theta = 2.2391\gamma$ and $\theta = 1.7495\beta$ on the other hand predict the HAZ hardness of cast iron weldment cooled in air as a function of the HAZ hardness of aluminum or mild steel welded and cooled under the same conditions. Re-arrangement of the general model also resulted to the evaluation of the corresponding HAZ hardness in aluminum and mild steel weldments

$$\gamma = \left(\frac{2.9774\theta\beta - \theta}{\beta + \theta}\right)^2 \quad (3)$$

$$\beta = \left(\frac{\gamma\theta + \theta^2}{2.9774\theta - \gamma}\right) \quad (4)$$

It was found that the validity of the model is rooted on the fractional expression; $\gamma/2.9774\theta + \gamma/2.9774\beta + \theta/2.9774\beta = 1$ since the actual computational analysis of the expression was also equal to 1, apart from the fact that the expression comprised the three metallic materials. The respective deviations of the model-predicted HAZ hardness values θ, γ, and β from the corresponding experimental values $\theta_{exp,}$ $\gamma_{exp,}$ and β_{exp} was less than 0.003% indicating the validity and reliability of the model.

The present work is to derive a model for predictive analysis of hardness of the heat affected zone (HAZ) in aluminum weldment cooled in groundnut oil, relative to HAZ hardness of mild steel and cast iron welded and cooled under the same conditions.

2. Materials and methods

Aluminum, mild steel and cast iron were cut and welded using the shielded metal arc welding technique and the hardness of the HAZ (cooled in groundnut oil maintained at room temperature) tested. The hardness of the HAZ is as presented in Table 2. The full details of the experimental procedures and equipment used are presented in the previous report [8]. Table 1 shows the welding current and voltage used.

Materials	Current Type	Welding current (A)	Welding Voltage (V)
Aluminum	Direct (d.c)	120	280
Cast Iron	Alternating (a.c)	180	220
Mild Steel	Alternating (a.c)	180	220

Table1: Variation of materials with welding current and voltage [8].

Table 2: Hardness of HAZ in weldments [8].

Materials	HAZ Hardness (VHN)
Aluminum	412
Cast Iron	920
Mild Steel	513

3. Model formulation

Experimental data obtained from research work [8] carried out at Metallurgical and Materials Engineering Department of Federal University of Technology, Owerri were used for this work. Results of the experiment as presented in the report [8] and used for the model formulation are as shown in Table 2. Computational analysis of the experimental data [8] shown in Table 2 resulted in Table 2.

Table 3: HAZ Hardness ratio between aluminum, mild steel, and cast iron weldments cooled in groundnut oil.

β/γ	412/920	0.4478
β/α	412/513	0.8031
γ/α	920/513	1.7934

Table 3 shows that the hardness of HAZ in aluminum weldment cooled in groundnut oil is a function of the hardness of HAZ in cast iron and mild steel weldment also cooled in groundnut oil. Therefore,

$$\beta = 0.4478\gamma \quad (5)$$

$$\beta = 0.8031\alpha \quad (6)$$

$$\gamma = 1.7934\alpha \quad (7)$$

Multiplying equations (5) and (6) as arranged in Table 2;

$$\frac{\beta}{\gamma} \times \frac{\beta}{\alpha} = 0.4478 \times 0.8031 \quad (8)$$

$$\frac{\beta^2}{\gamma\alpha} = 0.3596 \quad (9)$$

$$\beta^2 = 0.3596\,\gamma\alpha \quad (10)$$

$$\beta = \sqrt{(0.3596\gamma\alpha)} \quad (11)$$

$$\beta = 0.5997\sqrt{(\gamma\alpha)} \quad (12)$$

The derived model is equation (12)

Where

β = Model-predicted hardness of HAZ in aluminum weldment cooled in groundnut oil (VPN)

α = Model-predicted hardness of HAZ in mild steel weldment cooled in groundnut oil(VPN)

γ = Model-predicted hardness of HAZ in cast iron weldment cooled in groundnut oil (VPN)

4. Boundary and initial conditions

The welding was carried out under atmospheric condition. After welding, weldments were also maintained under atmospheric condition. Welding current and voltage used are 180A and 220V respectively. SiO_2-coated electrodes were used to avoid oxidation of weld spots. The coolants used were maintained at 25^0C (room temperature). Volume of coolants used; 1000cm^3. No pressure was applied to the HAZ during or after the welding process. No force due to compression or tension was applied in any way to the HAZ during or after the welding process. The sides and shapes of the samples are symmetries.

5. Model validation

The derived model was validated by evaluating the model-predicted values of HAZ hardness in aluminum weldment cooled in groundnut oil β and comparing them with the corresponding values obtained from the experiment β_{exp} [8]. Following re-arrangement of the model equation; (8), the values of γ and α were also evaluate as;

$$\alpha = \left(\frac{\beta^2}{0.3596\gamma} \right) \quad (13)$$

$$\gamma = \left(\frac{\beta^2}{0.3596\alpha} \right) \quad (14)$$

and compared with their respective corresponding experimental values γ_{exp} and α_{exp} to further establish the validity of the model. The model-predicted values of β, γ and α are shown in Table 3.

Analysis and comparison between the model-predicted values β, γ, α and the respective corresponding experimental values $\beta_{exp,}$ γ_{exp} and α_{exp} reveal deviations of model data from the experimental data. This is attributed to the non-consideration of the chemical properties of the coolant and the physiochemical interactions between the materials (aluminum, mild steel and cast iron) and the coolant which is believed to have played vital roles in modifying the microstructure of the HAZ during the coolant process. These deviations necessitated the introduction of correction factor to bring the model-predicted values to exactly that of the corresponding experimental values.

Deviation (Dv) of the model-predicted HAZ hardness values (β, γ and α) from the corresponding experimental values $\beta_{exp,}$ γ_{exp} and α_{exp} is given by

$$Dv = \left(\frac{M_H - E_H}{E_H} \right) x\ 100 \quad (15)$$

Where

M_H = Model-predicted HAZ hardness values

E_H = HAZ hardness values from the experiment [8]

Correction factor (Cf) is the negative of the deviation i.e.

$$Cf = -Dv \quad (16)$$

Therefore

$$Cf = -100 \left(\frac{M_H - E_H}{E_H} \right) \quad (17)$$

Introduction of the value of Cf from equation (17) into the models give exactly the corresponding experimental values $\beta_{exp,}$ γ_{exp} and α_{exp} [8].

6. Results and discussion

Tables 4 and 5 show that on comparing the HAZ hardness values from experiment and those of the model, model values were found to be very much within the range of the experimental values. Model

values of β evaluated from equations (5) and (6) and tabulated in Table 4 show that all the equations are valid since all of them gave almost the same corresponding experimental values. The value of γ in equation (7) was evaluated to establish the validity of the model. It was found that the model-predicted γ value was also almost the same as the corresponding experimental value . This is a clear indication that the HAZ hardness of any of aluminum, mild steel and cast iron weldments cooled in groundnut oil can be predicted as a function of the HAZ hardness of any of the other two materials, providing each pair was cooled in groundnut oil. Table 5 also indicates that the model-predicted value of α is approximately the same as the corresponding experimental value.

N	Models derived	M_H	E_H	Dv (%)	Cf (%)
2	$\beta = 0.5997\sqrt{(\gamma\alpha)}$	411.9900	412.00	-0.0024	+0.0024
2	$\gamma = \beta^2(0.3596\alpha)^{-1}$	920.1474	920.00	+0.0160	-0.0160
2	$\alpha = \beta^2(0.3596\gamma)^{-1}$	513.0822	513.00	+0.0160	-0.0160

Table 4: Comparison of the hardness of HAZ in aluminum, mild steel and cast iron weldments cooled in groundnut oil as obtained from experiment [8] and as predicted by derived model (each material as a function of 1- material).

N	Models derived	M_H	E_H	Dv (%)	Cf (%)
1	$\beta = 0.4478\gamma$	411.9760	412.00	-0.0058	+0.0058
1	$\beta = 0.8031\alpha$	411.9903	412.00	-0.0024	+0.0024
1	$\gamma = 1.7934\alpha$	920.0142	920.00	+0.0015	-0.0015

Table 5: Comparison of the hardness of HAZ in aluminum, mild steel and cast iron weldments cooled in groundnut oil as obtained from experiment [8] and as predicted by derived model (each material as a function of 2- materials).

Where

N = No. of materials constituting the corresponding model as independent variable.

It can also be seen from Table 5 that the model-predicted values of γ and α are also almost the same as the corresponding experimental values of γ and α respectively. Tables 4 and 5 indicate that the respective deviations of the model-predicted HAZ hardness values β, γ and α from those of the corresponding experimental values are all less than 0.02% which is quite negligible and within the acceptable model deviation range from experimental results. Furthermore, the values of γ and α (from equations (13) and (14) respectively) evaluated to be approximately equal to the respective corresponding experimental values confirm the validity of the model. This also implies that the general model; equation (12) can predict the HAZ hardness of any of aluminum, mild steel and cast iron weldments cooled in groundnut oil as a function of the HAZ hardness of the other two materials, providing the three materials constituting the model (aluminum, mild steel and cast iron) were cooled in groundnut oil. Equation (12) is regarded as the general model equation because it comprises of the HAZ hardness of all the materials considered for the model formulation. Based on the foregoing, the models in equations (5), (6) and (12) are valid and very useful for predicting HAZ hardness of aluminum, mild steel and cast iron weldments cooled in groundnut oil depending on the material of interest and the given HAZ hardness values for the other materials.

Conclusion

The derived model can predicts the HAZ hardness of aluminum weldment cooled in groundnut oil relative to the HAZ hardness of mild steel and cast iron welded and cooled under the same conditions. Furthermore, re-arrangement of these models could be done to evaluate the HAZ hardness of mild steel or cast iron respectively as in the case of aluminum. The respective deviations of the model-predicted HAZ hardness values β, γ and α from the corresponding experimental values was less 0.02% indicating the reliability and validity of the model.

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A Mathematical Model For Emission Control Of Industrial Pollution

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ABSTRACT: In this paper, a mathematical model for controlling the generation of industrial pollution in a given economic system is presented. For each sector of the economy, the model determines the appropriate technologies that can be used to produce the amount of pollution allowed for the sector's external demand. The conditions for that model are relaxed is this paper. The relaxation makes the new model more realistic and more applicable than the previous one. [New York Science Journal. 2009;2(6):99-104]. (ISSN: 1554-0200).

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***Keywords*:** Control; input-output; Leontief models; mathematical model; pollution; pollution emission; mathematical programming

1. INTRODUCTION

The need to have a safe and pollutants-free environment is a widely discussed issue in the society today. Consequently, manufacturing companies are looking for ways to reduce the amount of pollutants they emit into the atmosphere. For companies to come to grips with the pollutant emission problem, they must work to eliminate from their production processes, those factors that cause high pollutant emission. In most industrial set-ups, a major factor that influences the amount of pollutants emitted into the atmosphere is technology. It is easy to see that two different sets of machines for producing an item emit different levels of pollutants into the atmosphere. The amount of pollutants produced by a given sector of the economy using a given technology is estimated. From this information, the amount of pollutants per unit output a sector produces using a given technology is calculated. Agencies charged with the responsibility of protecting the environment place restrictions on the amount of pollutants a sector of the economy can produce per unit output. In Nigeria, the Federal Environmental Protection Agency (FEPA) is charged with this responsibility. FEPA shall be the frame of reference in this paper.

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among different goods [9]. If technology is fixed, then increase in final demand leads to increase in the level of pollutants emitted into the atmosphere. Also pollutants emitted by various industries increase or decrease if the technology matrix and final demand are held constant. Assuming minimal changes in a composition of final demand, choosing the right technology is the most important factor in reducing industrial pollution.

The following problem would be addressed in this paper given different technologies for the production of item j by industry j,$j = 1...$, n, which technology should be chosen by industry j so as to (1) satisfy, FEPA permissible pollutant levels for the industry, and (2) satisfy demand for output j as much as possible. By permissible pollutant level (PPL), we mean pollutant quantities, which place limits on the amount of pollutants an industry can produce; the actual quantities produced by the industries may be different from the PPL values. The PPL can be considered as the pollutant levels that are allowed for demand external to the economic system. Once the PPL values are

determined, the system can generate enough pollutants to produce corresponding goods and services. Changing the PPL values lead to new emission standards. The Leontief production model shall play an important role in our formulation of the model.

The structure of the rest of the paper is as follows. In Section 2, the Leontief Input-output model is explained. Terminology associated with this model shall be used extensively in the paper. We formulate the model in section 3 and provide solutions technique in section 4. An example illustrating an application of the model is given in Section 5. In section 6, we summarise our results.

2. LEONTIEF PRODUCTION MODEL

The Lentitive input-output production model describes the inter-relationship among prices, production levels, and demands in a given economic system (8). For a fixed period of activities, the Leontief input-output production model is described by the equation.

$$x_j = \sum_{k=1}^{n} {}^{a}\, jk^{x} k^{+b} j \qquad (1)$$

Where

n = Number of industries / Sectors in the system;

x_j = Total outputs from industry *j*;

b_j = Units available / needed at industry *j* to satisfy demand;

a_{jk} = Technical coefficient representing units of production of industry *j* required by industry k.

The vectors $x = [x_1, ..., x_n]^t$ x and $b = [b_1, ..., b_n]^t$ are called production vector and demand vector, respectively. The associated matrix $[a_{ik}]_{i,k}^{n}$ is called coefficient matrix or technology matrix. In the next section, we extend and modify this model to address the pollution control problem.

3. MODEL FORMULATION

Consider an economy with n industries, each of which must produce an item. Let $mj \geq 1$ be the number of different technologies available for the production of output j by industry j. Let

x_j = monetary value of the amount of pollutants produce by industry *j*

b_j = Monetary value of the amount of pollutants require to satisfy external demand for industry *j* products

$a^{j}{}_{ik}$ = Monetary value of the output of pollutants by technology *i* resulting from the production of one unit of item *j* by industry *j* for industry *k*.

The requirement that the amount of pollutants produced by sector j is at most equal to the amount allowed for both internal and external demands is equivalent to:

$$xj \leq b_i^j + \sum_{k=1}^{n} a_{ik}^j x_{kj} : i = 1,...,m_j xj[\{\ \}] = 0, j = 1,...,n. \qquad (2)$$

Observe that the quantity $\sum a_{ik}^j x_k$ is the amount of pollutants needed to satisfy internal demands, and that this is not restricted in this model. One argument for not restricting pollutants generated in order to satisfy internal demand is that doing so could weaken the national economy.

Apart from meeting the FEPA requirement on pollution emission, it is important for an industry to

meet the demand for its products as much as possible. To ensure that production levels of chosen technologies meet demands for goods and services, we add the condition:

$$xj\left[\max\left\{xj - b_i^j - \sum_{k=1}^{n} a_{ik}^j x_k : i = 1,..., m_j\right\}\right] = 0,\ j = 1,..., n. \qquad (3)$$

The technology chosen by sector j is the one that satisfies Equations (2) and (3), simultaneously. The mathematical model for Emission Control Industrial Pollution is now defined as follows (MMECIP): Given the amount of pollutants b_i^j, in monetary values, needed to satisfy emission restrictions for sector *j* outputs, and the pollution input-output coefficients a_{ik}^j, find the amount of pollutants x_j, in monetary value, that sector *j* should produce so that

MMECIP: $xj \le b_i^j + \sum_{k=1}^{n} a_{ik}^j x_k,\ j = 1,..., n, 1 \le i \le m_j.$

$$xj\left[\max\left\{xj - b_i^j - \sum_{k=1}^{n} a_{ik}^j x_k : i = 1,..., m_j\right\}\right] = 0,\ j = 1,..., n.$$

$$xj \ge 0,\ j = 1.,,,.n.$$

4. SOLVABILITY OF THE PROBLEM

In this section, we provide procedures for solving equation (2) and (3) simultaneously. We observe that the system in (3) is non-linear. Let

$$E = \begin{bmatrix} e_1 & 0 & ... & 0 \\ 0 & e_2 & 0... & 0 \\ ... & ... & ... & ... \\ 0 & ... & ...o & e_n \end{bmatrix} \qquad d^j = \begin{bmatrix} b_i^j \\ . \\ . \\ . \\ b_{mj}^j \end{bmatrix} A^j = \left(a_{ik}^j\right)_{i=1,\,j=1}^{mj,\,n}$$

Where e_j is and m_j x 1 column vector of all ones. Moreover, define matrices *A* and *d* by

$$A = \begin{bmatrix} A^1 \\ : \\ A^n \end{bmatrix}, \quad d = \begin{bmatrix} d^1 \\ : \\ d^n \end{bmatrix}$$

Proposition: The vector x^* is a solution of the MP with optimal objective function value *z = 0* if and only if it is solution of the MMECIP

***Proof*:** We first observe that $G_j \ge 0$ for each *j*, *j = 1, .., n,* by Equation (2) and (4)

suppose x^* is a solution of the *MP* with *z = 0*. Then Equation (2) is satisfied by the constraints of the *MP*. Moreover, we must have.

$$z = \sum_{j=1}^{n} x^*{}_j G_j = 0$$

since the optimal objective value is zero.

This implies that $x^*_j \, G_j = 0$ for each j, since x^*_j and G^*_j are both nonnegative. By equation (4) and $x^*_j \, G_j = 0,$ equation (3) is satisfied. Thus x^* solves the MMECIP.

Conversely, suppose x^* solves the MMECIP. It is easy to see that the constraints of the *MP* hold by equation (2), By equations (3)

$$x^*_j \left\{ \min_{1 \le i \le m_j} \left(- x^*_j + b_i^j + \sum_{k=1}^{n} a_{ik}^j x_k^* \right) \right\} = 0.$$

This Implies that $x^*_j \, G_j = 0.$ for each j. Consequently,

$$z = \sum_{j=1}^{n} x^*_j \, G_j = 0.$$

This completes the proof.

Remark: G_j is a piecewise linear function. If the minimum is attained at i = p, then

$$G_j = -x_j + b_p^j + \sum_{k=1}^{n} a_{pk}^j x_k$$

for each *j*, G_j can easily be selected by solving at most m_j linear programs. Consequently, the objective function in the *MP* can be transformed into a quadratic function that is easily solved by mathematical programming software such as GINO.

5. EXAMPLE

Consider an economy with 2 industries, say, auto and steel industries. Suppose that the auto industry has 3 technologies for producing cars, and the steel industry has 2 technologies for producing steel. Assume that in this economic system, the input-output pollutant coefficients are as given below

Auto Industry

Technology	Air pollution output coefficients in thousand of tons emitted per $1m output.	Allowable pollution level for external demand in thousand of tons
Technology 1	.05 .10	405,000
Technology 2	.06 .11	405,000
Technology 3	.05 .09	405,000

Steel Industry

Technology	Air pollution output coefficients in thousand of tons emitted per $1m output.	Allowable pollution level for external demand in thousand of tons
Technology 1	.08 .0145	600,000
Technology 2	.06 .18	600,000

We want to determine the appropriate technology for each of the two industries that provide pollutant levels not exceeding these PPL requirements. We shall use the *MP*. The constraints corresponding to the auto industry are:

$$\varsigma x_1 \le 405{,}000 + 0.5x_1 + 0.10x_2$$

$$x_1 \le 405{,}000 + 0.6x_1 + 0.11x_2$$
$$x_1 \le 405{,}000 + 0.5x_1 + 0.09x_2$$

The constraints of steel industry are:

$$x_2 \le 600{,}000 + 0.8x_1 + 0.0145x_2$$
$$x_2 \le 600{,}000 + 0.6x_1 + 0.018x_2$$

The *Gs* are computed as follows:

$$G_1 = \min\begin{Bmatrix} -x_1 + 405{,}000 + 0.5x_1 + 0.10x_2, \\ -x_1 + 405{,}000 + 0.6x_1 + 0.11x_2, \\ -x_1 + 405{,}000 + 0.5x_1 + 0.09x_2, \end{Bmatrix}$$
$$= -x_1 + 405{,}000 + 0.5x_1 + 0.10x_2$$

OR

$$G_1 = -x_1 + 405{,}000 + 0.5x_1 + 0.09x_2$$

$$G_2 = \min\begin{Bmatrix} -x_2 + 600{,}000 + 0.8x_1 + 0.0145x_2, \\ -x_2 + 600{,}000 + 0.6x_1 + 0.018x_2 \end{Bmatrix}$$
$$-x_2 + 600{,}000 + 0.6x_1 + 0.018x_2$$

Substituting these into the MP gives the quadratic programming problem:

$$\max z = x_1G_1 + x_2G_2$$
S.T. $0.95x_1 - 0.10x_2 \le 405{,}00$
$$-0.06x_1 + 0.982x_2 \le 405{,}00$$
$$x_1 \ge 0, \ge 0.$$

Solving the MP, we obtain $x_1 = 493{,}807.31$ and $x_2 = 641{,}169.50,$ where G_1 corresponds to choosing technology 1 for the auto industry, and $G_2 = 0$ corresponds to choosing technology 2 for the steel industry. This result is interpreted as follows: The auto industry should choose technology 1. This technology produces 405,000 thousand tons of pollutants for external demand and 88,803.31 thousand tons of pollutants for internal demands. similar interpretation follows for the steel industry.

Note that using $G_1 = x_1 + 405{,}000 + 0.5x_1 + 0.09x_2$ and replacing the first constraint by $0.94x_1 - 0.11x_2 \le 405{,}000$ leads to the same results.

6.0 CONCLUSION

A mathematical model for controlling the generation of industrial pollution is presented. Information needed for the model's construction is available for the US economy. Nevertheless, many industrial nations have undertaken input-output studies of their economies and the concepts of this paper apply to their economies as well.

It is also shown that the model can be solved as a mathematical programming problem. This is advantageous considering the popularity of MP methodology in the manufacturing sectors of most industrial economies.

Finally, it is pertinent to point out that real applicability of any model based on empirical information, such as the one presented here, depends on accurate estimation of the needed numerical data. Fortunately, advances in new technology indicate that this is a task within reach.

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Biodiversity and Traditional Knowledge of Bergenia spp. in Kumaun Himalaya

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Abstract: Kumaun Himalaya is rich in biodiversity and home of several medicinal plants. Our ancestors were aware of the medicinal values of Pashanbheda and proves are our ancient literatures like Ayurveda, Charaka Samhita, Susrata Samhita and Vagbhata which where known as divine truth of this plant. *Bergenia ligulata* is a well known Indian drug, referred to as PASHANBHEDA or STONE BREAKER. In this paper, an attempt has been made to collect traditional data of total diseases from tribes of Kumaun Himalaya on the ailments cured by Pashanbheda (*B. ligulata*). [New York Science Journal. 2009;2(6):105-108]. (ISSN: 1554-0200).

Key Words: *Bergenia ligulata*, Stone Breaker.

Introduction

The objective of present study is to reveal traditional knowledge and biodiversity of *Bergenia spp.* (Saxifragaceae). It is an important medicinal plant of temperate Himalaya between 4,000 and 12,000 feet. Hooker (1888) has reported three species of this plant from India in The Flora of British India. Wehmer (1948) reported three species of *Bergenia* from India in The Wealth of India. Pande (1984) has observed one species, i.e., *Bergenia ligulata* **(Plate-1)** from Almora district in his Ph.D. thesis. Recently, Gaur (1999) also reported only *Bergenia ciliata* syn. *B. ligulata* from North-West Himalaya in The Flora of the District Garhwal, North-West Himalaya. Sharma (2003) observed two species, i.e., *Bergenia ligulata* and *Bergenia stracheyi* **(Plate-2)** from India in Medicinal Plants of India. Recently, Pangtey (2005) reported two species (*Bergenia ligulata* from lower altitude and *Bergenia stracheyi* from higher altitude) from Kumaun Himalaya.

Traditional information of several medicinal plants from tribes of Kumaun Himalaya was already documented and some are being currently used as drugs. Farooq (2005) has reported several plants from Kumaun Himalaya which is being currently used as drugs. The plant *Bergenia ligulata* is chief botanical source of 'Pashanbheda', drug used in indigenous system of medicine and incorporated in medical texts and material media (Pandey, 1995). Already, this plant has been recognized for its role in dissolving kidney stone. It is also effective in fever, eye ailments, dysentery and diarrhoea, piles, inflammation, chronic ulcers etc. The traditional data of Pashanbheda is limited and more information will help in discovering new drugs for several diseases. Beside, *Bergenia stracheyi* is also used in curing several ailments like old wounds, kidney stones, opthalmia etc.

Methodology

Extensive survey in and around Kumaun Himalaya revealed this plant found in mixed vegetation on rocky slopes in moist and shady habitats, predominantly on northern and western slopes. Plant specimens of *Bergenia ligulata* were collected from Almora at 4,500 feet, at 5,000 feet height along the road side of Bhowali, at 5000 to 6000 feet on the western slopes of Binsar forest. *Bergenia stracheyi* was collected along the Pindari Glacier route from 7,000 to 12,000 feet height (Prakash, 2004).

Interviews were carried out of the tribes of different age groups and different gender to get information on medicinal uses of Pashanbheda (*Bergenia ligulata)* by them. Firstly, information were

considered only after interacting with two or more tribal families. Secondly, the information given by the tribes was compared with standard literature (Farooq, 2005; Singh and Jain, 2003).

Results and Discussion

Traditional Knowledge of medicinal plant – Pashanbheda was gathered from various tribal families of different areas of Kumaun Himalaya. The results of traditional experiences are given in **table – 1**. As the name implies, it is considered a specific remedy against kidney and bladder stones. Rhizome is the officinal part and is light, cool, bitter, astringent, useful in cough and cold, cardiac problems, piles, fever, ulcers, swellings, old wounds, cuts and burns, septic, laizi, gastro-intestinal problems, eye problems, colitis etc. Leaves of *Bergenia ligulata* and *Bergenia stracheyi* are also used in treatment of several diseases like wounds, cough and cold, tonsils etc.

Plate-1: *Bergenia ligulata*

Plate- 2 : *Bergenia stracheyi*

Table 1: Traditional Remedies Prepared From Rhizome and Leaves of Pashanbheda to Cure Certain Diseases

S.No.	Ailments	Plant Parts Used	Method Used	Community Reported Used
1	Kidney and Gall bladder stone	Rhizome	Dried powder is used	Local knowledgable person, Van Rawat, Bhotiya and illiterate local people.
2	Wound / old wounds	Leaves and Rhizomes	Powder of dried leaves and rhizome are applied to heal old wounds.	Local illiterate people, Buxa and Van Rawat
3	Septic	Rhizome	Paste of rhizome used as	Locals and Van Rawat

			antiseptic.	
4	Cough and cold	Leaves and Rhizome	Leaves and rhizome boiled with water and given in cold and cough.	Bhotiya
5	Cut and Burns	Rhizome	Crushed rhizome mixed with curd and applied on burns.	Bhotiya and Van Rawat
6	Dysentery and Diarrhoea	Rhizome	Infusion of rhizome is taken orally for diarrhoea and dysentary.	Locals, Van Rawat and Bhotiya
7	Fever	Rhizome	Dried powder is given in fever.	Buxa
8	Asthama	Rhizome	Rhizome juice is given in acute asthma	Van Rawat and Buxa
9	Gasto-intestinal problems	Rhizome	All kinds of intestinal problems are cured by chewing fresh rhizome	Local literate and illiterate people
10	Eye ailments	Rhizome	Crushed rhizome sap is applied in eye diseases.	Local knowledgeable people, Van Rawat and Bhotiya.
11	Septic pimples developed on the head of new born baby (Laizi)	Rhizome	Rhizome paste is applied	Local people, Bhotiya and Van Rawat.
12	Chronic ulcers	Rhizome	The rhizome is crushed and used in all kinds of ulcers.	Van Rawat and Bhotiya
13	Cutaneous infections	Rhizome	Rhizome paste is effective in cutaneous diseases.	Local people
14	Inflammation	Rhizome	Paste of fresh rhizome is used.	Local people
15	Rheumatic	Rhizome	Rhizome paste is anti-rheumatic.	Local people
16	Helmintic	Rhizome	Fresh & dried rhizome extract is used orally.	Bhotiya
17	Piles	Rhizome	Fresh & dried rhizome extract is used orally.	Buxa, Bhotiya and Local people
18	Tonsils	Leaves and Rhizomes	Rhizome & leaves paste is applied externally.	Bhotiya and Van Rawat
19	Cardiac problems	Rhizome	Rhizome powder is given.	Bhotiya
20	Colitis	Rhizome	Rhizome paste cure internal wounds including colitis.	Bhotiya
21	Aphrodisiac	Rhizome	Rhizome powder is given to increase spermatozoa.	Bhotiya
22	Urinary diseases	Rhizome	Rhizome sap is taken orally in all kind of urinary problems.	Locals, Van Rawat, Bhotiya and Buxa

Conclusion

It is concluded that *Bergenia ligulata* or Pashanbheda possesses considerable medicinal properties which need to be exploited by the scientists. Based on traditional knowledge, verification of various diseases and their control measures by alkaloids and steroids present in Pashanbheda and *Bergenia stracheyi* shall be worked out in future.

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