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Paste Production From *Synodontis Membranaceus* Using Different Percentages of Ginger (*Zingiber officinale*)

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Abstract:

Synodontis membranaceus was subjected to fermentation (34 ±3°C) for a period of 4- weeks (one month) with varying concentrations of ginger (5%, 10%, 15%, 20%) and 20% salt as spices to produce paste. The samples were analyzed for proximate composition, pH, microbial load and organoleptic properties at the beginning and end of the fermentation. Results showed steady increase in nutrients such as crude fat, ash, and NFE (nitrogen free extract) but decrease in crude fibre. There were fluctuations in the crude protein of the fermented fish samples. There was an increase in the microbial load of the fermented fish and a slight decrease in the moisture content. The organoleptic test showed preference for taste, aroma, and overall acceptability for fish fermented with 20% ginger.[Researcher.2009;1(5):1-8].(ISSN:1553-9865)

Key words: *Synodontis membranaceus* fermentation, paste and spice

1. Introduction

There is a decrease in animal protein intake as a result of decrease in animal production and the rising growth in human population. The short fall in animal population has resulted in an astronomical increase in the cost of eggs, meat, and poultry. Fish have thus become the main source of animal protein to the average citizen since the price is relatively cheap and constant (Eyo and Abakar, 1988).

The on-going reliance on fish calls for cursory investment into methods of fish preservation that would be capable of utilizing the available fisheries resources to produce fish products, which are organoleptically and nutritionally acceptable to consumers (Eyo and Abakar, 1988).

Fish preservation is a crucial aspect of fisheries sub sector in Nigeria especially because of the usually high prevailing temperature causing rapid deterioration of fish (Aluko *et al*, 2000). Fermentation is one of the principal methods of preservation and fish fermentation has been found over the years to be a cheap method of fish preservation (Essuman, 1992).

Fish fermentation is an ancient technology practiced in many tropical countries especially in South - East Asia, Africa and Latin America (Eyo, 2001). The principal objective of fermentation is the development of distinctive

flavour in the final product. The product is therefore mainly used as condiment in preparation of traditional sauces (Essuman, 1992). Fish fermentation involves addition of salt to fish in 1:3 to 1:5 w/w and allowing it to ferment in earthen jars at ambient temperature (FAO, 1971). Fish could be fermented to improve the shelf life and to prevent wastage in times of glut and later used during scarcity. Moreover, it was found that if these changes are controlled, desirable flavours could be conferred on the product. These could increase the acceptability of the fish and mask other less pleasant flavours and odour. Fermentation is the breakdown of organic substances into simpler compounds by the action of enzymes or microorganisms. Products obtained from fish fermentation are fish paste, fish sauce, and salted fish (Farnworth, 2003).

Fish paste is a fermented fish product obtained by partial fermentation of the fish prepared by mixing fish with coarse salt in the ratio 3:1 and left to mature in clay vats (Elmer – Rico *et al*, 2005). The genus *Synodontis*, known commonly as catfish in English, or as Kurungu in Hausa is of economic importance (Reed *et al*, 1967). The flesh is whitish in colour, slightly soft, and of excellent flavours, particularly suited to making the traditional religion dish of peppered soup and it is also suitable for smoking in the traditional manner, after which they have excellent keeping

qualities. The fish is fleshy hence, more paste may be produced and this may be another way of processing the fish apart from the common methods. The FAO has given the daily dose of ginger to be between 2-5g (Ginger people Htm 2007). This work is therefore aimed at producing paste from *Synodontis membranaceus* with varying percentages of ginger and determines the nutritional content, microbial load and the consumer acceptability of the paste.

2. MATERIALS AND METHODS.

2.1 Fish samples and pre fermentation treatment

Fresh fish (*S.membranaceus*) about 5-7 cm in length and 80-120g obtained from (Kara market) Kainji Lake Basin and kept in nylon bags. The fish samples were then transferred within 1hr to the laboratory where they were washed thoroughly, eviscerated, rinsed with clean water and allowed to drip for 15mins after which they were cut into tiny bits and weighed. They were then subjected to the following treatments.

Sample A 750g fish + 20% salt.

Sample B 750g fish + 20% Salt + 5% ginger.

Sample C 750g fish + 20% Salt + 10% ginger.

Sample D 750g fish+ 20% Salt+ 15% ginger.

Sample E 750g fish+ 20% Salt+ 20% ginger.

2.2. Fermentation of samples

Each Sample was mixed thoroughly and pounded in mortar with pestle according to the method described for *patis* production in Asia (Martin, 1994). It was divided into three equal parts and kept in airtight plastic bottle, sealed with cellophane paper. These bottles were kept in a plastic buckets sealed with paper tape and then buried in a one-and-a-half-meter-deep hole for a period of one month around Fish Processing Laboratory of Federal College of Freshwater Fisheries Technology, New -Bussa.

2.3. Physicochemical analysis

The temperature of the environment was taken on week- days (Monday-Friday) 4 wks while the pH of each sample was taken before fermentation and after fermentation using

standard pH meter. The crude protein, crude lipid, ash, crude fibre and moisture content of all the Samples were determined at first and fourth week in the Department of Zoology, University of Jos, Jos, using the methods of A.O.A.C. (2000).

2.4. Sensory evaluation

Sensory quality attributes such as taste, odour, and overall acceptability were evaluated on a 9-point hedonic scale. A Panel of ten Judges was used after being briefed on what to do and necessary precautions taken to prevent a carry-over of the taste. Stew sauce was made and divided into five equal portions to which one tablespoon each of the sample was added. Each was warmed for three to five minutes on the same oven until boiled. It was served hot with white rice.

2.5. Microbiological analysis

For each fish sample 9ml of distilled water was measured into ten test tubes for serial dilution and 1ml each from slurry was measured into the 'whole' to make 10ml. Each dilution was pour-plated on nutrient agar and incubated at 30°C for total bacterial count (TBC). The logarithms of the colony unit per gram of the sample were calculated and recorded. The procedure was repeated for all the samples.

3. Results and discussion

Table 1 shows the pH of the fresh and fermented fish samples. The pH ranges from 6.2 - 7.45 throughout the fermentation period. In the first week, the pH dropped from 7.0 -7.2 to 6.2 - 6.6. At the second week of fermentation the pH increased slightly. The pH of the samples remained fairly constant at the range of 6.6-6.8 during the first 21 days of fermentation. After 21 days there was a drop in the pH of the samples compared to the pH of the control sample. The increase in the pH of sample A (control) was due to putrefaction with salt leading to the formation of basic nitrogenous compounds. The drop in the pH of sample B, C, D, and E could be attributed to the production of acids during bioconversion. According to Frazier and West Hoff (1988), the trend in the pH reduction may be due to the involvement of Lactic acid bacteria that are able to ferment sugars to produce lactic acid, which then resulted in the lowering of pH. Lee *et al.*, (1986) have also indicated such an inverse relationship between pH and Lactic acid and also pH and acid forming bacteria/yeast in a Lactic fermented fish called Sikhae.

The proximate compositions of the unfermented and fermented fish samples are as shown in Tables 2 and 3 below. The fermented products had slightly lower moisture content than the unfermented products, which might be due to the cryoprecipitant effect of the salt used (Achinewhu and Oboh, 2002).

The crude protein content in fermented samples A, B, C, D and E, 13.68%, 12.24%, 12.78%, 14.41% and 14.94% respectively were lower than those of the unfermented fish samples which were 14.46%, 15.56%, 15.75%, 16.04% and 16.20% respectively. The crude protein in the unfermented fish samples was higher than those of the fermented fish samples. During the four weeks of fermentation there was a relative decrease in the protein content of the fermented fish samples. This is in agreement with the result of Eyo (1993) who fermented *Alestes nurse* and associated the low protein level of the samples with proteolysis during the fermentation process with the production of volatile substances, which could be responsible in part for the subsequent odour, and flavour of fermented fish. Such proteolysis are implicated in the production of the matured flavours of pickled herring (Luipjen, 1959). Also, trypsin and similar enzymes in the pyloric caeca are largely responsible for the liquefaction of fish during the manufacture of some fermented products (FAO, 1971). This disagreed with the work of Achinewhu and Oboh (2002), which showed a slight increase in the crude protein of *Sardinella sp* from 16 to 18% and attributed the increase in the crude protein to the activities of the microorganisms that took part in the fermentation processes. This difference however may be due to the different location of the experiment as well as the different type of fish used. The moisture content of sample E increased but the moisture of samples B, C, D, and E, decreased considerably. The crude fat content of the fermented samples A, B, C, D and E were 3.10%, 6.60%, 5.75%, 5.08% and 4.85% respectively, where as that of the unfermented fish samples A, B, C, D and E were 2.50%, 2.30%, 2.54%, 2.24% and 2.80% respectively. The crude fat (lipid) content of the fermented fish sample was higher than the fresh (unfermented) samples. The slight increase in the crude fat (lipid) content of sample A was related to lipid oxidation, which produces volatile compounds, and the lipids of fish are known to be very unsaturated and very prone to oxidation (Eyo, 1993). Oxidized fish oils have a very characteristic taste and paint-like smell, the acceptability of such flavours in fermented fish

being dependent on local taste (FAO, 1971). The increase in the lipid content of the fermented samples B, C, E, may be due to the ginger spice added which contains antioxidants that prevented the fish from becoming rancid and spoilt (Voskrenensky, 1965) and so makes an available carbon source for the microorganisms responsible for fermentation to utilize. Other studies (Achinewhu, 1986; Beuchat and Worthington, 1974) have shown no difference in lipids of fermented plant products reaching the conclusion that microorganisms did not use lipids as carbon or energy source during the fermentation of African oil bean seed and peanuts.

The ash content of the fermented samples A, B, C, D and E were 18.15%, 18.25%, 17.60%, 16.50% and 22.30% respectively while that of the fresh samples A, B, C, D, and E were 19.90%, 14.60%, 17.00%, 17.40%, and 18.40% respectively. The ash content represents the mineral content. Fermented fish has more minerals content than unfermented fish. Loring Windblad, (2008) established that fermentation breaks down the cell wall (membrane) making them more easily digestible as the basic nutritional vitamin and minerals are directly made more accessible.

The crude fibre content of the fermented samples A, B, C, D and E were 0.67%, 0.84%, 0.95%, 1.02% and 1.13%, respectively, whereas that of the unfermented fish samples A, B, C, D and E were 0.90%, 1.21%, 1.30%, 1.40% and 1.52% respectively.

The NFE (Nitrogen free extract) of the fermented sample A was negligible while B, C, D and E were 1.92%, 3.57%, 3.84%, and 4.03% respectively. The NFE of the unfermented fish sample E was negligible but samples B, C, D and E were 6.03%, 2.76%, 1.82% and 4.18% respectively. Table 4 shows the microbial count in CFU/g of the fresh and fermented fish samples. It ranged from 5.0×10^6 – 40×10^6 at zero day to, 158×10^6 - 16×10^6 at the end of the 4th week for sample A. Others fall between these range except for samples C and D, which are far above others. Generally, there was an increase in the microbial population in all the treatments because the microorganisms responsible for fermentation were multiplying as a result of abundant substrate and suitable condition for their growth (Pelczar *et al.*, 1986). The highest microbial population was found in sample C even at the initial time of fermentation and this was maintained throughout the fermentation period. This is in agreement with

Eyo (2001) who stated that the microbial load of the environment/habitat of the fish reflects in the processing. The progressive increase in the microbial load of sample A agreed with the result of Soyiri *et al.*, (2003) who showed a systematic increase in the microbial load of salt treated fish samples. Thapa *et al.*, (2004) also fermented fish into Ngari, hentak and Tungtap, which are traditional fermented fish products and recorded increase in the microbial load of the fish samples. The physical examination of the population showed different colonies including yeast and fungi together with other types of rod shape and round shape colonies e.g. bacteria.

Table 5 shows the mean sensory scores of the fermented fish samples for aroma, taste, and overall acceptability. Sample E with 20% salt and 20% ginger was the most preferred (P< 0.05) in terms of taste, aroma and overall acceptability. It was significantly different (P< 0.05) from sample A in terms of taste, but in terms of aroma and overall acceptability, there was no significant difference between the samples. The higher percentage of ginger (20% in sample E) might have contributed to its accepted sensory qualities. Ginger is a generally accepted spice in food processing. The volatile oil in ginger (Zingerone) might have enhanced the quality attributes of the samples. The fermented fish

samples can therefore be used as a condiment in dishes.

4. Conclusions

At the end of one month a paste was made from *Synodontis membranaceus* with different percentage of ginger (5%, 10%, 15%, and 20%). The paste with 20% ginger and 20% salt was most preferred because it had the highest value in crude protein, crude fiber, NFE, ash content, and the lowest moisture content. Also the panelists showed preference for sample prepared with 20% ginger and 20% salt in terms of taste, aroma and overall acceptability. It also had the lowest microbial count in Cfu/g. It can be concluded that the higher the percentage of ginger, the better the product. Also the higher the percentage of ginger the lower the microbial load of the fish. This confirms the bacteriostatic effect of ginger on the microorganism. The active agent shagaol and zingerone may have enhanced this effect as the higher the percentage of ginger, the lower the microbial load of the fish paste.

5. Recommendation

It is therefore recommended that more research should be done on this work especially to identify the microorganisms present in the fermented fish (paste).

6. Results

Table 1: The pH of the fresh (unfermented) and fermented fish samples

Samples	pH				
	Fresh	Week 1	Week 2	Week 3	Week 4
A	7.20a	6.20a	6.80b	6.80b	7.45a
B	7.10a	6.40a	6.70b	6.70b	6.60b
C	7.20a	6.25a	6.80b	6.60b	6.20b
D	7.20a	6.60a	6.70b	6.60b	6.45b
E	7.00a	6.40a	6.85b	6.60b	6.40b

Table 2: Proximate composition of the fish samples before fermentation.

Samples	Moisture content	Ash %	Crude fat %	Crude fibre %	Crude protein %	NFE %
A	62.55a	19.90a	2.50ab	0.90b	14.46b	0.00e
B	60.30b	14.60d	2.30b	1.21ab	15.56a	6.03a
C	60.65ab	17.00c	2.54a	1.30ab	15.75a	2.76c
D	61.10ab	17.40bc	2.24b	1.40a	16.04a	1.82d
E	56.90c	18.40b	2.80a	1.52a	16.20a	4.18b

Key

A: Fish with 20% Salt alone, B: Fish with 20% Salt and 5% ginger:
 C: Fish with 20% Salt and 10% ginger, D: Fish with 20% Salt and 15% ginger.
 E: Fish with 20% Salt and 20% ginger

Table 3: Proximate composition of the fermented fish samples after 4 weeks

Samples	Moisture content %	Ash %	Crude fat %	Crude fibre %	Crude protein%	NFE %
A	64.80a	18.15b	3.10c	0.67b	13.68ab	0.00c
B	60.15ab	18.25b	6.60a	0.84b	12.24b	1.92b
C	59.35b	17.60b	5.75ab	0.95ab	12.78b	3.57a
D	59.15b	16.50b	5.08ab	1.02a	14.41a	3.84a
F	52.75c	22.30a	4.85b	1.13a	14.94a	4.03a

Table 4: Microbial count in CFU/g of the fresh (unfermented) and fermented fish samples after 4 weeks.

Samples	CFU/g	
Fresh	A	5.0 x 10 ⁶
	B	15 x 10 ⁶
	C	34 x 10 ⁶
	D	40 x 10 ⁶
	E	8 x 10 ⁶
WEEK 4	A	158 x 10 ⁶
	B	16 x 10 ⁶
	C	87 x 10 ⁶
	D	43 x 10 ⁶
	E	26 x 10 ⁶

Table 5: Summary of mean sensory scores for the fermented fish samples

Treatment	Samples				
	A	B	C	D	E
Taste	7.3a	8.0a	7.7a	7.6a	8.6b
Aroma	7.8a	7.6a	7.3a	8.0a	8.5a
Overall	8.0a	8.1a	7.5a	8.0a	8.5a
Acceptability					

Key

- A: Fish with 20% Salt alone,
- B: Fish with 20% Salt and 5% ginger:
- C: Fish with 20% Salt and 10% ginger,
- D: Fish with 20% Salt and 15% ginger.
- E: Fish with 20% Salt and 20% ginger

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Availability of Calcium, Magnesium and Sulphur and Their Uptake by *Amaranthus* as Influenced by Composts and Fertilizers

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Abstract: An investigation was done to evaluate the effects of composts, viz. aerobic compost (AC) and barrel compost (BC) on the availability of Calcium (Ca), Magnesium (Mg) & Sulphur (S) and their subsequent uptake by *Amaranthus*. The crop was grown for 42 days. The soils [Melandaha (Silt loam) and Dhamrai (Silty clay loam)] were treated with composts, composts plus fertilizer and only fertilizer. The 1st, 2nd, 3rd and 4th sets of experiment received 0 t ha⁻¹, 1 t ha⁻¹, 1.5 t ha⁻¹, and 2 t ha⁻¹ compost, respectively. The 5th, 6th, and 7th sets of experiment received compost + urea + TSP. The last set of experiment received only urea and TSP fertilizers. In most of the cases the NH₄OAc extractable (available) Ca & Mg decreased due to application of composts while the availability of S increased. However, the uptake of Ca, Mg and S increased significantly due to application of composts or compost plus fertilizers. [Researcher. 2009;1(5):7-11]. (ISSN: 1553-9865).

Key words: *Amaranthus*, compost, fertilizer, Ca, Mg, and S

1. Introduction

To produce at optimum yields, all crops must have an adequate supply of all of the 16 essential plant nutrients. If one or more is lacking in the soil, crop yields will be reduced even though an adequate amount of the other 13 elements are available. This is somewhat analogous to the fact that a wooden bucket will hold no more water than its shortest stave. Crop yields may be limited by the element that is in shortest supply. However, there are relatively few that focus on nutrients such as Ca and S (Egrinya-Eneji, et al., 2003). The elements Ca, Mg and S are known as macro and secondary nutrients. Ca is the third most used nutrient element and it comes from the weathering of a number of common minerals and rocks including feldspar, apatite, limestone and gypsum. Mg also weathers from minerals as a cation. Most soil S comes from the decomposition of organic matter; some comes from weathering of sulphate minerals like gypsum (CaSO₄. 2H₂O) and pyrite (FeS₂). Although there are many inorganic sources of sulphur, 70-90 % of the total soil S is found in organic matter (Miller and Donahue, 1992). Unlike S, the main source of Ca and Mg is inorganic. Their availability largely depends on total supply, soil pH, CEC, percent base saturation and ratio of them in soil solution (Tisdale *et al.*, 1993). The objectives of this study were to observe the changes in the availability and uptake of Ca, Mg and S due to application of composts or composts plus fertilizers.

2. Materials and Methods

Soils of Melandaha (Silt loam) and Dhamrai (Silty clay loam) series were collected from 0-15 cm depth in a composite manner. Two kg of air-dried (passed through 5 mm sieve) soil was taken into a series of small earthen pots. The experiment was conducted at the Soil Fertility Research Laboratory of the Department of Soil, Water and Environment, University of Dhaka. The duration of the experiment was from January 2000 to June 2001. The experiment consisted of 14 treatments with three replications. The pots were arranged in a completely randomized block design. The 1st, 2nd, 3rd and 4th sets received 0, 1, 1.5 and 2 t ha⁻¹ compost, respectively. The 5th, 6th, and 7th sets of experiment received additional urea and TSP fertilizers along with composts. The last set of the experiment received only urea and TSP fertilizers. For Melandaha soil, 96.2 kg ha⁻¹ N and 28.13 kg ha⁻¹ P₂O₅ were required on high yield goal basis but for Dhamrai soil it was 77.13 kg ha⁻¹ and 30.75 kg ha⁻¹, respectively. The rates were determined with the help of Fertilizer Recommendation Guide (BARC, 1997) for the field but we used this rate for our pot experiment. The compost or compost plus fertilizers or only fertilizers (urea and TSP) were mixed properly with the soil. *Amaranthus* seeds were sown and after emergence 5 seedlings were kept in each pot until harvest at 42 days. Water was also added to bring the soil at field capacity condition. After harvest, the plant and soil samples were analyzed for Ca, Mg, and S contents. Available

Ca and Mg contents of soil were extracted with 1 N NH_4OAc (pH 7.0) as described by Jackson (1962). Available S content was extracted by 500 ppm P solution [from Ca $(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$] and was determined turbidimetrically with the help of BaCl_2 and Tween-80 mixture in an acid medium (6 N HCl) by Spectrophotometer at 420 nm wavelength (Page 1990). For plant Ca, Mg and S, the plant samples were digested with HNO_3 and HClO_4 (HNO_3 : HClO_4 = 2:1). The Ca and Mg contents were determined directly by Atomic Absorption Spectrophotometer. Data were analyzed by analysis of variance (SAS Institute 1988).

3. Results and Discussion

3.1 Effect of compost on Ca availability: The control treatment of Melandaha and Dhamrai soils contained 1292 mg kg^{-1} and 1668 mg kg^{-1} available Ca, respectively. This content changed due to application of compost or compost plus fertilizers or only fertilizers (Table 1). The availability was found to be 1112 mg kg^{-1} and 1561 mg kg^{-1} in Melandaha and Dhamrai soils,

respectively due to fertilizer application (Table 1). Application of aerobic compost (AC) showed decrease in the availability in Melandaha soil at AC_1 (1220 mg kg^{-1}) treatment, increase at $\text{AC}_{1.5}$ (1327 mg kg^{-1}) and did not show any change at AC_2 (1292 mg kg^{-1}). Fertilizers along with AC decreased the availability significantly for $\text{AC}_{1.5}\text{F}$ (1184 mg kg^{-1}) and AC_2F (1112 mg kg^{-1}) (Table 1). After treating with BC, the availability decreased at BC_1 (1220 mg kg^{-1}) and $\text{BC}_{1.5}$ (1238 mg kg^{-1}) treatments but increased at BC_2 (1327 mg kg^{-1}) in the same soil. Fertilizers along with BC decreased the availability in BC_1F (1148 mg kg^{-1}) but increased in $\text{BC}_{1.5}\text{F}$ (1740 mg kg^{-1}) and BC_2F (1776 mg kg^{-1}) treatments (Table 1). The availability increased significantly at AC_1 (1740 mg kg^{-1}) and decreased for other treatments due to AC or AC plus fertilizer in Dhamrai soil (Table 1). Following treatment with BC, the availability of Ca in Dhamrai soil decreased significantly at BC_1 (1633 mg kg^{-1}), $\text{BC}_{1.5}$ (1579 mg kg^{-1}) and BC_2F (1579 mg kg^{-1}) treatments but did not show any change at BC_2 (1668 mg kg^{-1}), BC_1F and $\text{BC}_{1.5}\text{F}$ treatments (Table 1).

Table 1. Changes in the availability of Ca, Mg and S due to application of compost and fertilizer.

Treatments	Melandaha Soil (mg kg^{-1})			Dhamrai Soil (mg kg^{-1})		
	Ca	Mg	S	Ca	Mg	S
Control	1292 c	433 c	8.07 a	1668 b	431 b	9.70 a
AC_1	1220 b	415 b	6.45 a	1740 c	436 b	10.50 b
$\text{AC}_{1.5}$	1327 d	422 b	9.70 b	1650 a	437 b	10.50 b
AC_2	1292 c	423 b	8.87 b	1525 a	437 b	9.70 a
AC_1F	1292 c	364 a	9.70 b	1597 a	422 a	8.07 a
$\text{AC}_{1.5}\text{F}$	1184 a	357 a	8.07 a	1615 a	431 b	8.87 a
AC_2F	1112 a	363 a	7.27 a	1507 a	430 b	8.07 a
BC_1	1220 b	434 c	8.87 b	1633 a	424 a	8.07 a
$\text{BC}_{1.5}$	1238 b	435 c	9.70 b	1579 a	415 a	8.87 a
BC_2	1327 d	430 c	9.70 b	1668 b	429 b	8.87 a
BC_1F	1148 a	426 b	8.87 b	1668 b	426 a	8.07 a
$\text{BC}_{1.5}\text{F}$	1740 e	405 b	8.87 b	1668 b	440 c	10.50 b
BC_2F	1776 e	419 b	10.50 b	1579 a	426 a	10.50 b
F	1112 a	424 b	7.27 a	1561 a	441 b	8.07 a

Means followed by different letters in each column are significant ($p=0.05$) according to Ryan-Einot-Gabriel-Welsch Multiple Range test. A=aerobic compost, C_1 =compost @ 1 t ha^{-1} , $\text{C}_{1.5}$ =compost @ 1.5 t ha^{-1} , C_2 =compost @ 2 t ha^{-1} , B=barrel compost, F=fertilizers.

Table 2. Uptake of Ca, Mg and S (mg/100 plants shoot or root) by *Amaranthus* in Melandaha soil as affected by composts and fertilizer.

Treatments	Calcium		Magnesium		Sulphur	
	Shoot	Root	Shoot	Root	Shoot	Root
Control	177 a	19.03 b	163 a	19.90 b	30.61 b	4.33 b
AC ₁	213 b	20.41 b	222 b	15.40 b	34.45 b	4.30 b
AC _{1.5}	250 c	24.23 b	277 c	20.04 b	49.22 c	5.83 c
AC ₂	197 a	12.42 a	265 c	12.96 a	56.26 c	3.01 a
AC ₁ F	190 a	18.23 b	217 b	12.50 a	45.23 c	2.54 a
AC _{1.5} F	489 e	40.56 d	782 e	32.76 c	95.87 d	8.68 c
AC ₂ F	250 c	29.90 c	293 c	20.54 b	23.92 a	4.34 b
BC ₁	312 d	22.08 b	374 d	18.96 b	54.29 c	4.01 b
BC _{1.5}	276 c	13.20 a	302 d	22.96 b	48.02 c	4.79 b
BC ₂	291c	18.17 b	365 d	13.98 a	49.59 c	3.89 b
BC ₁ F	331 d	20.66 b	433 d	18.15 b	50.12 c	5.23 c
BC _{1.5} F	311 d	13.80 a	394 d	14.40 a	49.86 c	5.01 c
BC ₂ F	333 d	13.80 a	420 d	23.70 b	48.63 c	7.50 c
F	402 e	15.64 a	600 e	27.41 c	88.44 d	8.68 c

Means followed by different letters in each column are significant ($p=0.05$) according to Ryan-Einot-Gabriel-Welsch Multiple Range test. A=aerobic compost, C₁=compost @ 1 t ha⁻¹, C_{1.5}=compost @ 1.5 t ha⁻¹, C₂=compost @ 2 t ha⁻¹, B=barrel compost, F=fertilizers.

3.2Effect of compost on Mg availability: The control treatment of Melandaha and Dhamrai soils contained 433 mg kg⁻¹ and 431 mg kg⁻¹ available Mg respectively (Table 1). The availability changed to 424 mg kg⁻¹ and 441 mg kg⁻¹ in Melandaha and Dhamrai soils, respectively for fertilizer application (Table 1). AC decreased the availability in Melandaha soil and was more pronounced in the presence of fertilizer as compared to control and compost treatments. The highest value was found for AC₂ (423 mg kg⁻¹) and the lowest was for AC_{1.5} (357 mg kg⁻¹) (Table 1). Application of fertilizers along with BC decreased the availability as compared to control and compost treatments and the lowest value was observed for BC_{1.5}F treatment in the same soil (Table 1). In Dhamrai soil the availability increased (though not significant) due to AC and decreased when fertilizers were added along with AC (AC₁F). For this case the highest value was found for AC_{1.5} and AC₂ (437 mg kg⁻¹) and the lowest was for AC₁F (422 mg kg⁻¹) treatments. In most cases (except BC_{1.5}F) the availability decreased significantly due to application of BC or BC plus fertilizers in Dhamrai soil (Table 1).

3.3Effect of compost on S availability: The control treatment of Melandaha and Dhamrai soils contained 8.07 mg kg⁻¹ and 9.70 mg kg⁻¹ available S, respectively.

This content changed due to management practices (Table 1). The value was found to be 7.27 mg kg⁻¹ and 8.07 mg kg⁻¹ in Melandaha and Dhamrai soils, respectively due to fertilizer application. The availability increased significantly at AC_{1.5}, AC₂ and AC₁F due to AC or AC plus fertilizer treatments and the value ranged from 6.45 mg kg⁻¹ (AC₁) to 9.70 mg kg⁻¹ (AC_{1.5} and AC₁F) in Melandaha soil (Table 1). The availability also increased significantly due to BC or BC plus fertilizer application in the same soil and ranged from 8.87 mg kg⁻¹ (BC₁, BC₁F or BC_{1.5}F) to 10.50 mg kg⁻¹ (BC₂F) (Table 1). Similar results were obtained for AC₁ and AC_{1.5} in Dhamrai soil. AC along with fertilizer did not change the availability significantly and the value ranged from 8.07 mg kg⁻¹ (AC₁F and AC₂F treatments) to 10.50 mg kg⁻¹ (AC₁ and AC_{1.5}) (Table 1). BC alone in Dhamrai soil did not change the availability although there has been some increase in presence of fertilizer (BC_{1.5}F and BC₂F) (Table 1).

It was found that for almost all cases, the availability of Ca decreased. Similar result was also found for Mg in Melandaha and S in Dhamrai soils (Table 1). This was most probably due to higher consumption of these elements by plants or their fixation by organic matter (Tisdale *et al.*, 1993). The main source of Ca and Mg is inorganic and the

availability largely depends on the total supply, soil pH, CEC, percent base saturation, types of soil colloids, and ratio of them to other cations in soil solution (Tisdale *et al.*, 1993). In Melandaha soil S availability increased. This may be due to the mineralization of compost (organic matter) (Stevenson, 1986).

3.4 Effect of compost on Ca uptake: The Ca uptake was found to be 177 mg/100 plants shoot and 19.03 mg/100 plants root in Melandaha soil (Table 2). Due to application of fertilizer the values changed to 402 mg/100 plants shoot and 15.64 mg/100 plants roots. In

shoots, the uptake increased significantly due to compost or compost plus fertilizer application. The more pronounced uptake was shown for BC over AC but for individual treatment the highest uptake was for AC_{1.5}F (489 mg/100 plants shoot) treatment. For root, the highest uptake was also found for the same treatment. The uptake by roots decreased for AC₂, BC_{1.5}, BC_{1.5}F and BC₂F treatments (Table 2). For Dhamrai soil, the uptake increased for AC₁F, AC_{1.5}F and AC₂F, BC₁, BC₁F treatments in shoots as compared to control (Table 3). In roots it increased significantly for almost all cases.

Table 3. Uptake of Ca, Mg and S (mg/100 plants shoot or root) by *Amaranthus* in Dhamrai soil as affected by composts and fertilizer.

Treatments	Calcium		Magnesium		Sulphur	
	Shoot	Root	Shoot	Root	Shoot	Root
Control	269 b	7.85 a	263 c	16.57 c	34.50 c	3.79 b
AC ₁	211 a	11.50 b	182 b	20.75 c	26.45 b	2.22 a
AC _{1.5}	274 b	14.89 b	200 b	13.92 b	22.82 a	3.18 b
AC ₂	280 b	6.91 a	305 d	10.32 b	40.63 d	6.00 c
AC ₁ F	339 c	15.09 b	312 d	9.91 b	51.16 e	4.68 c
AC _{1.5} F	355 c	16.69 bc	258 c	10.23 b	38.67 d	6.43 c
AC ₂ F	426 d	23.61 c	342 d	13.38 b	53.06 e	6.83 c
BC ₁	305 c	16.38 bc	235 c	14.82 b	62.47 f	6.18 c
BC _{1.5}	268 b	9.15 a	230 c	8.85 b	68.14 f	2.79 a
BC ₂	112 a	9.42 a	76 a	3.87 a	17.98 a	4.34 b
BC ₁ F	423 d	20.45 c	393 d	13.10 b	62.63 f	6.83 c
BC _{1.5} F	188 a	11.90 b	88 a	3.21 a	31.32 c	3.83 b
BC ₂ F	182 a	13.55 b	146 b	6.32 a	33.20 c	2.45 a
F	346 c	19.69 c	377 d	9.52 b	45.86 d	5.18 c

Means followed by different letters in each column are significant ($p=0.05$) according to Ryan-Einot-Gabriel-Welsch Multiple Range test. A=aerobic compost, C₁=compost @ 1 t ha⁻¹, C_{1.5}=compost @ 1.5 t ha⁻¹, C₂=compost @ 2 t ha⁻¹, B=barrel compost, F=fertilizers.

3.5 Effect of compost on Mg uptake: The Mg uptake by plants was found to be 163 mg/100 plants shoot and 19.90 mg/100 plants root in Melandaha soil. The values changed to 600 mg/100 plants shoot and 27.41 mg/100 plants root, respectively due to fertilizer application (Table 2). The absorption increased significantly in shoots for AC, AC plus fertilizer, BC and BC plus fertilizer as compared to control treatment in Melandaha soil (Table 2). The highest value was found for AC_{1.5}F (782 mg/100 plants shoot) and the lowest were for AC₁F (217 mg/100 plants shoot). For roots, the values obtained are not very prominent. In Dhamrai soil inconsistent results were obtained in almost all cases both for shoots and roots (Table 3).

3.6 Effect of compost on S uptake: The S uptake by plants was found to be 30.61 mg/100 plants shoot and 4.33 mg/100 plants root in Melandaha soil. The values were 88.44 mg/100 plants shoot and 8.68 mg/100 plants root due to fertilizer application in the same soil, respectively (Table 2). In almost all cases, S uptake in shoots increased significantly due to AC, AC plus fertilizer, BC and BC plus fertilizer. The higher uptake was observed for BC but the maximum uptake both for shoots and roots were obtained for AC_{1.5} F treatment (Table 2). Similar results were also found for Dhamrai soil (Table 3) both for AC, AC plus fertilizer, BC and BC plus fertilizer. For this case the highest value was obtained for BC_{1.5} (68.14 mg/100 plants shoot) and the lowest value was obtained for BC₂ (17.98 mg/100

plants shoot). In root, the highest value was for AC₂F and BC₁F (6.83 mg/100 plants root) and the lowest was for AC₁ (2.22 mg/100 plants root).

In most cases, the uptake of Ca, Mg, and S increased significantly due to application of compost or compost plus fertilizer. This might be due to higher growth of plants. The growth increased due to application of compost or compost plus fertilizers; that growth increase occurs due to compost application is in report (Schegel, 1992; Eghball and Power, 1999; and Molla and Huq, 2003). In almost all cases, the maximum uptake took place when fertilizers were added along with compost. The maximum uptake occurred in Melandaha soil when it was treated with barrel compost (Table 2 and Table 3). From this result it can be said that uptake of Ca, Mg and S increased significantly due to application of compost or compost plus fertilizer.

4. Conclusion

From the present study, it can be concluded that the availability of Ca and Mg decreased but S availability increased due to application of compost or compost plus fertilizer. Ca availability increased when barrel compost was applied in Dhamrai soil indicating availability depends on soil types. The uptake of Ca, Mg and S is increased in shoots over roots indicating the elements are mostly needed in aerial parts. Better results were observed with Barrel compost but for individual treatment AC_{1.5}F gave the best uptake of these elements. The best production was also obtained at this treatment (Molla and Huq, 2002).

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Environmental Philosophy: Impacts on Law and Education in the Protection and Enhancement of the Natural Environment

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Abstract: The 21st century has brought humankind face to face with the consequences of our actions over successive generations. Issues such as climate change, habitat loss, desertification and many others have awakened in us the need for greater protection and enhancement of our natural environment. Also, dialogue and research regarding the impact that philosophy, law and education have had on our goals of greater enhancement and protection of nature has been integral to our understanding of such issues. This review seeks to add to that discourse by advancing the perspective that philosophy is most critical to any effort aimed at preserving or enhancing the natural environment. Assessing the development of environmental law and education in a historical context, it will be shown that the dominant philosophy of a culture influences attitudes to nature. This has continued to the present as with the converging of world economies under globalization, dominant world philosophies at work influence environmental legislation and education at all levels. The prospects for meaningful protection and enhancement of the natural environment within the current global context are discussed. [Researcher. 2009;1(5):12-17]. (ISSN: 1553-9865)

Keywords: environment, enhancement, degradation, philosophy, culture, history, law, education

“A little philosophy inclineth man’s mind to atheism, but depth in philosophy bringeth men’s minds about to religion.”- Sir Francis Bacon 1561-1626

1. Introduction

Dialogue and research regarding how best the human race can negotiate the treacherous space that exists between two vastly competing ideals are now at the forefront of virtually all academic inquiry. Human goals of fully maintaining or improving our standards of living while caring for and protecting the very resource base on which we depend for survival have been described by scholars as incongruous at best (Leavenworth, 2002). These issues were brought to the fore with the historic signing of Agenda 21 in the early 1990’s. Historically however, discordance has not been a limiter of our efforts; the last 100,000 years have seen homo-sapiens overcome seemingly insurmountable odds to the point where we now virtually dominate the planet as a species.

The above words by noted British polymath Bacon during the seventeenth century present an overall framework within which the above title will be examined. Humans’ philosophical leanings have served to shape our societies since we first became settled in and around the Fertile Crescent during the Chalcolithic Period. The ways in which we have framed issues relating to sensitive topics such as justice, truth, knowledge and our very existence have

collectively served as a backbone on which human civilizations have been built. This has affected the content and methodology of instruction in our homes and schools, and importantly also the system of rules that strengthen and keep societies intact.

To examine the issue at hand most effectively, the roles of both education and law in environmental enhancement and protection will be summarized. The key point being that philosophy serves as an overarching concept that has influence over both, serving as a common rudder to the vessels that are environmental law and education. At this point, providing definitions for key terms is prudent.

Using the Oxford English Dictionary, environmental enhancement is defined as an increase in the quality, value or extent of the surrounding conditions (biotic and abiotic) in which we live, while protection denotes any act aimed at keeping said safe from harm, destruction or injury. Philosophy (using the same source) can be defined as the study of the fundamental nature of knowledge, reality and existence or as a theory or attitude that guides one’s behavior. Education is the knowledge or skill obtained or developed by a learning process.

Finally, law refers to a rule or system of rules recognized by a country or community as regulating the actions of its members and enforced by the imposition of penalties.

It is important to remember that the latter three terms can be applied to virtually every field of enquiry. For the purposes of this paper, it is their application within the fields of environmental improvement and protection that will be focused on. It will be shown, based on work done by scholars from different fields, that philosophy plays the most critical role in environmental enhancement and protection. Throughout this paper, it will become evident that where, as dominant world philosophies changed from ones extolling the intrinsic values of nature to ones in which instrumental values became more important, our methods of education and the laws we implement are also changed.

2. Environmental Education and Philosophy

Modern efforts at integrating 'environmental education' into school curricula throughout the world can be traced back to the Stockholm Declaration of 1972. Created by the United Nations Educational, Scientific and Cultural Organization (UNESCO), at its core lay the need to 'inspire and guide the peoples of the world in the preservation and enhancement of the human environment' (UNEP, 1972). The basic principles of the Stockholm declaration has been amended and improved on over the years by different groups but the overall goal was to get the world community on a similar page as it relates to environmental education. The decades following the 1970's saw growing concern over the negative effects development was having on the environment. Indeed, environmental education intensified during the 1990's with the formulation of goals of immediate environmental improvement and long term 'sustainability' education (Tilbury, 1995)

Historically, less structured forms of 'environmental education' have been a key aspect of human societies. In fact it can even be argued that for the vast majority of human history, mankind's role as a part of nature was more understood and accepted than at present. Even today, vestiges of the most ancient of human civilizations still maintain a deep abiding respect for the natural environment and its preservation. Examples of this abound over the globe: from Chinese agriculturalists to Australian aboriginal tribes: they all maintain a great reverence for and admiration of nature. O'Niell (1992) and Jameson (2002) have described what others have termed the assigning of intrinsic value to different aspects of

nature. The oldest among the more modern wave of agriculturalists, subsistence farmers throughout the developing world for example, understand the importance of maintaining soil fertility using creative means (even at the expense of yield reduction). Nature worship, and by extension the philosophy of living in harmony with the environment by all means, had allowed ancient civilizations to survive far longer (with smaller populations of course) than the current 200 year run of modern society.

If one was to peer objectively at the changes seen in environmental education since the Stockholm Declaration, great thought and planning has been placed in efforts aimed at protecting and enhancing our environment. As we are now well into the 21st century, 'environmental education' in one form or another is now part and parcel of almost all formal schooling systems the world over. With all this however, environmental degradation as a grave problem persists and can even be argued as increasing. While it is in fact true that great strides have been made compared to the levels of environmental ruin during the industrial era, problems still continue. How can this fact be explained? Environmental education the world over has intensified under the direction of international bodies such as the United Nations (UN), but many of these principles have no great bearing on the daily lives of people all over the world, especially as they relate to environmental enhancement and protection.

This new era termed the 'information age' has truly revolutionized knowledge acquisition. For the first time in our convoluted history, humans now have access to the vast body of knowledge accumulated over successive generations and at different locations. A seven year old child can easily explain the importance of trees, and discussing the significance of nutrient cycling to ecosystem health is a task not too difficult for an internet browsing twelve year old. We understand the direct consequences of our actions and have seen firsthand what happens if and when the natural environment is not cared for. In short, we are now more 'environmentally educated' than at any time in our history. With all this, problems such as deforestation and pollution still continue not because of a lack of being 'environmentally educated', but due to the philosophies driving the world's education systems. If a culture's overriding philosophy is skewed in a particular way, the education of its people will reflect such leaning.

As mentioned earlier, philosophy deals with general human problems focusing on the fundamental

nature of knowledge, existence and justice. A people's dominant philosophy and their perception of their 'place' in nature serve to guide how education in different spheres proceeds. Human history has seen the development of philosophies according to the spatial and temporal realities of early civilizations. Academics have seen it fit to use the dichotomy of eastern and western philosophy to categorize human philosophical development. Western philosophy centered on the teachings of Greco-Roman founding fathers such as Plato and Aristotle, and has gradually morphed over the centuries to what is now termed contemporary philosophy (1900-present).

Eastern philosophical traditions based on the ideas of early Indian, Persian, Chinese, Korean and middle-eastern thinkers are largely believed to be the source of western thought. This is evidenced by the fact that the origins of many western belief systems can be traced to eastern philosophical understandings. Indeed, the spread of the monotheistic tradition and the Abrahamic religions can be traced to earlier origins within eastern philosophy.

This brings up perhaps the key point which can be used to link philosophy to our understanding of our place in nature and hence our efforts aimed at environmental enhancement and protection through education. Religion and philosophy are deeply entwined and are seen by some as circularly causal. Both have great bearing on each other and both affect our understanding of the world in which we live. Lynn White, noted historian, has written extensively about how Judeo-Christian religions as aspects of western philosophy have served to underpin the basic systems of belief that drove modern technological advancement at the expense of the environment. White (1967) wrote of the 'exploitative' attitudes towards nature developed in the western world during the Middle Ages, a time of significant consolidation of Islam, Judaism and Christianity. They have exercised their God-given 'dominion' over the planet by changing it in unimaginable ways. Increased resource-exploitation through the application of new technology has allowed huge growths in our populations. Furthermore, this burden to provide for greater numbers has led to even more resource exploitation, all in increasingly unsustainable manners.

White is among a group of noted academics who have drawn parallels between Christianity and the driving forces behind advances in modern technology. Such names include Max Weber, Robert Forbes and Ernst Benz. The God-given mandate of Genesis 1:28 giving mankind 'dominion' over the earth, care for

the less fortunate, and the destruction of 'pagan' animism are key attributes of Judeo-Christianity. On careful analysis, it can be seen that the philosophies which guided the most ancient of societies were vastly different than those in effect today. For the greater part of human history, men saw themselves as a part of the environment with a specific role to play, just like other components. Enhancement and more so protection of the environment were part and parcel of the societal education that all received.

True environmental enhancement and protection via education generally are difficult tasks because the dominant philosophies guiding them still elevate mankind above nature. On a daily basis all over the globe, the reasoning behind both goals still centre on their perceived benefits to human survival. If for whatever reason no immediate or long term benefits can be seen, the preservation of an untouched landscape will rarely ever occur over some form of modern development. Education is not the critical factor in the goal of environmental enhancement and protection as if the overall philosophy guiding that instruction raises mankind above nature; such attitudes will be reflected in the actions of all people.

3. Environmental Law and Philosophy

The system of rules put in force through a set of institutions in an effort to maintain civil obedience and in this particular case to regulate how humanity interacts with the natural environment is also greatly influenced by philosophy. From the dawn of civilization, different cultures have developed their environmental laws from their own particular belief systems. A society's perception of humanity's role in nature will be borne out in the character of the laws that society accedes to. What then does this mean for current attempts to use international agents such as the United Nations and its International Court of Justice to formulate and administer global environmental laws? The answer to this question lies in the fact that the world economy marches more or less to the beat of Western, Judeo-Christian Philosophy. An analysis of these trends and the prospects for greater environmental enhancement and protection ensues.

National governments have always sought to pass different laws aimed at protecting human health from environmental contamination. Numerous examples abound throughout history where as soon as a new resource is harnessed or technology developed, laws are implemented to protect human welfare. Perhaps the earliest recorded example of such laws were the code of Hammurabi, the sixth

Amorite king of Babylon ruling between 1792 and 1750 B.C. Turner (2008) in describing Hammurabi's series of 282 laws wrote of the responsibilities the King placed on those in charge of protecting the city's water supplies and the penalties to be faced when such were renegeed on. Compared to today's standards, life during ancient Babylon is seen by some as barbaric with the strict laws the King instituted regarding the 'public good'.

In AD 80 the Senate of Rome passed legislation aimed at protecting the city's supply of clean water for drinking and bathing. Moving westward, the burning of coal in London and the disposal of waste in waterways were prohibited in 14th century England. Across the Atlantic, William Penn, the Quaker leader of the English colony of Pennsylvania ordered that for every five acres of forest cleared for settlement purposes, one should be preserved. On that same continent, Benjamin Franklyn is known as much for his work as a scientist and politician as he is for leading furious campaigns against the dumping of waste. Finally, few people remember that the British government in the midst of the industrial revolution passed numerous regulations against the toxic effects of coal burning and the manufacturing industry (Encyclopaedia Britannica, 2006).

It is a known fact that this modern wave of environmental regulation came about after mankind collectively began to realize the adverse effects we have had on the planet. Indeed, since the development of agriculture, humans have greatly modified our surroundings but it was not until the industrial era that this activity increased in a manner never before seen in the history of the earth. We are seeing these ill effects come home to roost today in the form of decreased standards of living as a result of atmospheric pollution, contaminated water supplies plus a myriad of other detrimental effects of our own advancement. In short, the need for environmental enhancement and protection via the use of legislation only came about as our quality of life began to be directly affected by our actions – a symptom of today's dominant world philosophy.

As the world's economies and political systems converge under globalization, numerous international organizations seeking to legislate environmental protection have come to the fore. Gyorgy Szenasi (1999) has written extensively on the role of the United Nation's International Court of Justice (UNICJ) in the development of international environmental law. A great deal of work has indeed been done in this respect regarding the formulation of the numerous treaties, statutes and conventions

regulating environmental protection and enhancement on the world stage.

The concept of 'sustainable development' which came out of the United Nation's Conference on Environment and Development at Rio de Janeiro in 1992 is a further reflection of the dominant philosophy leading efforts at environmental enhancement and protection through law today. The formulation of a term such as this reinforces the belief of humans that somehow, the natural laws which govern the universe are not applicable to them. Homo-sapiens are somehow 'above' all other living things and with proper legislation, development can indeed be 'sustainable'. An even casual analysis of evolutionary history would show that growth or development in all its forms is never sustainable. Attempts can be made to use certain resources sustainably but the western belief that resources must be continually consumed to allow for more 'growth' or development is one that may eventually lead to our demise.

Environmental justice as an issue has now come to the fore with the signing of various international agreements aimed at environmental protection. The chief purveyors of this new 'green' world, the developed countries of the west, in their own infancy had free reign to pursue environmentally detrimental modes of production and resource extraction. As these activities were combined with the vast benefits gained through injustices such as the slave trade and later colonial rule, a huge gap now exists between 'developed' and forever 'developing' countries who yearn for the high standards of living and consumption patterns seen in the west. With the implementation of numerous environmental laws increasing yearly, what real opportunities exist for the poorest of countries to chart their own development within these same laws? The answer to that lies in the attitudes of countries such as China which have largely accepted the fact that economic advancement will come at the expense of the environment. Laws and regulations protecting nature are secondary to the fostering of economic growth.

Western philosophy has again taken the lead in environmental legislation. The world has waited for the developed countries of the western world to at first cause the environmental problems so forcefully described in 1972, and beginning in 1992 to attempt to solve them by implementing legislation to prevent other countries from charting their paths to development in said 'unsustainable' manners. The validity and hence effectiveness of any environmental law implemented in such a contested

context comes into question as many academics query the fairness of such efforts.

As was mentioned earlier, the anthropocentric nature of most western ethical perspectives has assigned intrinsic value only to humans and their welfare. If we were to begin at the root, Aristotle, in *Politics* (Bk. 1, Ch. 8) speaks of how “nature has made all things specifically for the sake of man” and that everything non-human in nature basically serves only an instrumental value. These are the belief systems which have led to the development of western society that now seeks to formulate laws aimed at environmental enhancement and protection. If therefore no immediate value can be seen in an ecosystem, it is highly unlikely that laws will be implemented for its preservation or enhancement, a trend that has continued to this day.

How effective has these anthropocentric-influenced laws been over the years in environmental enhancement and protection? Led by the United Nations under the United Nations Environment Programme (UNEP) and the International Court of Justice, the constitution of international environmental law has been refined periodically to reflect changing realities in the world arena. Where new resources have been exploited, laws aimed at governing their use emerged. Amazingly, it took 20 years for the first legally-binding treaty to be agreed on by participant nations of the first conference in 1972. Adopted at the 1992 Rio Conference, the United Nations Framework Convention on Climate Change (UNFCCC) and the 1992 Convention on Biological Diversity marked the world’s first tangible forays into environmental regulation. In essence, it took over 200 years for a legally binding document among nations regarding environmental protection to be agreed upon since the start of the industrial era in the late 18th century. Furthermore, these legally binding treaties were still only the first step in the formulation of clear laws in an effort to address the problem of environmental degradation.

Out of the UNFCCC emerged the Kyoto protocol, a highly contested aspect of the treaty which aimed to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” (UNFCCC, Jan 2009). The issue of individual countries’ responsibility has emerged as many argue that developed countries should be made to pay more for the ‘damage’ to the earth’s atmosphere. Also, legitimate scientific opposition to the magnitude and in some cases accuracy of anthropogenic global warming has all but signaled

the death knell for the Kyoto protocol. As the figures for greenhouse gas emissions show, the Kyoto protocol has indeed failed to meet its targets and is at present in the process of revision.

Other global environmental laws show prima facie evidence of being far more successful than Kyoto. Examples include the successful Montreal Protocol on substances that deplete the ozone layer which came into full force on January 1st 1989. If the agreement is adhered to (as it is currently), the ozone layer is expected to recover by 2050. The convention on biological diversity is another treaty and attendant laws of the UN which have been relatively successful. It has been important as it relates to the protection of threatened species.

Environmental laws based solely on the guiding anthropocentric philosophy of the western world very rarely become effective tools at environmental enhancement and protection. When this is combined with politics, unsound science and the thirst for power evident in the efforts of many public ‘environmentalists’, the future does indeed seem bleak for the earth as a whole as it relates to environmental enhancement and protection. The majority of efforts to date are highly reactive to environmental degradation rather than being proactive about the sustainable use of the planet’s resources. Western philosophy extolling humans above nature has changed the course of history in unimaginable ways. Our environmental laws reflect that dominant attitude and the environment; as long as it is merely of instrumental value it will be continually degraded.

4. Conclusion

As the human race proceeds along the linear path of economic, social and demographic transition, it is hoped that the dialogue that exists on how best to sustainably utilize earth’s existing resources will continue. Out of that discourse has emerged debate on the roles philosophy, education and law play in the enhancement and protection of the environment. An understanding of these roles is critical in the formulation of plans of action relating to both goals.

Teaching people about the environment so they are able to make informed decisions has been a part of history since early human civilization. Indeed, ‘environmental’ knowledge as tool may be the reason the most ancient of civilizations lasted as long as they did compared to those most recent. The assigning of significant intrinsic value to nature as a key aspect of the philosophy of cultures as noted by O’Niell (1992) and Jameson (2002) were used to explain why

philosophy serves as a compass to environmental education. The example of the world being far more 'environmentally educated' while at the same time decreasing the levels of protection and enhancement of the environment under a new guiding philosophy is most salient. Western philosophy, under which environmental education proceeds presently, only assigns instrumental value to nature so that protection and enhancement are seen as importance when humans are to benefit directly.

Human societies have also historically formulated laws aimed at the protection and enhancement of the natural environment. As with education, philosophy as a guide to legislation was expounded on. In past times, locally instituted environmental laws such as the code of Hammurabi in the 18th century B.C. showed that where laws were congruous with the philosophies of the people they govern, the rates at which they were accepted and followed were greater.

However, as the world has converged in the wake of the industrial era, environmental legislation has taken on a truly global nature. The United Nations (UN) has led this effort and has had both successes and failures in the implementation of environmental laws with the examples of the Montreal and Kyoto protocols given. This has again been due to the heterogeneity in philosophies throughout the world. The hunting of some endangered species for food (some Pacific turtle species for example) is seen as being in contravention of some biodiversity laws formulated by the UN. The powers of the western world are also the purveyors of world philosophy at present, so virtually all laws reflect this sentiment. Laws are made with value placed primarily on human survival; elements of nature having no instrumental value to us are very unlikely to emerge in discourse on 'environmental protection'.

The opening words by Bacon reflect the power philosophy has over the minds of humans. The depths at which we seek to understand the fundamental nature of knowledge, reality, and existence serve as a guide to our behavior. Human history supports this fact as the dominant philosophy of a time and place can be seen in the methodology of our education systems and the laws we implement. Philosophy is therefore the most critical discipline in environmental enhancement and protection, serving as the foundation of both education and legislation.

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5/8/2009

Beautiful Algebra

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Abstract: The square root of two ways irrational. The sum of the two odds is always an even number. The polynomial quadratic equation cannot have more than two solutions. And in the late of nineteenth century, Beltrami, Cayley, Klein, Poincare and others showed the independency of the parallel postulate. But the author looked at the other side of the coin and obtained an interesting result. [Researcher. 2009;1(5):18-19]. (ISSN: 1553-9865).

Keywords: Euclid, elements, postulates, triangles, non-Euclidean geometries, algebra

Construction: Draw a spherical line AA'. On AA' take a point O. Make OB such that OB = OA. Choose a point C not on AA'. Join A and C. Join B and C. On BC take a point S. Join A and S. Produce AS up to W. Join C and W. And join B and W. Join C and O cutting AS at R. Since points C and O lie on the opposite sides of AS can meet AS. Please note that Euclid uses this principle. [1, prop. 10] Now extend RS up to C'. On OC' cut off OD such that OD = OR. Small letters denote the sum of the interior angles of triangles and quadrilateral RSBO. Also, let a, b, c, d, e, f, g, h, i, j, k, l, t and u respectively refer to the sum of the interior angles of triangles and quadrilaterals ACW, ACS, RCW, ABW, ROBW, ABS, ABD, ACD, ACO, ARD, BCD, BOC, RSBD and BWC.

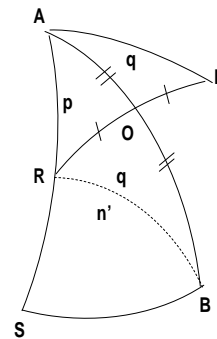


Figure II [Spherical]

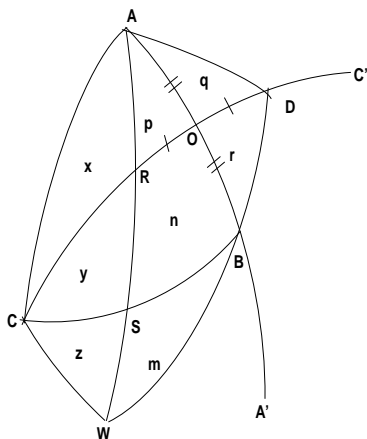


Figure I [Spherical]

Results:

The angles ARS, RSW, CRO, ROD, AOB, BSC are all straight angles and so their measures are all equal to 180 degrees. Let v be the value of this (1).

- Assuming (1), $x + y + z = 2v + a$ (2)
- $v + b = x + y$ (3)
- $y + z = v + c$ (4)
- $3v + d = m + n + p$ (5)
- $m + n = v + e$ (6)
- $2v + f = p + n$ (7)
- $q + r = v + g$ (8)
- $2v + h = x + p + q$ (9)
- $x + p = v + l$ (10)
- $v + j = p + q$ (11)
- $y + n + r = 3v + k$ (12)
- $2v + l = y + n$ (13)
- $n + r = v + t$ (14)
- $v + u = z + m$ (15)

Adding (2) to (15), $2v + u + l + j + h + f + d + b + y + z + 3r$

$$=m + t + k + I + q + g + e + c + a + 3p$$

$$p + q = v + j \quad (11)$$

$$v + c = y + z \quad (4)$$

$$m + n + p = 3v + d \quad (5)$$

$$x + p + q = 2v + (9)$$

Adding the above five eqns., $x + n + u + f + b + 3r = 3v + t + k + i + g + e + a$

$$v + t = n + r \quad (14)$$

Putting (13) in (12), $v + k = l + r$

$$v + i = x + p \quad (10)$$

$$v + g = q + r \quad (8)$$

$$v + e = m + n \quad (6)$$

Applying (3) in (2), $a + v = b + z$

$$z + m = v + u \quad (15)$$

Adding the above eight relations, $f + v = p + q$ (16)

Now look at figure II, Join B and R.
By construction, $OA = OB$ and $OR = OD$. Angles AOD and ROB are equal.

So, by SAS correspondence, triangles AOD BOR are congruent.

So, $p + q + n' = 2v + f$ [see (7)]

Putting (16) in LHS.
 $n' = v$ (17)

i. e the sum of the interior angles of spherical triangle BSR is equal to 180 degrees (18).

Discussion

The parallel postulate problem is 2300 years old. The great mathematicians from Proclus to Gauss, Bolyoi, Lobachevsky, Sachheri, Riemann and many others tried their best to prove the fifth Euclidean postulate as a theorem but failed. But their attempts

gave birth to two consistent models of non - Euclidean geometries namely Lobacheskian and Riemannian. These geometries are widely used in quantum mechanics and general theory of relativity. So, (19) is a challenge to us [1 & 2]. Throughout this work, we have applied the basic operations of number theory and algebra. So, beyond all the doubt (18), is consistent. Geometry and physics have lived together in close association for centuries. The relationship has had its ups and downs, but for the past 125 years it has blossomed in a remarkable manner. New physical theories require very sophisticated geometrical models and will have in turn a profound influence on the burning problems of physics. The marriage of geometry with physics was arranged in Heaven. So, further probes may give rise to a new branch of geometric field which will be a milestone in theoretical physics

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6/5/2009

Mango (*Mangifera indica*. L) Malformation an Unsolved Mystery

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Abstract : Mango (*Mangifera indica* L.) universally considered to be one of the finest fruits, and is an important crop in tropical and subtropical areas of the world. There are about 1500 varieties of mango in the world of which about 1200 are found in India. Among the known diseases of mango, mango malformation is the most serious disease. The etiology of malformation has not yet been discovered due to paucity of information and thus no effective control measure is known. This review summarizes the plausible cause of the etiology of this disease. [Researcher. 2009;1(5):20-36]. (ISSN: 1553-9865).

Key words: Malformation, Ethylene, ACC oxidase, cyanide,

Introduction

Mango Malformation

Mango malformation is the chief problem and a serious constraint to mango production in India and other mango growing countries (tropical and subtropical) of the world (Crane and Campbell, 1994). This disorder is widespread in flowers and vegetative shoots of mango. It has a crippling effect on mango production (Hiffny *et al.*, 1978) bringing in heavy economic losses. In spite of several decades of incessant research since its recognition in 1891, the etiology of this disease has not been established and no effective control measure is known (Ram and Yadav, 1999; Pant, 2000; Bains and Pant, 2003).

Distribution of Mango

Mango trees can withstand air temperature as low as 2⁰F (-39⁰C) for few hours with injury to leaves and small branches. Young trees may be killed at 29⁰ to 30⁰F (-1.7 to 1.1⁰C) flowers and fruits may be killed if temperature falls below 40⁰F (4.4⁰C) for few hours (Crane and Campbell, 1994). Mangoes are native to Southern Asia, especially eastern India, Burma and Andaman Islands. Mango production predominates in dry and wet tropical low land areas 23⁰26' North and South of the equator, on the Indian subcontinent, Southeast Asia and Central and South America (Litz, 1997).

India ranks first among world's mango producing countries accounting for 57.18 per cent of the total world mango production of 19.22 million tones (Negi, 2000). India's contribution to the world's mango production is the highest *i.e.*, 15,64200 mt whilst only 0.3 per cent (47,149 mt) is exported, compared to South Africa whose total

production is 38,000 mt and 32.5 per cent of it *i.e.*, 12,341mt is being exported, being the highest in terms of export among the other countries (FAO, 2002). The production share of mango was found to be next to that of banana (NBH, 2004).

Distribution of Mango Malformation

Mango malformation was reported for the first time from Darbhanga, Bihar by Maries in 1891. The disease is widespread in North India. Mango malformation though occurs all over India, incidence is more in northwest than in the northeast and South India (Mallik, 1963). Later, after Bihar, this malady was described from Bombay. Subsequently, it was observed from other mango growing provinces like Uttar Pradesh, Punjab, Maharashtra (Narasimhan, 1954), Bihar (Mallik, 1961), West Bengal (Chakrabarty and Kumar, 1997).

Malformation causes heavy damage to trees as the inflorescence fails to produce fruits. The extent of damage varies from 50 to 60 % in some cases and in severe cases the loss may be 100 per cent (Summanwar, 1967). It was reported that the intensity of disease is higher in western districts of Uttar Pradesh than eastern (Prasad *et al.*, 1965). The incidence of malformation is sporadic in southern parts (Summanwar, 1973). However, few cases have also been reported from Southern India (Kulkarni, 1979). It is also stated that the region beyond Hyderabad is free from this malady (Majumdar and Sharma, 1990). Apart from India, malformation has been reported from the Middle East, Pakistan (Khan and Khan, 1960), South Africa (Schwartz, 1968), Brazil (Flechtmann *et al.*, 1970), Central America, Mexico, USA (Malo and McMilian, 1972), Cuba

(Padron, 1983), U.A.E (Burhan, 1991) and Bangladesh (Meah and Khan, 1992).

Symptoms

Mango malformation has been broadly classified as vegetative and floral malformation (Kumar and Beniwal, 1987). However, the two classes of malformation are assumed to be symptoms of the same disease since hypertrophy of tissues is involved in both cases, and vegetative malformation appears at times on trees bearing malformed inflorescence (Tripathi, 1954; Schlosser, 1971a; Kumar and Beniwal, 1987). Further proof was obtained by grafting diseased scion onto healthy rootstocks. The diseased scion that would have produced a malformed inflorescence in on-year (flowering year) produced symptoms typical of vegetative malformation (Kumar and Beniwal, 1987).

Vegetative Malformation

Vegetative malformation is more pronounced on young seedlings (Nirvan, 1953). The seedlings produce small shoot lets bearing small scaly leaves with a bunch like appearance on the shoot apices. Apical dominance is lost in these seedlings and numerous vegetative buds sprout producing hypertrophied growth, which constitutes vegetative malformation. The multi-branching of shoot apex with scaly leaves is known as “Bunchy Top”, also referred to as ‘Witch’s Broom” (Bhatnagar and Beniwal, 1977; Kanwar and Nijjar, 1979). The seedlings, which become malformed early, remain stunted and die young while those getting infected later resume normal growth above the malformed areas (Singh *et al.*, 1961; Kumar and Beniwal, 1992).

Floral Malformation

Floral malformation is the malformation of panicles. The primary, secondary and tertiary rachises are short, thickened and are much enlarged or hypertrophied. Such panicles are greener and heavier with increased crowded branching. These panicles have numerous flowers that remain unopened and are male and rarely bisexual (Singh *et al.*, 1961; Schlosser, 1971a; Hiffny *et al.*, 1978). The ovary of malformed bisexual flowers is exceptionally enlarged and non-functional with poor pollen viability (Mallik, 1963; Shawky *et al.*, 1980). Both healthy and malformed flowers appear on the same panicle or on the same shoot. The severity of malformation may vary on the same shoot from light to medium or heavy malformation of panicles (Varma *et al.*, 1969). The heavily malformed panicles are compact and overcrowded due to larger flowers. They continue to grow and remain as black masses of dry tissue during summer but some of them continue

to grow till the next season. They bear flowers after fruit set has taken place in normal panicles (Singh *et al.*, 1961; Varma *et al.*, 1969; Hiffny *et al.*, 1978; Shawky *et al.*, 1980) and contain brownish fluid (Prasad *et al.*, 1965; Ram and Yadav, 1999) (Figure 1.1).

Cultivar Susceptibility

Susceptibility to malformation in mango varieties is variable; the governing factors being temperature, age of the tree, time, etc. In general, late blooming varieties are less susceptible to malformation than the early blooming ones (Khurana and Gupta, 1973). The level of polyphenol oxidase (PPO) in the early years of plant growth or in the flush of vegetative growth may provide an estimate of synthesis of phenolic compounds in the plants, which may be correlated to susceptibility or resistance to floral malformation (Sharma *et al.*, 1994).

Based on polyphenol oxidase activity, phenolic content and panicle malformation 24 mango cultivars were classified into five groups.

Etiology

The etiology of malformation has remained controversial and is yet to be established. Diverse claims have been made for the cause and control of malformation. They have been ascribed to a number of biotic and abiotic factors summarized in (Figure 1.2).

Stress ethylene and mango malformation

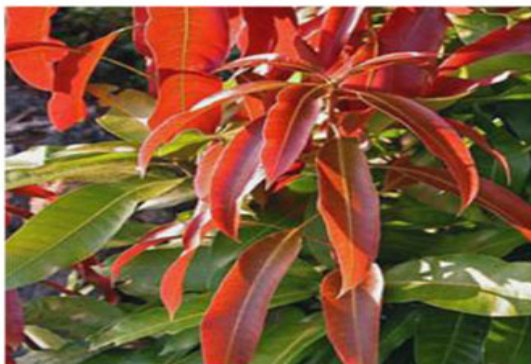
The basic phenomenon of increased ethylene production in response to stress is commonly called 'stress ethylene'. Production of stress ethylene can initiate various physiological responses, which include leaf epinasty, abscission, formation of aerenchyma etc. (Abeles, 1973).

It is proposed that mango malformation may be due to stress ethylene. The occurrence of leaf epinasty and disturbance in the natural orientation of the shoots and panicles, suppression of apical dominance, hypertrophy of lenticels and increased gummosis in trees with malformation in the same tree have been attributed to ethylene effect in malformed trees (Pant, 2000). Furthermore, the putative causal agent of mango malformation, such as excessive soil moisture, insect infestation, fungal pathogens, virus, chemical stimuli such as metal ions, herbicides and gases like SO₂ etc., seem to add to the production of stress ethylene. In the light of these facts, it was suggested that the disorder may be due to the production of 'stress ethylene' by mango plants (Pant, 2000). Studies on ethylene production in

malformed as well as healthy tissues of mango cultivars Amrapali, Khas-ul-Khas, Dashehari revealed that evolution of ethylene was maximum in the time period from 12 noon to 2 pm. Increased temperature at 12 noon to 2 pm may cause a heat

stress which increases ethylene production during this time interval (Krishnan, 2003, Nailwal *et al.*, 2006).

Healthy vegetative tissue



Healthy floral inflorescence



Malformed vegetative tissue



Malformed floral inflorescence



Figure 1.1 Types of inflorescence

Table 1.1: Classification based on polyphenol oxidase activity, phenolic content and panicle formation

Resistance/susceptibility to panicle malformation	Varieties
Highly resistant	Bhadauran and H-8-1
Moderately resistant	Dashehari, Langra, Kurukkan and Fazli
Susceptible	Sensation, Eldon, Rataul, Mallika and Alphonso
Moderately susceptible	H-31-1, Lalsundri, Totapari, Red small, Himsagar,
Highly susceptible	Neelum, Extreme, Zill, Eward and Amrapali Tommy Atkins, Chausa, Zardalu and Ratna

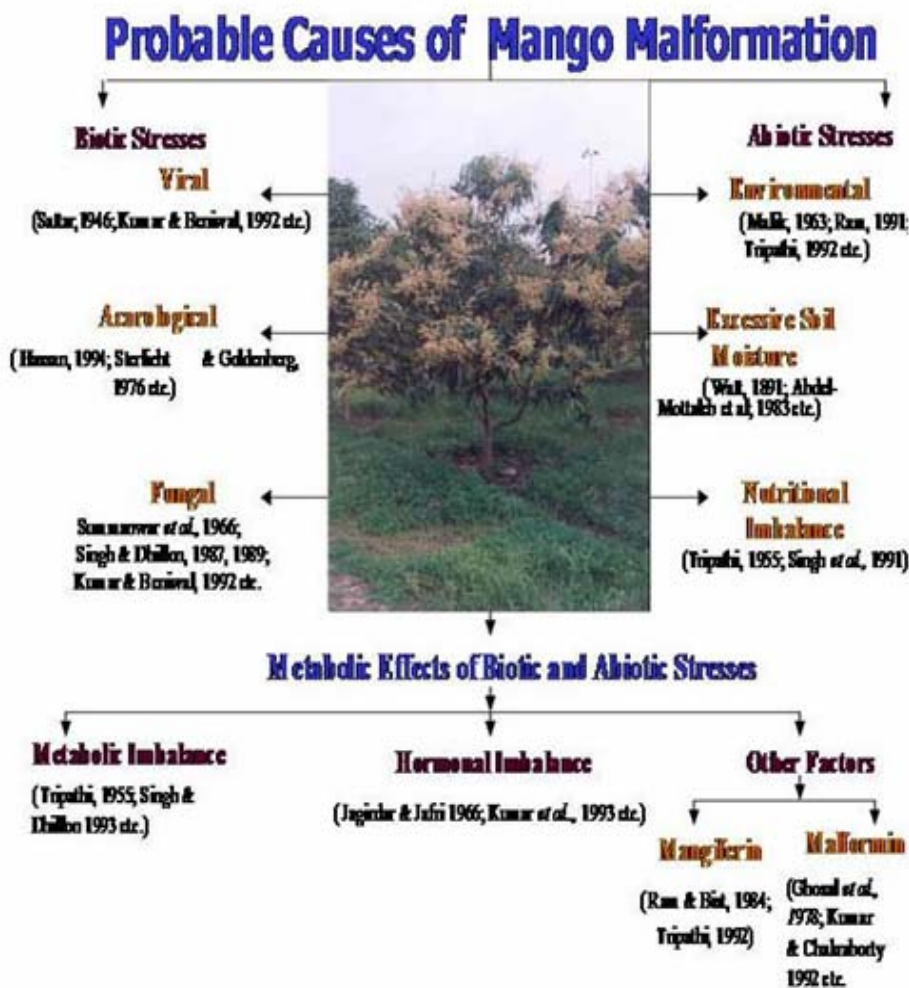


Figure 1.2 Probable causes of Mango malformation

Biosynthesis of stress ethylene

The methionine-ACC pathway has been established to operate in plants for ethylene biosynthesis and has been extensively studied (Yang and Hoffman, 1984; Miyazaki and Yang, 1987; Imaseki, 1991). S-adenosylmethionine (SAM) is synthesized from methionine and ATP. SAM is converted to 1- aminocyclopropane-1-carboxylic acid (ACC) and 5- methylthioadenosine (MTA). In the presence of air, ACC is rapidly converted to ethylene. MTA is rapidly hydrolyzed to 5-methylthioribose-1-phosphate (MTR-1-P) by means of ATP dependent phosphorylation. MTR-1-P is converted into 2-keto-4-methylthiobutyrate (KMB), which is finally transaminated into methionine. The

cyclic pathway continuously recycles the methylthio group of methionine for methionine production by utilizing ribose moiety of methionine during the synthesis of ethylene. This completes the methionine cycle. Thus, a small pool of methionine in the tissue can give rise to considerable amount of ethylene (Figure1.3). Stress ethylene is also synthesized via the methionine and ACC pathway. ACC synthase is the key enzyme and the main site of control of the biosynthetic pathway of ethylene (Imaseki, 1991). In the ethylene biosynthetic pathway, the final reaction where ethylene is produced from 1-amino-cyclopropane-1-carboxylic acid is accompanied with cyanide production on a one to one basis derived from C-1 of ACC.

The effect of cyanide on respiration and the possibility of the development of cyanide insensitive respiration in the malformed tissue cannot be ruled out (Rychter et al., 1988). Increased levels of cyanide due to 'stress ethylene' may result in the accumulation of toxic levels of cyanide resulting in the necrosis and death of malformed tissues of mango (Kukreja and Pant, 2000).

Both floral and vegetative malformations were reported to be reproducible by simply spraying spore suspension of *Fusarium* spp. (Chakrabarty and Ghosal, 1989; Ploetz and Gregory, 1993). In contrast to this, symptoms could not be produced unless the tissue was wounded prior to inoculation (Manicom, 1989). Therefore, pathogenicity for *Fusarium* in causing malformation is not clear and is yet to be proved. We ought to identify the factors that may induce biochemical and structural changes (MIP) having a potential to develop the symptoms typical of malformation, as distinct from symptoms of toxicity obtained after inoculating *Fusarium* (TP) (Kumar and Beniwal, 1992; Pant, 2000).

Temperature and growth of *Fusarium* spp.

A study of seasonal variation of populations of *Fusarium moniliforme* on mango shoots in India indicated that fungal density reaches maximum in February, when min/max temperature ranges from 8-27°C and humidity is high (85%); hotter and drier periods coincided with decline in the fungal population, Shawky et al., 1980; Campbell, 1986). *Fusarium moniliforme* var *subglutinans* has been reported to grow well at lower temperature and its growth is completely checked above 55°F (12.8°C) (Varma et al., 1971). The in vitro growth characters of the fungus were determined on different culture media, at varying temperature, light and pH conditions. Mycelial growth was better observed at temperature between 25-30°C and pH 7.0 on potato dextrose agar medium than on nine other media tested (Akhtar et al., 1999). Similar observation indicated that *Fusarium* growth was optimal on potato dextrose agar (PDA) medium at temperature between 15°C-28°C and was minimal on malt extract agar (MEA) medium at the same temperature. In 30 days old cultures, sporulation levels of *Fusarium* spp. were higher when day time temperature was 30°C versus 20°C. The high day time temperature also caused greater sporulation of macroconidia to form, and lowered the abundance of mesoconidia (Winder, 1999). The higher colonization of *Fusarium moniliforme* was observed at temperature >25°C coupled with relatively low pH (7.1-7.7), whereas low temperature during winter (<20°C) adversely affected the pathogen growth (Bisht, 2000). All these conflicting reports

suggest the need of further investigations on *Fusarium* spp. at high temperature particularly in southern part of India where malformation is rarely reported. The isolates of *Fusarium* spp. isolated from healthy and malformed tissues of mango grown at different temperatures (5-40°C) indicated that the most suited temperature for growth and development of isolates was 25°C, 30°C, 35°C and none of the spores of isolates germinated below 10°C temperature. The minimum time required to start germination was 6 hour and maximum was recorded after 24 hours (Ansari, 2004).

The enhanced promotion of ethylene is an early biochemical event in many plant-pathogen interactions. About one-third of fungi tested produced ethylene; a fact that led the scientists to conclude that ethylene is a common metabolic product of fungi (Hislop et al., 1973; Archer and Hislop, 1975; Yang and Pratt, 1978; Boller, 1982; Boller, 1990). In virus-infected plants this clearly represents 'stress ethylene' produced by plant; viruses lack the capacity to produce ethylene. However, in fungal diseases the situation is more complicated because some fungi have the capacity to produce ethylene themselves (Ilag and Curtis, 1968; Abeles et al., 1992; Lund et al., 1998; Chauge et al., 2002).

Isolates of *Fusarium* sp. from mango were observed to produce ethylene in range of 9.28 to 13.66 n mol /g dry wt/ day. Etherel was found to stimulate the germination of spores of isolates of *Fusarium* sp. obtained from mango cultivars at concentrations from 5 ppm to 100 ppm. Higher concentration of etherel was toxic for spore germination (Ansari, 2004). It was reported that significant differences were observed in the levels of cations and anions (chloride, sulfate and phosphate) in healthy and malformed tissues at, prior to full bloom and full bloom stage, but a consistent pattern was not seen. The exception was that of phosphate ion which was present in higher concentration in the malformed floral tissues at full bloom stage (Kaushik, 2002).

It is evident that the flowering period of mango that is January in the northern hemisphere and July in the Southern hemisphere, tallies closely with the temperature prevailing in the environment during that period. Roughly, two seasons of flowering in mango are apparent globally, one falling during January-March and the other during June-September (Bains and Pant, 2003).

Role of Ethylene in Mango Flowering

Ethylene mediated induction of flowering is utilized in the commercial production of mangoes. Growers in the Philippines and in India maintain smoky fires in mango orchards for several days

during a vegetative flush to induce good flowering (Valmayor, 1972). Smoke from smudged trees contains ethylene, which stimulates flowering in mango trees (Dutcher, 1972). Endogenous ethylene plays an integral role in the floral inductive process (Sen et al., 1973; Chacko et al., 1974a, b).

The involvement of endogenous ethylene in the flowering process is also supported by observations that indirectly link ethylene production to the flowering process. Symptoms such as extrusion of latex from terminal buds and epinasty of mature apical leaves, which are associated with high levels of ethylene, occur in mango plants at the time of inflorescence initiation and expansion of the panicles (Abeles, 1973; Davenport and Nunez-Elisea, 1990, 1991).

Indirect evidence of role of ethylene in flowering comes from reports of gradual increase in internal leaf ethylene production with the approach of flowering season. Inconsistent (Pandey *et al.*, 1973; Sen *et al.*, 1973) or non-responsive (Pandey and Narwadkar, 1984; Pandey, 1989) results using ethephon sprays have also been reported. Ethephon spray resulted in an elevated ethylene production in mango shoots without an accompanying floral response (Davenport and Nunez-Elisea, 1990, 1991). From these reports, it seems that the role of ethylene in flowering is still unresolved. Levels of ethylene were found to be higher in malformed vegetative and floral tissues as compared with that of healthy tissues at both prior to full bloom and full bloom stages (Pant, 2000; Bains, 2001; Kaushik, 2002; Bains *et al.*, 2003).

1-Aminocyclopropane-1-Carboxylate Synthase (ACC Synthase)

A simple and sensitive chemical assay was developed for 1-aminocyclopropane-1-carboxylate synthase (ACC synthase). The assay is based on the liberation of ethylene from ACC at pH 11.5 in the presence of pyridoxal phosphate, $MnCl_2$ and H_2O_2 . This assay was used to detect ACC in extracts of tomato fruits (*Lycopersicon esculentum* Mill.) and to measure the activity of a soluble enzyme from tomato fruit that converted S-adenosylmethionine (SAM) to ACC. The enzyme had a K_m of 13 μM for SAM, and conversion of SAM to ACC was competitively and reversibly inhibited by



An important characteristic of ACC oxidase is its requirement for ascorbic acid, Fe^{2+} and oxygen. The conversion of ACC to ethylene is accompanied by HCN production. This cyanide is produced in an

aminoethoxyvinylglycine (AVG), an analog of rhizobitoxine. The K_m value for AVG was 0.2 μM . The level of ACC-forming enzyme activity was positively correlated with content of ACC and the rate of ethylene formation in wild-type tomatoes of different developmental stages (Boller *et al.*, 1979).

The molecular mass of 1-aminocyclopropane-1-carboxylate synthase (ACC synthase) from a variety of sources was examined by high-performance gel-filtration chromatography and polyacrylamide gel electrophoresis in the presence of sodium dodecylsulfate. Enzymes used were prepared from wounded or non-wounded pericarp of ripe tomato fruits and wounded mesocarp of winter squash fruits as well as from cells of *E. coli* that had been transformed with cDNAs for the wound-induced or ripening-induced ACC synthases of tomato and the wound-induced or auxin-induced enzymes from winter squash. The enzymes from tomato tissues were isolated in a monomeric form, whereas the enzymes synthesized in *E. coli* from cDNAs for tomato ACC synthase were isolated in a dimeric form. ACC synthases of winter squash obtained either from fruit tissues or from transformed *E. coli* cells were isolated in dimeric forms (Satoh *et al.*, 1993). A multigene family encodes ACC synthase. Increased ethylene production is usually correlated with the accumulation of ACC synthase transcripts, indicating that ethylene production is controlled via the transcriptional activation of ACC synthase genes (Oetiker *et al.*, 1997).

1-Aminocyclopropane-1-Carboxylate oxidase (ACC Oxidase)

In higher plants ethylene is synthesized via methionine ACC pathway (Yang and Hoffman, 1984; Abeles and Abeles, 1972). In this pathway two crucial enzymes regulate the rate of ethylene synthesis, i.e. ACC synthase and ACC oxidase (Yang and Hoffman, 1984; Abeles *et al.*, 1972; Kende, 1993; Percott and John, 1996). The final reaction in this pathway, which gives rise to ethylene from 1-aminocyclopropane-1-carboxylic acid (ACC) is catalyzed by ACC oxidase, previously referred to as 'ethylene forming enzyme'. The ACC oxidase reaction is summarized as follows:

amount stoichiometrically equivalent to ethylene (Peiser *et al.*, 1984) and is detoxified by conversion to β -cyanoalanine. It has been demonstrated that ACC oxidase is induced by various factors such as

fruit ripening (Ververidis and John, 1991; Dong *et al.*, 1992, Balague *et al.*, 1993, Nakatsuka *et al.*, 1998), senescence, wounding and infection by pathogen. In these studies results have shown that endogenous or exogenous ethylene participated in the regulation of ACC oxidase (Kim and Yang, 1999), further it was suggested that protein phosphorylation and dephosphorylation were responsible for the signal transduction in ethylene-mediated expression of ACC oxidase gene.

Ethylene was found to involve in the progress of senescence of post harvest broccoli florets. The induction of ACC oxidase activity rapidly occurred during senescence, which is correlated with the increased level of endogenous ethylene (Kasai *et al.*, 1998).

It was studied that a low oxygen concentration induces an increase in the ACC oxidase mRNA level, which causes an increased concentration of ACC oxidase protein. Although this protein is less active in low oxygen concentration, the increase in enzyme activity ensures that there is enough ethylene produced to stimulate petiole elongation during submergence in *Rumex palustris* (Vriezen *et al.*, 1999).

Mangiferin

Mangiferin, a non-toxic polyphenol and a normal metabolite in mango was reported to play an important role in the disease (Ghosal *et al.*, 1979). Enhanced production of mangiferin and increase in the activity of polyphenol oxidase in infected tissues were recorded. Polyphenol oxidase was considered as mangiferin degrading enzyme (Kumar and Chakraborty, 1992). Symptoms of mango

malformation induced by accumulated mangiferin (Table 1.2).

It was suggested that higher concentration of mangiferin in diseased tissues may lower the level of *Fusarium* sp. infection inside the diseased tissue. The higher concentration of mangiferin in malformed vegetative tissues and floral tissues do not clearly reveal the fact that *Fusarium* sp. infection prevents the translocation of mangiferin which results into its accumulation at the site of synthesis and do not predict an authentic correlation between *Fusarium* sp. infection level and higher concentration of mangiferin with respect to disease incidence (Ansari, 2005).

Hydrogen Cyanide

Cyanide is a harmful ion, hazardous to life, which forms a very stable complex with the active site (iron and magnesium) in enzymes, thereby inhibiting vital functions in cells such as respiration, CO₂ fixation and nitrate reduction. Cyanogenic compounds are widespread in plant species and are mostly stable compounds when conjugated to saccharides forming cyanogenic glycosides. Hydrogen cyanide is released from the cyanogenic compounds during tissue disruption, infection (Yip and Yang, 1998).

Other plant species, which don't accumulate cyanogenic glycosides but synthesize cyanohydrin from amino acids are known (Olechno *et al.*, 1984). The degradation of cyanogenic compounds (Poulton, 1990) and the oxidation of 1-aminocyclopropane-1-carboxylic acid (ACC) in ethylene biosynthesis are the two major sources by which cyanide is produced in higher plants (Yip and Yang, 1998).

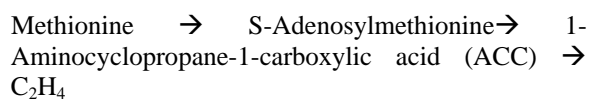
Table 1.2: Symptoms of mango malformation induced by accumulated mangiferin

<i>Effect of Mangiferin</i>	Symptoms
1. Increased IAA content	More vegetative growth
2. Increased chlorophyll content	Malformed shoots/panicles look greener.
3. Increased photosynthesis	More carbohydrate synthesis
4. Reduced respiration and amylase activity	Carbohydrate accumulation disturbed C/N ratio
5. Reduced catabolism	More longevity
6. Reduced transpiration	High moisture content

(Source: Chakarabarti and Kumar, 2002)

Cyanide – a Co product of Ethylene Biosynthesis

Ethylene biosynthesis in higher plants is established through the following pathway:



(Yang and Hoffman, 1984). By employing the ^{14}C tracer labeled at different positions of ACC, it was demonstrated that during the *in vivo* oxidation of ACC to ethylene, the carboxyl carbons, C-1 and C-2 and C-3 of ACC are metabolized into CO_2 , L-3-cyanoalanine derivatives, and ethylene, respectively. Although no free HCN was identified, it was asserted that C-1 of ACC is initially liberated as HCN, but is rapidly conjugated into L-3-cyanoalanine derivatives as soon as it is liberated. This notion was based on the observation that the metabolic fate of the C-1 of ACC during its conversion to ethylene was identical to that of administered HCN and that the amount of HCN-conjugates formed was equivalent to that of ethylene produced (Peiser *et al.*, 1984). Thus, the degradation of ACC into ethylene can be represented by the following equation:



This reaction was further confirmed in *in vitro* using the purified ACC oxidase from apple (Dong *et al.*, 1992).

Metabolism of Cyanide in Plants

Since no free HCN was detected even in plant tissues, which produced ethylene at very high rates, it was suggested that plants must have ample capacity to metabolize the HCN originating from

ACC (Peiser *et al.*, 1984). In higher plants the key enzyme to detoxify HCN is L-3-cyanoalanine synthase (EC. 4.4.1.9 (Figure 1.3).

Cyanide production in healthy and malformed tissues of Mallika, Khas-ul-Khas and Langra revealed that the change in cyanide level was highest in the time period of 12.00 noon to 2.00 pm. The cyanide levels were higher in the malformed floral tissues at all time intervals with maximum cyanide being observed at 1.0 pm. No cyanide was detectable in healthy or malformed floral tissues during early or the late light period generally (Nailwal, 2004; Nailwal *et al.*, 2006).

Beta cyanoalanine synthase

β -cyanoalanine synthase is an enzyme that catalyses the conversion of cyanide and cysteine to β -cyanoalanine (Miller and Conn, 1980). It has been detected in all plants examined but considerable variability occurs in levels of activity between species and between different tissues of the same plant. The main physiological role of CAS has been suggested to be the detoxification of cyanide produced in various stages of plants life cycle (Hendrickson and Conn, 1969; Akapyan *et al.*, 1975; Wurtele *et al.*, 1985; Manning, 1988;), such as wounding of cyanogenic plants (Poulton, 1990) and enhancing ethylene biosynthesis (Yip and Yang, 1988).

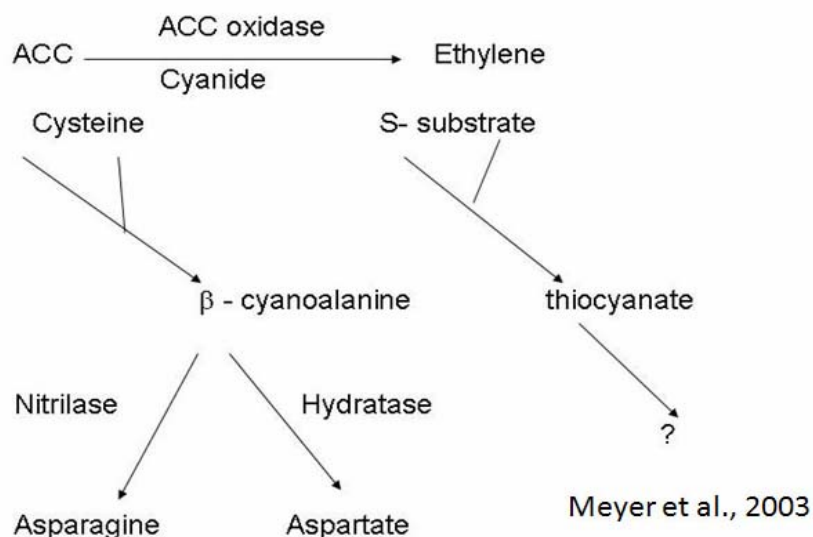
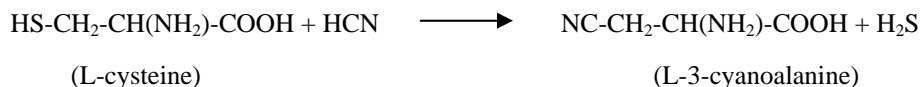


Figure 1.3 Scheme of cyanide release during ethylene formation and its putative detoxification pathways in higher plants

Beta-cyano-L-alanine-synthase or L-cysteine hydrogen sulfide lyase (adding HCN) EC (4.4.1.9), a pyridoxal dependent enzyme which catalyses the reaction between cysteine and HCN to form β -cyanoalanine (β -CA) and H_2S , was first described in 1963 (Blumenthal-Goldschmidth *et al.*,



L-3-cyanoalanine synthase is widely distributed in higher plants (Miller and Conn, 1980). L-3-cyanoalanine thus formed is further metabolized to asparagine or to γ -glutamyl-L-3-cyanoalanine (Akapyan *et al.*, 1975; Blumenthal *et al.*, 1963; Blumenthal *et al.*, 1968; Hendrickson and Conn, 1969; Manning, 1986; Peiser *et al.*, 1984; Pirrung, 1985). Thus, the cyanide is detoxified and the N is conserved as the amide of asparagines (Castric *et al.*, 1972). L-3-cyanoalanine synthase has been purified about 4000-fold from blue lupine seedlings and this enzyme is pyridoxal-dependent and can be inhibited by 2-aminoxyacetic acid (AOA) or 3-aminoxypropionic acid (Akapyan *et al.*, 1975).

Distribution of β -CAS has been observed in several plants (Miller and Conn, 1980; Peiser *et al.*, 1984). The close relationship has been found between cyanogenesis potential and CAS activity in a variety of higher plants (Miller and Conn, 1980; Peiser *et al.*, 1984 and Wen, 1997).

β -CAS is predominantly located in mitochondria (Akapyan *et al.*, 1975; Wurtele *et al.*, 1985). The ubiquitous presence of β -cyanoalanine in plants (Hendrickson and Conn, 1969; Wurtele *et al.*, 1984, 1985; Mizutani *et al.*, 1987) suggests that the enzyme is constitutive and has an important metabolic function. One plausible role, alluded to by numerous researchers, is the detoxification of cyanide produced during ethylene biosynthesis or from other sources (Blumenthal *et al.*, 1968; Miller and Conn, 1980; Wurtele *et al.*, 1984, 1985; Manning, 1986; Mizutani *et al.*, 1987).

High enzyme activities were found in tissues of cyanogenic and non-cyanogenic species and were correlated with cyanide production (Miller and Conn, 1980) and ethylene levels (Mizutani *et al.*, 1987). The capacity to metabolize cyanide is greater in older plant tissues and areas with meristematic activity (Wurtele *et al.*, 1985). Ethylene has been suggested to induce de novo synthesis of β -CAS (Manning, 1988). Since in vitro β -CAS activity in tissues that produce ethylene at high rates is quite high (1650 n mol $g^{-1} h^{-1}$ in ripe apples) and the cyanide levels are low (0.2 n mol g^{-1} fresh weight, calculated to be 0.2

1963; Floss *et al.*, 1965 and Blumenthal *et al.*, 1968). The main biological function of β -CAS is evidently β -replacement of -SH in cysteine by CN. The reaction catalyzed by the enzyme is shown below:

μM), it was Yip and Yang (1988) who concluded that plant tissues have ample capacity to detoxify HCN derived from ethylene biosynthesis by β -CAS activity. The concentration of HCN appeared to be kept below the non-toxic level of approximately 1 μM .

The K_m of β -CAS for cyanide is high; it ranges from 500 to 10,000 μM (Manning, 1988). Tissues also became cyanogenic after treatment with ACC (Yip and Yang 1988). In mungbean hypocotyls cyanide levels went up to approximately 8 μM (Grossmann, 1996).

Although CAS has been reported to be compartmentalized within the mitochondria (Wurtele *et al.*, 1985). The existence of non-mitochondrial cytoplasmic CAS in developing seeds was suggested (Ikegami *et al.*, 1989). Investigation was undertaken to demonstrate the existence of two types of CAS in germinating seeds and to determine which type is stimulated by ethylene (Hasegawa *et al.*, 1995).

Germinating seeds of many species contain two types of β -cyanoalanine synthase. One is cytoplasmic CAS (cyt-CAS) which is precipitated by 50 % to 60 % $(NH_4)_2SO_4$ and has a pH optimum of 10.5; cyt-CAS is present at high levels in dry seed and its activity does not increase during imbibitions. The activity of cyt-CAS is not affected by exogenously applied C_2H_4 except in rice (*Oryza sativa* cv. Sasanishiki). The second type of CAS found in seeds is mitochondrial CAS (mit-CAS), which is precipitated by 60 % to 70 % $(NH_4)_2SO_4$ and has an optimum pH of 9.5. Mit-CAS is present at low levels in dry seed, and its activity increases greatly during imbibition in the seeds of all species tested. Exposure to C_2H_4 stimulated mit-CAS activity in seeds of rice, barley (*Hordeum vulgare* cv. Hadakamugi), cucumber (*Cucumis sativus* cv. Kagafushinari) and cocklebur (*Xanthium pennsylvanicum*) (Hasegawa *et al.*, 1995). More and more studies have found more than one CAS isozymes in plants. Ikegami *et al.*, 1988 separated the CASs in higher plants into two classes. The CASs in lupin and barley were proposed to belong to one class. But those from spinach and

Lathyrus la tiliifolius were proposed to belong to another class, which possessed some structural similarity with Cysteine synthase (CS) in higher plants.

In blue lupine besides CAS, a CS was also found to be able to catalyze the formation of β -cyanoalanine from cyanide and cysteine (Hendrickson and Conn, 1969). Two types of CAS were also detected in cocklebur seeds (Hasegawa *et al.*, 1995). One type of CAS was attributed to a cysteine synthase (Maruyama *et al.*, 1998). Since the cytosolic CAS activity in cocklebur cotyledons was about 10 times higher than that of the mitochondrial CAS activity, CS in cytosol may be involved in cyanide metabolism in plant tissues (Maruyama *et al.*, 2000). Two of the three CAS isozymes from potato tuber slices and spinach leaves were also attributed to CSs with CAS capacity (Maruyama *et al.*, 2000; Warrilow and Hawkesford, 2000). Both CAS and CS belong to β -substituted alanine synthase family. They possess different substrate specificities and reaction efficiencies. CAS from spinach leaves showed a 10 – fold higher affinity for O-acetylserine than CS, but had a much lower substrate turnover rates than CS in Cys synthesis reaction (Warrilow and Hawkesford, 2000). In studies on the CAS and CS of potato, spinach and *Arabidopsis*, their obvious distinction was also confirmed by the immunodetection results with antibodies against CAS and CS (Maruyama *et al.*, 2000; Hatzfeld *et al.*, 2000).

Two CAS isozymes (CAS₁ and CAS₂) were observed in tobacco. Both CAS isozymes were detected in the isolated cytosol. But only CAS₁ was observed in isolated mitochondria and no CAS activity was found in the isolated chloroplast (Liang and Li, 2001). Drought stressed tobacco plants for two days did not inactivate CAS₂. Both CAS isozymes were induced and contributed to detoxify cyanide in the tobacco plants under drought stress (Liang, 2003).

CAS purified from other plant source has been reported to be a dimer (Ikegami *et al.*, 1988, 1989). CAS purified from potato tuber was composed of 34 KDa polypeptides separated by SDS-PAGE analysis, whereas the molecular mass of the native CAS was estimated to be 50 KDa by gel filtration (Maruyama *et al.*, 2000).

The β -CAS activity studied in healthy and malformed tissues of mango showed the higher levels of β -CAS activity in healthy tissues suggesting that the greater amount of HCN is being metabolized in the healthy tissues. It can be speculated that the increased level of 'stress ethylene' in the malformed tissues is responsible for the augmented levels of cyanide in the malformed tissues as compared to healthy tissues. Thus, lower levels of β -cyanoalanine

synthase in the malformed tissues coupled with augmented ethylene production may result in the accumulation of toxic quantities of cyanide resulting in necrosis of tissues (Kukreja, 2000).

Cyanide Resistant Respiration

The first observation on cyanide-resistant respiration in plants was made over 75 years ago, when Genevois found that the respiration of seedlings of *Lathyrus odo rata* (sweet pea) was resistant to cyanide. It is now well documented that cyanide-resistant respiration is a widespread phenomenon in higher plants (both monocotyledons and dicotyledons); it also occurs in a few animal species and in fungi, bacteria and algae (Henry and Nyns, 1975).

Mitochondria isolated from roots and leaves of ten species (three legumes, one C₃-monocotyledon, one C₄-monocotyledon, the rest non-leguminous C₃-dicotyledons) examined displayed cyanide-resistant oxygen uptake, which was sensitive to both SHAM and tetraethylthiuram disulfide (disulfiram). Concentrations of SHAM greater than 2 mM caused inhibition of the cytochrome path as well as of the alternative path in isolated mitochondria (Lambers *et al.*, 1983). In thermogenic spadix tissue of certain members of the family Araceae (e.g. skunk cabbage, voodoo lily) cyanide-resistant respiration contributes to respiratory rates that rival those found in insect flight muscle. This cyanide-resistant O₂ uptake takes place on the inner mitochondrial membrane and appears to contribute a pathway "alternative" to the main cyanide-sensitive cytochrome pathway by which electrons from reduced tricarboxylic acid (TCA) cycle substrates flow to the terminal electron acceptor, O₂ (Siedow and Berthold, 1986). In winter rape leaf slices grown at 5°C, the patterns of cold-induced changes in total respiratory activity and in the estimated activity of alternative pathway were found to be similar. It seemed that in leaf slices from plants grown in the cold, the cyanide-resistant, alternative pathway participates in oxygen uptake. The effect of cyanide on respiration and the possibility of the development of cyanide insensitive respiration in the malformed tissue cannot be ruled out (Rychter *et al.*, 1988).

It was proposed that activation and engagement of the alternative oxidase might keep Q reduction levels low in order to prevent harmful high levels of free radical production. Complete purification of the alternative oxidase present in the inner mitochondrial membrane has not been achieved successfully, because of its instability on solubilization (Zhang *et al.*, 1996).

Molecular characterization of Mango

Determination of male parent in mango is difficult due to small flower size and large number of flowers on a plant. The ability to distinguish true hybrids versus those resulting from self-pollination would be very useful in mango evaluation programs. A DNA based marker was evaluated for its usefulness in determining parentage among mango seedlings. Caging mature trees of the cultivars Keitt 'and Kent' produced two populations. Seedlings from each cultivar were examined by DNA analysis using RAPD markers. The Keitt' population appeared to result from self-pollination, while considerable outcrossing had occurred among the Kent' seedlings. The number of non-segregating loci in the parental cultivars was surprisingly high. This result was unexpected as mango is generally considered to be highly polymorphic. Bands amplifying in the progeny that are not present in either parent have also been found. These complications make RAPD markers less desirable for this type of analysis than other DNA molecular markers (Schnell *et al.*, 1995). Random amplification of polymorphic DNA (RAPD) markers have been extensively used to study the genetic relationship in a number of fruit crops (Ravishankar *et al.*, 2000). Apart from RAPD, other techniques like RFLP and AFLP have been used for molecular analysis of tropical and subtropical fruit trees for the identification of cultivars, somatic hybrids, chimaeras, nuclear and zygotic seedlings and in pedigree analysis, construction of genetic linkage maps and molecular marker - assisted selection (Guixin *et al.*, 2002).

DNA based RAPD markers were used to study the genetic relatedness for identification of mango cultivars (Schnell *et al.*, 1995). It was also revealed that a high degree of genetic diversity existed among the mango cultivars (Hemanth *et al.*, 2001).

The mango genotypes were grouped based on their geographical origin and the majority of mango cultivars originated from local gene pool (Lopez-Valenzuela *et al.*, 1997 and Ravishankar *et al.*, 2000).

Several rapid methods for genomic DNA extraction from plant tissues have been described (John, 1992, Kim *et al.*, 1997 and Porebski *et al.*, 1997). It was reported that isolation of genomic DNA from plants containing a high content of polyphenolics such as grape (*Vitis* spp), apple (*Malus* spp), pear (*Pyrus* spp) was difficult (Kim *et al.*, 1997).

The basic extraction protocol was slightly modified (Dellaporta *et al.*, 1983). Precipitation of DNA by 2.5 ml 5M NaCl and 10 ml ethanol was used and half volume of 5M NaCl and one volume

of isopropanol to get better yield (Ravishankar *et al.*, 2000 and Hemanth *et al.*, 2001). RAPD analysis of 29 Indian mango cultivars comprising popular landraces and some advanced cultivars generated 314 bands, 91.4% of which were polymorphic. A UPGMA dendrogram showed the majority of the cultivars from northern and eastern regions of India clustering together and separate from southern and western cultivars. Analysis of molecular variance revealed that 94.7% of the genetic diversity in mango existed within regions. However, differences among regions were significant; northern and eastern regions formed one zone and western and southern regions formed another zone of mango diversity in India (Karihaloo *et al.*, 2003).

RAPD analysis for establishing genetic variability showed that the amplified DNA fell in the range of 1400 to 350 kb. The pattern differed with each primer. Unique bands of different sizes specific to malformation were obtained with all the primers (Krishnan, 2003).

The UPGMA (Unweighted pair-group method with arithmetical averages) dendrogram revealed that healthy and malformed inflorescence of each of the varieties studied were quiet distantly placed in the dendrogram further confirming genetically diverse nature of healthy and malformed inflorescence (Nailwal, 2004).

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Smoking habit as a synergistic factor for genotoxicity and chest infection induced by occupational exposure to cadmium

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Abstract: Several studies proved the genotoxic effect of cadmium (Cd) exposure and damaging the respiratory epithelium leading to increase the risk for respiratory infections. In addition, the impact effect of smoking was also reported. The present study aimed at finding out the genotoxicity and lung infection caused due to confounding role of smoking habit with occupationally exposure to (Cd). The study sample was 40 exposed workers (27 smokers and 13 non smokers) compared to 40 control subjects (28 smokers and 12 non smokers) comparable in their age and socioeconomic status. A cytogenetic study was performed, biological indices' of Cd(Blood Cd(B-Cd) and Urine Cd(U-Cd) levels were estimated for the two groups. Microbiological profile for the virulent pathogens causing lung infection were screened. Statistical analysis proved a significant difference between smoking index, biological indices' of Cd (B-Cd and U-Cd) on one hand and SCE on the other hand. Cytogenetic analysis revealed the mean significant cytogenetic changes for all exposed and control groups, in the form of SCE and chromosomal abnormalities were found to be significantly higher among the exposed workers compared to controls. Microbiological profile determined more implication in smokers of both groups. In conclusion, smoking habit proved to have synergistic effect on genotoxicity and lung infection with occupationally exposure to (Cd). [Researcher. 2009;1(5):37-43]. (ISSN: 1553-9865).

Keywords: cadmium, genotoxicity, smoking, chest infection, occupational exposure

1. Introduction

Cadmium (Cd) is a heavy toxic metal commonly found in industrial workplaces. It has no nutritive function in humans (Newman-Taylor 1998), and it is a probable lung carcinogen in humans according to the Agency for Toxic Substances and Disease Registry (ATSDR 1999). Non-occupational sources of cadmium exposure within the general population include ingestion of contaminated food (Järup, et al., 1998) and inhalation of cigarette smoke (Satarug et al., 2004).

High levels of cadmium exposure are known to cause emphysema in occupationally exposed workers, but little has been reported to date on the association between chronic environmental cadmium exposure and pulmonary function (Lampe, et al., 2008)

Cigarette smoking remains a major health problem causing infectious diseases, heart disease, chronic lung disease and cancer (Kirschvink et al., 2006). Smokers have higher body burdens of cadmium

than nonsmokers (Erzen and Kragelj 2006; Grasseschi et al. 2003).

Mutation and genotoxicity caused from Cd exposure in the form of chromosomal and chromatid breaks, and high frequency of sister chromatid exchange were reported by (IRAC, 1993).

Enhancing the mutagenic action of Cd and invasive lung disease caused by excessive exposure to smoking might explain the observed increases in cancer rates, which lead to consider it a confounding factors for the increase in cancer among workers exposed to Cd (IRAC, 1993).

We aimed in this study to find out the genotoxicity and lung infection caused due to confounding role of smoking habit with occupationally exposure to (Cd).

2. Materials and Methods

2.1 Subjects

The design of this study was cross sectional study:

The study subjects were as follow:

- 40 male workers from an electroplating factory exposed to Cd (27 were smokers and 13 were non smokers)
- 40 control subjects (comparable in age and socioeconomic status), who were never occupationally exposed to Cd (28 were smokers and 12 were non smokers).

An interviewing questionnaire for recording:

- 1- Personal data (duration of employment, sources of pollutants in their residential areas, smoking duration, number of cigarettes in a package).
- 2- Clinical and medical history for any previous diagnosis of bronchial asthma, cystic fibrosis, or bronchiectasis; diagnosis of neoplasia; clinical-radiologic evidence of pneumonia.

Exclusion criteria:

Those who received any type of antibiotic treatment over five days prior to sputum sampling (for microbiological culture).

2. 2 Methods

(1) Determination of cadmium level in blood and urine:

Samples were collected from the two groups, were digested with high purity nitric acid (65%) and perchloric acid (60%) by 3:1.

Cd was determined using atomic absorption spectrophotometer. The concentration of cadmium was expressed as $\mu\text{g/L}$ blood or urine (Litonjua et al., 2005). ± 1 -G-banding according to Bayani and Squire (2004), such that for each person we examined 50 metaphase. 2-SCEs analysis: according to Pendzich et al., (1997) such that 25 – 30 complete cells were analysis from each case and SCE were scored / metaphase).

(2) Microbiological Study:

Sputum samples were collected in a sterile vial and sent within 2 h to a laboratory for processing.

Sputa were processed microbiologically for semiquantitative study following accepted laboratory methods. Balows et al., (1997). Using the microbiological loop, 0.01 ml. sputa were seeded in

the following culture media: blood agar, MacConkey agar (24 hours at 37°C), chocolate agar (the atmosphere contained 5 to 7% CO_2), and Sabouraud's agar plus chloramphenicol (35 \pm 2°C in aerobic conditions). Two types of Api-technique (bioMerieux, France) as a rapid identification system were used for identification of the various bacterial isolates based on enclosed instruction:

1- Api stept.identification system for *Streptococci*.

2- Api 20 E: identification system for *Enterobacteriaceae* and other Gram –negative rods.

Bacterial agents recovered were classified into three groups:

1- Group (1): *Pseudomonas aeruginosa*, *Enterobacteriaceae* spp. (e.g. *Proteus* spp, *Citrobacter freundii*, *Escherichia coli*, *Serratia marcescens*).

2- Group (2): *Streptococcus pneumonia* and other Gram-positive cocci, e.g. *Staphylococcus aureus*.

3- Group (3): Gram-negative cocci, e.g. *Moraxella catarrhalis*.

(3) Statistical Analysis

The collected data were statistically analyzed using SPSS. χ^2 was used for the statistical analysis of the qualitative data and t-test, as well as analysis of variance (ANOVA). The difference was considered significant at P- value ≤ 0.05 levels.

3. Results

Table (1) showed no statistically significant difference between both exposed and control regarding smoking habits.

Table (2) demonstrated that the biological indices of Cd of the exposed group were significantly higher than that of the control group.

Table (3) demonstrated that there were significant difference between smoking index, biological indices' of Cd (B-Cd and U-Cd) on one hand and SCE on the other hand while no significant difference in comparison to chromosomal aberration.

From Table (4) the mean significant cytogenetic changes for all exposed and control groups, in the form of SCE and chromosomal abnormalities were found to be significantly higher among the exposed workers compared to controls, with exception of chromatid and chromosome gaps.

Semiquantitative bacterial cultures were performed on all samples. Bacterial numbers less than (10^3) colony-forming units (cfu) x ml(-1) were found only in the two smoker workers & two non-smokers in both groups. Colonization with $10(3)$ cfu x ml(-1), was present in 1/13 and 3/27 in the worker (nS, S), and 2/28 of S. A higher cfu $>10^4$ colonized 1/13& 3/27 in the workers (nS, S), and 1/28 of S. Whereas, $>10^5$ colonized only smokers of both group. It was noticed

from table (6) that the most frequently isolated bacteria were group 2 organisms (53.9%), followed by the other two groups which were isolated nearly by the same percentage (18.2% and 18.6%). In addition, 37% and 23% of smoker & non smoker exposed group of workers were infected with different kinds of bacteria. Whereas, the percentage were 21.4% and 8.3% among Smoker and non smoker controls.

Table 1. Distribution of smoking habits among studied groups

Variables	Exposed (40)		Control (40)		χ^2	P value
	No.	%	No.	%		
Smoking habit						
Smokers	27	67.5	28	70	0.058	NS
Non-smokers	13	32.5	12	30		

NS= non significant.

Table 2. Blood and urine cadmium level among the studied groups

Variables	Exposed (40)	Control (40)	Statistical Analysis	
	Mean±SD	Mean±SD	Independent t-test	P>value
B-Cd µg/liter	18.66±9.61	2.48±1.23	10.56	0.0005*
U-Cd µg/liter	18.47±4.84	4.16±2.32	5.06	0.0005*

Table 3. Statistical variations between smoking index, (B-Cd), U- Cd levels and SCE, chromosomal abnormalities among exposed group

Variables	SCE	Chromosomal abnormalities
B-Cd µg/liter	0.7*	0.1
P-value	0.0005	NS
U-Cd µg/liter	0.5*	0.2
P-value	0.0005	NS
Smoking index	0.75*	0.15
P-value	0.0005	NS

*= significant. NS=non-significant

Table 4. Mean of all Chromosomal abnormalities for all the exposed and control groups (metaphases were 100/person)

Parameters Mean±SD	Exposed(40)		Control(40)		Statistical analysis	
	Mean±S D	Mean± SD	Mean±S D	Mean± SD	Independent t-test	P>value
		9.453±1.6		5.643±0.9		13.29
Chromosomal abnormalities	No.	%	No.	%	χ^2	P-value
Cromatid gap With*	16	40	14	35	0.213	NS
Without**	24	60	26	65		
Chromatid break With*	18	45	0	0	23.226	P<0.0001
Without**	22	55	40	100		
Chromosome gap With*	18	45	12	30	1.92	NS

Without**		22	55	28	70		
Chromosome break	With*	27	67.5	7	17.5	20.46	P=0.0001
	Without**	13	35.5	33	82.5		
A centric fragment	With*	8	20	0	0	8.889	P<0.005
	Without**	32	80	40	100		
Tetraploidy	With*	9	22.5	2	5	5.165	P<0.05
	Without**	31	77.5	38	95		
Dicentric	With*	11	27.5	1	2.5	9.804	P<0.005
	Without**	29	72.5	39	97.5		

With* = had Chromosomal abnormalities

Without**= had no Chromosomal abnormalities

Table 5. Distribution of the semiquantitative bacterial culture among studies groups

	Control		Occupational workers	
	Smokers (s) (n=28)	Non smokers (ns) (n=12)	Smokers(s) (n=27)	Non smokers (ns) (n=13)
<10 ³ cfu/ml	0	1	2	1
10 ³ -10 ⁴	2	0	3	1
10 ⁴ -10 ⁵	1	0	3	1
10 ⁵ -10 ⁶	1	0	2	0
>10 ⁶	0	0	0	0

Table 6. Colonized microorganisms in different groups

Microorganisms groups	Control		Occupational workers		Total colonized from each group
	Smokers (n=28)	Non smokers (n=12)	Smokers (n=27)	Non smokers (n=13)	
Group 1 <i>Pseudomonas aeruginosa</i> & <i>Enterobacteriaceae</i>	2/28 (7.1%)	-	4/27 (11.1%)	-	18.2%
Group 2 Gram-positive cocci <i>Staphylococcus aureus</i> , <i>Streptococcus pneumoniae</i>	3/28 (10.7%)	- 1/12(8.3%)	5/27 (18.5%)	2/13 (15.4%)	52.9%
Group 3 Gram-negative cocci <i>Moraxcella catarrhalis</i>	1/28 (3.6%)	-	2/27 (7.4%)	1/13 (7.6%)	18.6%
Total	21.4%	8.3%	37%	23%	

4. Discussion

Cadmium contamination of the environment is very persistent. Thus in polluted areas cadmium is not only an occupational but also environmental and public

health problem of a large magnitude (Linshaw et al., 1996).

The mutagenic action of smoking was proved in many studies (Mili et al., (1991), Sopori et al. (1998) and Mori et al. (2003).

The present study discussed the confounding effect of smoking in mutagenicity of occupational exposure to Cd (Cadmium) levels in blood, urine, hair and other tissues reflect the degree of exposure. The average daily excretion of Cd in persons is usually below 1 µg/L creatinine, increasing with age and smoking (Allessio et al., 1993). Normal blood concentration of Cd in non – exposed persons ranges from 0.05 to 0.3 µg/dL. Occupationally exposed persons may be at range 1-10 µg/dL. A blood level of 5 µg/dL or higher is considered toxic (Grum 1990). The blood and urine Cd level of exposed workers in the present study were significantly higher compared to their controls. Our results agrees with those of Tang et al. (1990).

Our results showed a significant difference between smoking index ,biological indices' of Cd (B-Cd and U-Cd) on one hand and SCE on the other hand which results agreed with those of many studies who demonstrated a close relation between B-Cd and U-Cd and cigarette smoking (Wulf et al., 1986; Järup et al., 1998; Rowland and Harding, 1999; Mori et al., 2003 and Mannino et al., 2004). Which suggested that smoking was considered as confounding factor influencing the level of SCE.

Shiraishi et al.,(1972) reported marked increase in various chromosomal aberrations due to Cd increased exposure, also Bauchinger et al.,(1976) found a significant increase in chromatid breaks and acentric fragments but not dicentrics of 24workers at a smelting plant occupationally exposed to dust and fumes of zinc, lead and Cd. Furthermore, positive data of genotoxicity in a group of workers with the high cumulative exposure to Cd was documented (Forni, 1992).

The present study revealed a high prevalence of various chromosomal aberrations such as breaks, acentric fragments, acentric chromosome and tetraploidy with significant difference between Cd exposed workers and the control individuals.

The observed higher frequency of chromosome breaks was explained by Bui et al. (1975) to be due to a more frequent effect of Cd prior to the phase of DNA synthesis of the cell cycle.

In contrast, Tang (1991) did not found SCE among Cd exposed with increased chromosomal aberrations, which showed a significantly higher mean value for SCE of the exposed workers compared to the controls. In addition SCE was significantly correlated with B-Cd

and U-Cd levels of the exposed workers. Studies of Bilban (1998) agreed with our results.

Our results showed that 37% of smoker workers were infected with different kinds of bacteria followed by non smoker workers (23%). Whereas, infection was noticed in 21.4% of and 8.3% of Smoker and non smoker controls. Those results confirmed the synergistic effect between smoking and occupational exposure to Cd. Simpson et al. (1998) reported that people exposed to cigarette smoking have a high prevalence of work related respiratory tract symptoms which are related to dust exposures and smoking habits. Some experts believe that a low-level infection in the lungs may trigger an inflammatory reaction that continues to produce subsequent acute attack. The possible mechanisms by which smoking increases the risk of infections include structural changes in the respiratory tract and a decrease in immune response, both systemically and locally within the lungs (Lidia et al., 2004). In addition, Cigarette smoking is an important risk factor for virulent bacterial and viral infections. For example, smokers showed 2- to 4-fold increased risk of invasive pneumococcal disease. Influenza risk is seven fold higher and is much more severe in smokers than nonsmokers (Arcavi and Benowitz ,2004).

So, we recommended the cytogenetic studies to be an essential component of pre-employment evaluation of cadmium exposed workers, also to exclude susceptible individuals. In addition, regular biological indices of cadmium should be checked regularly. Also, engineering control measures exhaust ventilation and health educational courses should be implemented to highlight dangerous impact of smoking on health. This study suggests that chronic cadmium exposure is associated with reduced pulmonary function, and cigarette smoking modifies this association. These results should be interpreted with caution because the sample size is small, and further studies are needed to confirm our findings.

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A Simple Experimental Verification of Einstein's Variance of Mass with Velocity Equation

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Abstract: Like any scientific theory, the theory of relativity must be confirmed by experiment. So far, relativity has passed all its experimental tests. The special theory predicts unusual behavior for objects traveling near the speed of light. So far no human has traveled near the speed of light. Physicists do, however, regularly accelerate sub atomic particles with large particle accelerators like the recently canceled Superconducting Super Collider (SSC). Physicists also observe cosmic rays which are particles traveling near the speed of light coming from space. When these physicists try to predict the behavior of rapidly moving particles using classical Newtonian physics, the predictions are wrong. When they use the corrections for Lorentz contraction, time dilation, and mass increase required by special relativity, it works. For example, muons are very short lived subatomic particles with an average lifetime of about two millionths of a second. However when they are traveling near the speed of light physicists observe much longer apparent lifetimes for muons. Time dilation is occurring for the muons. As seen by the observer in the lab time moves more slowly for the muons traveling near the speed of light. Time dilation and other relativistic effects are normally too small to measure at ordinary velocities. But what if we had sufficiently accurate clocks? In 1971 two physicists, J. C. Hafele and R. E. Keating used atomic clocks accurate to about one billionth of a second (one nanosecond) to measure the small time dilation that occurs while flying in a jet plane. They flew atomic clocks in a jet for 45 hours then compared the clock readings to a clock at rest in the laboratory. To within the accuracy of the clocks they used time dilation occurred for the clocks in the jet as predicted by relativity. Relativistic effects occur at ordinary velocities, but they are too small to measure without very precise instruments. The formula $E=mc^2$ predicts that matter can be converted directly to energy. Nuclear reactions that occur in the Sun, in nuclear reactors, and in nuclear weapons confirm this prediction experimentally. Albert Einstein's special theory of relativity fundamentally changed the way scientists characterize time and space. So far it has passed all experimental tests. It does not however mean that Newton's law of physics is wrong. Newton's laws are an approximation of relativity. In the approximation of small velocities, special relativity reduces to Newton's laws. In this short paper, the authors proposed a simple experimental verification for Einstein's variance of mass with velocity equation. [Researcher. 2009; 1(5):44-46]. (ISSN: 1553-9865).

Key words: Special theory of relativity, mass-velocity equation, experimental verification, bosons and gravity.

1. Introduction

Special theory of relativity (a physical theory of relativity based on the assumption that the speed of light in a vacuum is a constant and the assumption that the laws of physics are invariant in all inertial systems).

Einstein's theory that describes the motion of particles moving at any speed, even close to the speed of light. The theory proposes that the measured speed of light is a constant even if the source or observer of the light is moving. In contrast, measured distance, time,

and mass all depend on the relative velocity of the source and observer.

Einstein's version of the laws of physics, when there is no gravity. The two fundamental concepts in the foundation of this theory are equality of observers, and the constancy of the speed of light. The first of these means that the laws of physics must be the same, no matter how quickly an observer is moving. The second means that everyone measures the exact same speed of light. This theory is useful whenever the effects of gravity can be ignored, but objects are moving at nearly the speed of light. It has been successfully tested many

times in particle accelerators, and orbiting spacecraft. For objects moving much more slowly than light, Special Relativity becomes very nearly the same as Newton's theory, which is much easier to use.

A description of the relationships and interactions between moving objects. The 'special' theory only applies to the special case of objects moving at constant speeds in straight lines. It does not deal with accelerated motions.

It states that laws of nature are the same for all observers regardless of how they move. Also, it describes that space and time are connected and no longer individually absolute. Developed and published in 1905 by Albert Einstein, it deals with the measurement of physical quantities by observers who are in uniform motion with respect to each other. Einstein's statement that the laws of physics are the same for all observers in uniform [linear] motion.

2. Experiment

Choose an 1HP (one horse power) electric motor whose RPM is 1440. Take two single cell torch lights made by one and the same company. Take two single tiny 1.5volt battery cells made by one and the same company. Fix one of the torches to a wheel of the motor. Let the second torch light be at rest. Now switch on the torch lights simultaneously and switch on the electric motor at the same time. In our experiment the torch light at rest gave light only for 90 minutes where as the torch light in motion emitted light for 111 minutes. That is, the torch light at motion gave light more than 11 minutes than the torch light at rest. From this, we get the moving mass (the torch light in motion) is greater than the rest mass.(the torch light at rest) And hence the proof for Einstein's mass-velocity equation.

3. Discussion

From where does the rotating torch light get more energy? Who has put the energy in the moving torch? How is it possible that the moving object has more energy? It is generally accepted that in quantum mechanics Higgs bosons whose nickname is the God particle gives energy to other particles. Since we have performed the experiment in open space on a table, there is no involvement of quantum mechanical forces/field. So, the moving torch light might have taken energy from the space which is filled with gravitons. Let us recall what Einstein said about gravity: We can not separate gravity from space. Space is full of gravity. In this experiment, a physical mystery happened naturally. The gravitational force was converted into electro magnetic force. This is the only possibility.

4. Conclusion

Needless to say, novel ideas rule the world. In science, the statements which are initially rejected are normally accepted later. Similarly the authors believe that their findings will be welcomed by the physics community. Guye and Lavanchy carried out their experiment 2000 times. Keeping this fact in mind, the authors also repeated their experiment for 700 times and the result was consistent.

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Physiological Effect Of Auxins On Growth Characteristics And Productive Potential Of *Verbascum thapsus* – A Medicinal Plant

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ABSTRACT: Due to current revival of interest in herbal drugs and pharmaceuticals, demand for medicinal plants is increasing day by day leading to destructive harvesting which ultimately has resulted into reduction and even extinction of many rare medicinal plants. Plant growth regulators like auxins have proved to increase the productivity and growth characteristics of many plants. They have proved their importance in agro technology of many plants hence, in the present study, an effort has been made to suggest agro technology of a very important medicinal plants-*Verbascum thapsus* (family: Scrophulariaceae), a hairy biennial plant which grows as wild in Himalayan region. The plant is used for curing a wide range of chest complaints and also to treat diarrhea. The leaves and flowers are Anodyne; Antiseptic; Astringent; Demulcent; Emollient; Expectorant; Narcotic; Odontalgic; Vulnerary. Effect of foliar spray of different concentration of auxins (IAA (50,100,200 ppm), 2,4-D (5,10,20 ppm) on augmentation of growth characteristics was studied. Observations reveal that IAA 50 ppm increased the shoot and root length, number of branches, nodes and leaves, while IAA 200 ppm was found to be the best for leaf area, number of flower and fruits. 2,4-D treated plants exhibited much reduction in number of flowers, indicating the adverse effect of this chemical towards growth. IAA 50 ppm resulted in maximum productivity of aboveground and underground compartment of *V. thapsus* on annual basis. [Researcher. 2009;1(5):47-51]. (ISSN: 1553-9865)

Keywords: *Verbascum thapsus*, growth regulators, net primary production, growth rate, net assimilation rate.

INTRODUCTION

Extensive research work on different ecological and physiological aspects of medicinal plants has been done in India and abroad. Studies pertaining to the agrotechnology of most of the important medicinal plants are fragmentary. Due to lack of agrotechnology the cultivation of medicinal plants is rather uncommon in the rural sector. But the commercial production of these plants is being largely felt due to increasing demand for herbal based medicines. Growth regulators like auxins have been reported to affect the growth behaviour and productivity of plants. *Verbascum thapsus* (Great or common mullein) is native to Europe, Northern Africa and Asia. It is widely used for herbal remedies with emollient and astringent properties. It is especially recommended for coughs and related problems. It acts by reducing the formation of mucus and stimulating the coughing up of phlegm, and is a specific treatment for tracheitis and bronchitis, but also used in topical applications against a variety of skin problems. A decoction of the seeds is used to soothe chilblains and chapped skin. A homeopathic remedy is made from the fresh leaves. It is used in the treatment of long-standing headaches accompanied with oppression of the ear. The plant is also used to make dyes and torches.

The leaves and flowers of the plant are anodyne, anti-inflammatory, antiseptic, antispasmodic, astringent, demulcent, diuretic, emollient, expectorant and vulnerary. An infusion is taken internally in the treatment of a wide range of chest complaints and also

to treat diarrhea. The plant is harvested when in flower and is dried for later use. The decoction of the roots is said to alleviate toothache and also relieve cramps and convulsions. The seeds are slightly narcotic and also contain saponins. Considering the importance of this plant, the agro technology of this plant is being reported in the present paper.

MATERIALS AND METHODS

The present study was undertaken to evaluate the effect of foliar spray of varying concentrations of growth regulators (IAA and 2,4-D) on *V. thapsus* to workout the quantitative characters and emphasis was laid down on Growth pattern study, Biomass structure and Net Primary Production.

The experiment was laid out in seven plots of 10 x 5 m size during April to September 2002 at Pauri town (1650 m AMSL) situated on Western Himalayas. The seeds of *V. thapsus* germinated after 20 days and were transplanted to different experimental plots after 30 days of germination.

The plants were subjected to foliar spray with auxins such as IAA (200, 100 and 50 ppm), 2,4-D (20, 10 and 5 ppm) and control (water spray) after the measurement of initial shoot length. Foliar spray was conducted at 60, 90 and 120 day stage. Final observations were made at 150 day stage.

RESULTS

Shoot length at 150 day stage reflected higher value in IAA 50 ppm treated plants (143.50±12.65)

over control treated plants (122.00 ± 0.78) whereas 2,4-D treated plants exhibited lower shoot length (104.00 ± 12.00) than control. Shoot diameter was maximum in plants of control plot (18.30 ± 1.85) followed by IAA 50 ppm (15.96 ± 1.35) and 2,4-D 5 ppm (15.86 ± 1.20) treated plants.

All concentrations of IAA also responded favourably towards root length as compared to control (17.00 ± 1.60). IAA 50 ppm treated plants exhibited longest roots (20.00 ± 2.10) followed by 100 ppm (19.25 ± 1.65). higher concentration of 2,4-D (20 ppm) had lower value of root length (14.25 ± 1.60) as compared to control.

In IAA and 2,4-D treated plants shoot and root length and number of leaves increased with the decrease in concentration of chemicals Root diameter was maximum in control (20.81 ± 1.34) followed by 2,4-D 5 ppm (18.90 ± 1.26) and IAA 50 ppm treated plants (18.75 ± 1.85), while leaf areas was maximum in IAA 200 ppm (311.75 ± 13.75) and 50 ppm (308.00 ± 13.05). Control treated plants had higher value of leaf area than all 2,4-D treated plants.

Value of node number was highest in IAA 50 ppm (20.50 ± 2.55), plants of control plot followed next (19.50 ± 1.80). 2,4-D treated plants had lower number of nodes compared to other treatments (Table 2).

Number of flowers at 120 day stage was higher in IAA treated plants over control. 2,4-D treated plants reflected lower number of flowers indicating the adverse effect of this chemical substantially.

At the end of the study period, the number of fruits was higher in IAA 200 ppm (313.00 ± 18.08). Control plot had 217.00 ± 12.10 numbers of fruits at this stage.

Gradual increment of biomass of aboveground and underground compartment has been observed in different treatments. Maximum biomass on dry weight basis was in IAA 50 ppm in both compartments followed by other IAA treated plants in aboveground and 2,4-D 5 and 10 ppm treatments in underground compartment. Minimum biomass as usual was in 2,4-D 20 ppm treated plants (Table 5).

Maximum aboveground productivity on yearly basis was observed in IAA 50 ppm (followed by IAA 200 and IAA 100 ppm). Plants of control exhibited lower Net Primary Productivity (NPP) than IAA treated plants. 2,4-D 20, 10 and 5 ppm plants had lower total productivity than control. In 2,4-D treated plants, NPP of underground compartment was highest in 5 ppm plants and lowest in 20 ppm treatment of 2,4-D. control had higher values than IAA 200 and 2,4-D 20 ppm treated plants.

Thus IAA 50 ppm increased the shoot and root length, number of nodes and leaves, whereas IAA 200 ppm was found to best for leaf area and number of flowers and fruits.

Rate of Extension Growth (REG)

REG values ranged from 0.45 to 0.48 at 60 day stage. Increasing trend was noticed at 90 and 120 day stage in all treatments. At 150 day stage REG also increased in all treatments except 2,4-D 5 ppm (4.49) treated plants (Table 3).

Leaf Area Expansion Rate (LAER)

Leaf area expansion rate initially ranged from 0.08 to 0.79. Increasing trend was noticed at 90 and 120 day stage. In IAA treatment an increased trend was observed while in control and 2,4-D treated plants a decreasing trend was noticed at 150 day stage. Maximum LAER value was reflected in IAA 200 ppm (5.55) while minimum value was recorded in 2,4-D 20 ppm (5.33) treatments at the end of the study period.

Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR)

RGR reflected increasing trend upto 120 day stage followed by a decline at 150 day stage. NAR on other hand shown increasing trend during entire study period. 6 to 15 times increment in NAR was noticed in between 90 to 120 day stage while this increment was 2 to 3 times during 120 to 150 day stage.

LAR exhibited fluctuating trend in different treatments. Values decreased at 120 day stage in all the treatments except 2,4-D 10 and 20 ppm treated plants (Table 4).

Table 1: Effect of growth regulators on the growth behaviour of *V.thapsus*.

Treatment	Shoot length	Shoot diameter	Root length	Root diameter
IAA 200 ppm	133.50 ± 12.50	15.56 ± 1.35	17.75 ± 1.25	17.24 ± 1.24
IAA 100 ppm	135.00 ± 12.00	15.85 ± 1.90	19.25 ± 1.65	17.65 ± 1.25
IAA 50 ppm	143.50 ± 12.65	15.96 ± 1.35	20.00 ± 2.10	18.75 ± 1.85
2,4-D 20 ppm	52.00 ± 5.00	12.80 ± 1.50	14.25 ± 1.60	15.80 ± 1.25
2,4-D 10 ppm	76.00 ± 7.20	14.18 ± 1.25	18.79 ± 1.80	17.90 ± 1.24
2,4-D 5 ppm	104.00 ± 12.00	15.86 ± 1.20	19.00 ± 1.90	18.90 ± 1.26
Control	122.00 ± 12.00	18.30 ± 1.85	17.00 ± 1.60	20.61 ± 1.34

Table 2: Effect of growth regulators on the growth behaviour of *V.thapsus*

Treatment	Number of nodes	Number of leaves	Leaf area	Number of flowers	Number of fruits
IAA 200 ppm	17.50 ± 1.57	17.00 ± 1.85	311.75 ± 13.75	29.50 ± 2.56	313.00 ± 18.08
IAA 100 ppm	15.50 ± 1.59	17.50 ± 1.67	310.00 ± 13.00	27.50 ± 2.65	269.00 ± 12.60
IAA 50 ppm	20.50 ± 2.55	22.50 ± 2.50	308.00 ± 13.05	27.00 ± 2.60	192.00 ± 16.00
2,4-D 20 ppm	11.00 ± 1.08	13.50 ± 1.53	249.25 ± 12.75	4.90 ± 1.06	18.50 ± 1.80
2,4-D 10 ppm	13.50 ± 1.50	14.50 ± 1.45	251.25 ± 17.75	5.50 ± 1.08	-
2,4-D 5 ppm	15.00 ± 1.65	16.00 ± 1.62	257.75 ± 14.10	12.50 ± 1.26	44.00 ± 4.02
Control	19.50 ± 1.80	22.50 ± 2.15	262.25 ± 19.25	26.00 ± 2.05	217.00 ± 12.10

Table 3: Rate of Extension Growth (REG) and Leaf Area Expansion Rate (LAER)

Treatment	No. of days							
	REG		LAER		REG		LAER	
	60		90		120		150	
IAA 200 ppm	0.45	0.09	3.005	4.99	4.712	5.53	4.734	5.55
IAA 100 ppm	0.48	0.09	2.996	4.94	4.719	5.52	4.744	5.55
IAA 50 ppm	0.48	0.10	2.828	4.60	4.760	5.53	4.804	5.54
2,4-D 20 ppm	0.53	0.09	2.750	4.16	3.746	5.37	3.823	5.33
2,4-D 10 ppm	0.48	0.09	2.869	4.29	4.005	5.38	4.194	5.34
2,4-D 5 ppm	0.47	0.08	2.897	4.39	4.522	5.39	4.490	5.37
Control	0.47	0.79	3.131	4.43	4.35	5.41	4.655	5.38

Table 4: Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Ratio (LAR) in *V.thapsus*.

Treatment	60*			90*			120*			150*		
	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR	RGR	NAR	LAR
IAA200 ppm	0.22	0.40	0.05	3.21	5.70	9.43	3.38	89.05	7.86	3.32	168.05	9.57
IAA100 ppm	0.23	0.49	0.05	2.38	9.00	16.08	3.42	84.36	10.90	3.29	166.79	9.53
IAA 50 ppm	0.23	0.47	0.05	2.29	9.23	14.16	3.59	59.28	8.86	3.37	165.78	8.40
2,4-D20 ppm	0.23	0.63	0.04	1.92	5.27	11.46	2.15	37.55	17.78	1.98	136.09	29.46
2,4-D10 ppm	0.23	0.53	0.04	2.17	6.89	11.70	2.52	43.24	13.79	2.51	137.40	18.78
2,4-D 5 ppm	0.22	0.60	0.04	2.28	3.66	10.12	3.11	46.35	9.90	2.99	140.50	11.14
Control	0.23	0.62	0.04	2.31	3.87	9.47	3.26	47.63	8.83	3.29	141.82	7.98

*values taken in mg for calculation to avoid -ve value. Values of NAR are taken at 10⁻¹ level

Table 5: Periodic variation in the aboveground (AG), underground (UG) and moisture percentage in *V.thapsus*.

Treatment		Aboveground	Underground		Moisture %
IAA 200 ppm	FW	182.50 ± 12.55	20.25 ± 1.90	AG	488
	DW	31.03 ± 2.88	6.28 ± 0.58	UG	222
IAA100 ppm	FW	190.00 ± 10.80	24.40 ± 2.10	AG	525
	DW	30.40 ± 2.50	7.56 ± 0.88	UG	223
IAA 50 ppm	FW	219.00 ± 19.05	30.36 ± 3.10	AG	566
	DW	32.85 ± 3.10	9.11 ± 1.05	UG	233
2,4-D20 ppm	FW	52.00 ± 5.02	18.95 ± 1.40	AG	566
	DW	7.80 ± 0.66	6.25 ± 0.72	UG	203
2,4-D10 ppm	FW	89.00 ± 7.50	27.02 ± 1.90	AG	566
	DW	13.35 ± 1.25	8.92 ± 0.70	UG	202
2,4-D 5 ppm	FW	110.00 ± 10.80	28.00 ± 0.62	AG	400
	DW	22.00 ± 1.65	8.92 ± 0.62	UG	212
Control	FW	215.00 ± 17.50	25.40 ± 2.15	AG	614
	DW	28.09 ± 2.80	8.13 ± 0.80	UG	213

DISCUSSIONS

Report of different workers revealed that application of growth regulators ultimately affect the endogenous level of auxin which finally work on the growth and development of the plants. Literature review revealed that the time of application with respect to growth stage of plant (Kamp and Nightingale, 1999) with the concentration of chemical play an important role on growth modification and yield. Indole-3-acetic acid (IAA) as the principal auxin in higher plants, stimulate fundamental processes such as cell elongation and division (Kende and Zeevaart, 1997).

Role of growth regulators in improving branching and enhancing different growth processes of many ornamental crops has been extensively studied. Growth augmentation and yield due to foliar spray of IAA has been reported by several workers (Sinha and Pal, 1983; Patil *et al.*, 1987; Fuloria *et al.*, 1990; Arora *et al.*, 2000). IAA concentration upto 100 ppm has been found to increase shoot length in *Hippeastrum hybridium* (Bose *et al.*, 1980). IAA sprayed plants of *V.thapsus* reflected positive response towards maximum leaf number, leaf area, number of flowers and fruits than the other treatments in this study (Table 1). Increased leaf area (length and breadth) and number of leaves per plant by IAA treatment observed in the present study is in agreement with those of Das *et al.* (1992), Mishra *et al.* (2000) and Nandhini Devi and Chezliyas (2001). Increased leaf area means higher photosynthesis efficiency of the plants treated with IAA. Accumulation of higher photosynthates has a direct bearing on net productivity of the plant. Accumulation and its partitioning to different compartments at various stages of life cycle may be attributed to varying values of NAR of above and underground compartment in all the plants in the present study.

Root length was maximum in IAA 50 ppm similar are the findings of Parekh (1968) who observed root improvement in tomato by using IAA. Similar results have been observed in *Dendrocalamus strictus* by Misra and Misra (1982). Increasing trend in the growth was observed with decreasing concentration of 2,4-D.

Rate of Extension Growth (REG) and Leaf Area Expansion Rate (LAER) was maximum in all the three concentrations of IAA (Table 3). IAA also influenced Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) reflecting maximum values, whereas Leaf Area Ratio (LAR) was maximum in 2,4-D 20 ppm treatment (Table 4).

Kumar (1982) using 10 and 50 ppm concentrations of 2,4-D on groundnut concluded that lower concentration is more effective to increase dry weight. Similar result in the present study was

obtained with *V. thapsus* plants treated with 2,4-D 10 and 5 ppm exhibiting higher UG biomass on dry weight basis than control (Table 5). Dry weight of aboveground compartment was maximum in IAA 200 ppm (31.03 ± 2.88) whereas minimum DW was observed in 2,4-D 20 ppm (7.80 ± 0.66). IAA 50 ppm exhibited maximum DW values (9.11 ± 1.05) of Underground compartment in the present study (Table 5). Fuloria (1990) has reported higher productivity with lower concentrations of growth retardant in oat and ragi crops. Responses observed in the present study are in conformity with these finding. Moisture percentage was maximum in control treated plants in the aboveground compartment. IAA 50 ppm treated plants reflected higher moisture percentage in the underground compartments in the present study.

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Study on Traffic Access Mode Choice of Urban Railway System in Beijing

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Abstract: An effective traffic access system of urban railway will greatly increase the accessibility of transportation system. This paper analyzes the distribution between the access modes choice and the access distance and access time by a revealed preference survey for the ingress and egress of urban railway in Beijing. Then a joined nested mode choice logit model is sets up using the survey data. Three factors of access time, access cost and access distance on the traffic access mode choices of urban railway are analyzed. It is confirmed to be effective based on the combined estimated methodology by the comparison between the joined model and the ML model. The elasticity analysis of the model's variables is conducted to analyze to what extent each variable influences the access mode choice of travelers. The conclusions provide an analytical tool for urban railway planning and construction, also advices on policy application. [Researcher. 2009;1(5):52-57]. (ISSN: 1553-9865)

Key words: railway access mode; nested logit model; joined model

1 Introduction

The convenience of the traffic access mode of the ingress and egress of urban rapid railway system influence the individual's travel mode choice to some extent. To build an effective traffic access system will increase railway's attraction, bring forth the function of urban railway and decrease traffic jams.

Many scholars have done researches on the traffic access mode of urban railway. Korf and Demetsky had classified the subway stations into five types and analyzed the subway station access mode choices (Korf, 1981). Bates had classified traffic access facilities based on the service covered by buses and intercity passenger transport and railways. It had discussed how to improve the present access facilities (Bates, 1978). Dickins had put forward the proposals for the locations, attributes and size of the access facilities based on the survey data of 51 cities in Europe and North America (Dickins, 1991). There were some studies about the traffic access facilities in China including the analysis on the access time, access distance and system evaluations from a planning view (Wang, 2003; Du, 2005; Wu, 2005). Guan Hongzhi had developed two different logit models based on the survey conducted in Beijing to analyze the mode choice behavior on the arrival and departure railway station respectively (Guan, 2007).

This paper focuses on the analysis of traffic access mode choice behaviors based on a survey

conducted in Beijing and analyzes the factors that influence the traffic access mode choices of travelers riding urban railways. A nested logit model is then used to develop a traffic access mode choice model of railway. This model analyzes the access process of the ingress and egress of the railway. Furthermore, the elasticity of each influencing factors was analyzed to illustrate how the variables affect the access mode choice behavior of travelers using urban railway systems. The conclusions are valuable for the traffic policies of the urban railway system.

2 Surveys and analysis

The revealed preference data survey was conducted in Beijing. In order to analyze the traffic access mode choice preference of railway users, the questionnaire include items about the individual gender, age, occupation, income, and car ownership and trip purpose, trip origin, traffic access modes, access time and cost. There are six traffic access modes considered in the survey including buses, walking, taxis, bikes, private cars, and others (Guan, 2007).

The survey uses face-to-face interviews. Six railway stations were selected based on the different land exploitation degree and layouts, geographic locations, and development characteristics around the railway station in Beijing. The number of valid questionnaires is 761, which is suitable for the sample data in the building of the logit model.

2.1 Distribution of the traffic access modes

The traffic access modes of the railway include ingress and egress access modes as shown in Fig. 1. As shown in Fig. 1, the differences between the distribution of ingress and egress access modes choice are small. Walking is the dominant traffic access mode of urban railway and the choice proportion is over 70%. Bus ranks as the secondary traffic access mode of urban railway with a proportion of over 20%. The proportions of the other traffic access modes are relatively small.

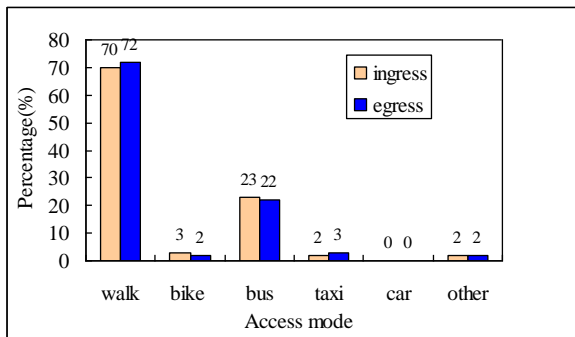


Figure 1. Access mode distribution

2.2 Distribution of access distance

Fig. 2 shows the access distance differs significantly between the access and egress access mode choice. The mean access distance is 1.4 km and the average egress access distance is 2.0 km. This indicates that the egress access distance is higher than that of the access mode.

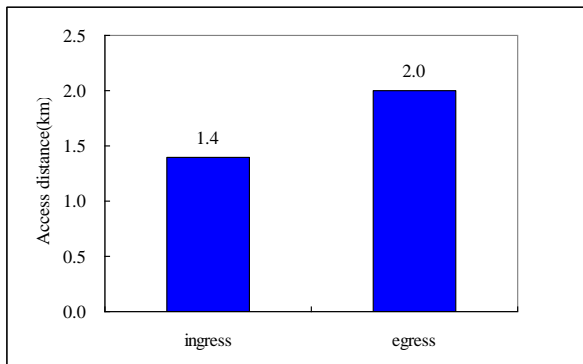


Figure 2. Distribution of access distance

2.3 Distribution of bus access time

Also, Fig. 3 shows that the bus access time varies greatly between ingress and egress access modes choices when railway riders take bus as a traffic access mode. The mean bus access time is 11 minutes, which is largely lower than the mean egress access time of 25 minutes.

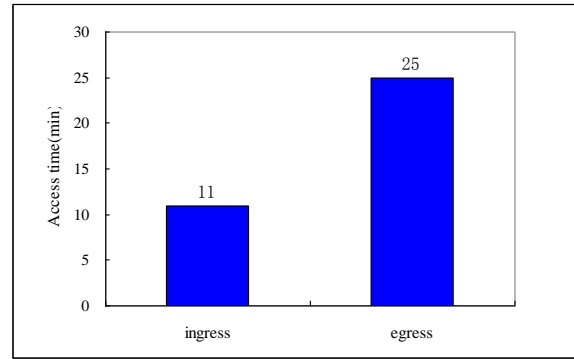


Figure 3. Distribution of bus access time

3. Methodology and models

As the logit model is an effective mathematical tool to study traffic behavior and is required a small sample, this paper adopts the NL (Nested Logit) model to do researches on the behavior of transport mode choices put forwarded here. The normal equation of NL model is as follows (McFadden, 1973):

$$P_n(tm) = P_n(t|m)P_n(m) = \frac{\exp(V_{(t|m)n})}{\sum_{t'=1}^{R_m} \exp(V_{(t'|m)n})} \cdot \frac{\exp[\omega(V_{mn} + I_d)]}{\sum_{m'=1}^M \exp[\omega(V_{m'n} + I_d)]} \quad (1)$$

Where:

$P_n(tm)$ —the probability of the n^{th} traveler choosing tm ;

$P_n(m)$ —the probability of the n^{th} traveler choosing m ;

$P_n(t|m)$ —the probability of the n^{th} traveler choosing t under the condition of choosing m first;

$V_{(t|m)n}$ —the fixed part of the utility function of t under the condition of choosing m ;

V_{mn} —the fixed part of the utility function of m ;

I_d —the inclusive value;

ω —the scale parameter.

It is convenient to organize ingress and egress mode in one model to show the distinct influence of each variable. According to the preceding statistical analysis, there is little difference between ingress and egress of railway in terms of the proportion for each mode, but the variation of bus access time and access distance is considerable. The structure of the NL model

is shown in Fig. 4. It has four branches of access modes: bus, walking, taxi, and bike, as well as two limbs: ingress and egress. What is noticeable is that the relationship between ingress and egress is not mutually exclusive but parataxis, so the estimation methods will be a little different from the normal NL model.

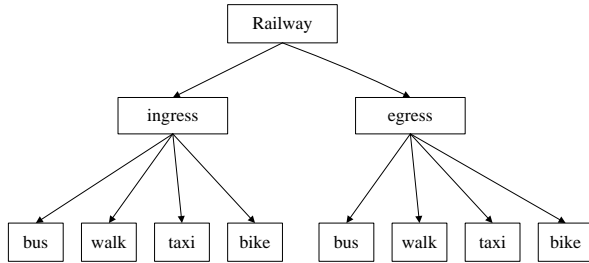


Figure 4. Access model structure

Firstly it is assumed that the fixed part of the utility functions of ingress and egress is the same and the random components' variances of the utility functions have different levels of randomness, which can be expressed by (Guan, 2004; Ben-akiva, 1990):

$$Var[\varepsilon_f] = \frac{1}{\omega^2} Var[\varepsilon_r] \tag{2}$$

Then the scale parameter “ μ_r ” and “ μ_f ” of the utility functions of arrival and departure can be expressed by:

$$\frac{\mu_r}{\mu_f} = \omega \tag{3}$$

If assume $\mu_r = 1$, using standardized process, hence the maximum likelihood function of traffic mode choice of railway's arrival and departure can be formulated as

$$L_f(\theta, \omega) = \sum_{n=1}^N \sum_f \delta_{fn} \left[\omega V_{fn} - \ln \sum_f \exp(\omega V_f) \right] \tag{4}$$

$$L_r(\theta, \omega) = \sum_{n=1}^N \sum_r \delta_{rn} \left[V_{rn} - \ln \sum_f \exp(V_f) \right] \tag{5}$$

where δ_{fn} and δ_{rn} are results of traffic mode choice of railway's arrival and departure:

$$\delta_{in} = \begin{cases} 1 & \text{then } n^{\text{th}} \text{ traveler choosing } i^{\text{th}} \text{ mode} \\ 0 & \text{others} \end{cases} \quad (i = f, r); \tag{6}$$

where θ is the unknown vector parameter of utility functions V_{fn} and V_{rn} .

Based on these assumptions, the parameter can be estimated by the following sequential estimation method:

Step1:

$$\text{Define } V_{fn} = \theta_{f0} + \sum_k \theta_k X_{nk} \quad (X_{nk} \text{ is the}$$

influence factor on travelers' transport mode choice of railway access); and then estimate the access model in function 3 from the access data to obtain $\hat{\theta}_{f0}$ and $\hat{\omega}\hat{\theta}_k$.

Step2:

$$\text{Define } V_{rn} = \theta_{r0} + \gamma \sum_k \hat{\omega}\hat{\theta}_k X_{nk} \quad (X_{nk} \text{ is the}$$

influence factor on travelers' transport mode choice of railway egress); and then estimate the egress model in function 4 from the egress data to obtain $\hat{\gamma}$ and $\hat{\theta}_{r0}$,

$$\text{Calculate } \hat{\omega} = \frac{1}{\hat{\gamma}}, \quad \hat{\theta}_k = \hat{\omega}\hat{\theta}_k / \hat{\omega}.$$

Step 3:

Multiply X_{fnk} by $\hat{\omega}$ to obtain a modified access data set, and change the fixed part of access model's utility functions “ V_{fn} ”,

$$\text{define } V_{fn} = \theta_{f0} + \sum_k \theta_k (\hat{\omega}X_{fnk}); \text{ Pool the egress}$$

data and the modified access data; and then estimate the two models jointly to $\hat{\theta}_k$.

In order to find a model which is suitable for both ingress and egress model, according to the access model structure shown in Fig. 4, this paper utilizes scale parameter “ ω ” to join the ingress data and egress data. In order to explain its validity and superiority, this paper also set up another model was just a simple ML (Multinomial Logit) model with data of ingress and egress.

Application of the survey data in the logit railway access mode choice model for arriving at and departing from the stations gave the results listed in Table 1. According to the correlation analysis and the research in the transportation mode we select some variables: access time, access fee and access distance to establish the choice model.

Table 1. Parameter estimates of the access model

	model1 (joined model)		model2 (ML)	
	Coefficient	t-statistics	Coefficient	t-statistics
Constant(walk)	3.233	2.7743	8.6656	7.1451
Constant(bike)	-2.4782	-2.4631	1.7322	1.6724
Constant(bus)	1.3092	1.7351	3.3009	3.5798
Access fee	-0.7812	-5.5936	-0.1945	-3.7942
Access time	-0.5335	-5.4789	-0.1298	-1.4398
Access distance	-4.1627	-7.8584	-4.1486	-7.5715
Scale parameter ω	2.1681	5.8500	—	—
$\bar{\rho}^2$	0.8267		0.8032	

Comparing model 1 with model 2, the value of $\bar{\rho}^2$ of model 1 improved from 0.8032 to 0.8267. And the value of t test on access time, which is the most important variable to influence the behavior of people’s access mode choice, increased greatly from -1.4398 to -5.4789, which is significant under confidence level of 95%. From this point of view, model 1 is more effective than model 2.

The coefficients for three variables in model 1 (access time, access fee, and access distance) are all negative, which means some access mode’s utility will decrease with the increase of any one of these three variables. The finding is in accordance with the widely accepted belief that the more time-consuming, the higher access fee, and the longer distance access to the metro station a trip is, the greater possibility that one will switch to an alternative transport mode.

Furthermore, it is noticeable the value of access time and access fee’s coefficients. Normally the value of the coefficient reflects each variable’s impact on the utility function. As these two variables are public, the ratio of access fee and access time will reflect travelers’ time value to some extent. An interesting result is this ratio is much higher than the actual value of travel time for Beijing. This is because the average income of rail users is higher than the average income for all of Beijing, which is clearly shown in Fig. 5. Compared to all modes users, the proportion of mid income rail users is larger, while the proportion of high income group is equal.

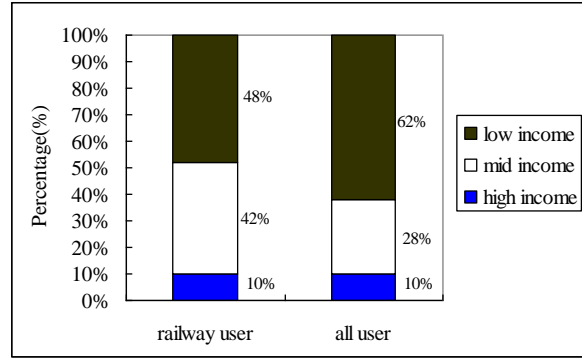


Figure 5. Contrast of the income between rail users and all users

4. Elasticity analysis

To analyze how and to what extent each variable influences choices of policy makers; we conduct the elasticity analysis to find out how the mode choice ratio changes when only the studied variable changes while other variables remain constant. So this paper chooses access distance, bus access time, and bus access fee as the variables to analyze. Here only bus access fee and bus access fee are chosen in sensitiveness analysis, the reason is that the access between rail and bus has attracting more and more attentions.

4.1 Access distance

Based on model 1, Fig. 6 shows an elasticity analysis of access distance variable, therein X axis is the access distance and Y axis is traveler’s choice probability on each transport mode under different access distance. The conclusion is that when access distance increases, the proportion of the walking mode decreases sharply, while the proportion of bike and bus modes surge. Since the proportion of taxi is zero until the access distance exceeds 4 km, Fig. 6 excluded the taxi mode. It is interesting to note that when access distance reaches 1.5 km, the proportion of the walking mode is equal to that of the survey. It can be confirmed that the convenient walking access distance is 1.5 km, slightly longer than the common belief of 0.5~1km. The reason may be that the density of railway stations and the railway network in Beijing are not large enough, leading the rail station far away from the origins and destinations. So the conclusion is that the best access distance between two rail stations is less than 1.5 km.

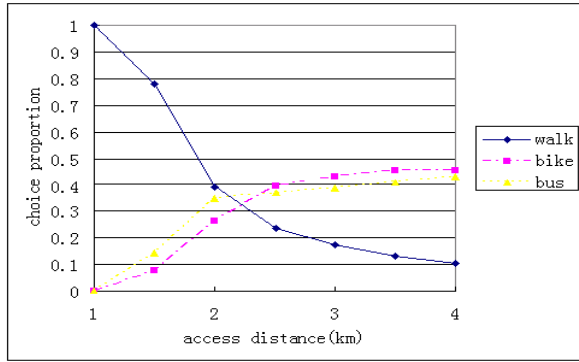


Figure 6. Analysis of sensitiveness on distance

4.2 Bus access time

Based on model 1, Fig. 7 shows the sensitive analysis of bus access time variable. Due to the negligible influence of bus access time on walking mode proportion, Fig. 7 has not shown the walking mode. In Fig. 7, the conclusion is that with the increase of bus access time, the proportion of bus mode decreases while those of the other three modes increase. When the bus access time is 10 minutes, the proportion reaches 25%, nearly the same as the actual proportion revealed in the survey. So it can be concluded that when the bus access time is less than 7 minutes, the proportions of the other modes will be transferred to the bus mode; when the bus access time is between 10 minutes and 20 minutes, the bus mode proportion will shift to the walking mode; when the bus access time increases from 30 minutes to 50 minutes, the bus mode proportion will mainly move to the bike mode, and when the bus access time is more than 50 minutes it will mainly transfer to the taxi mode. So the convenient access time is less than 20 minutes for the bus mode.

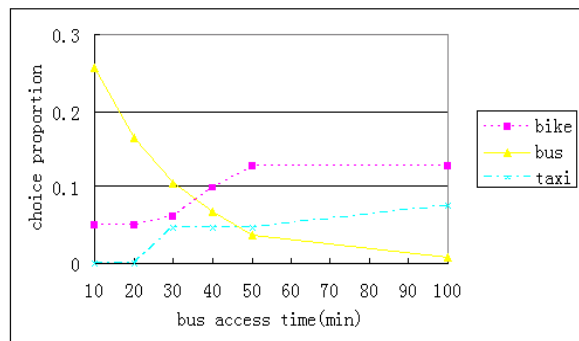


Figure 7. Analysis of sensitiveness on bus time

4.3 Bus access fee

Based on model 1, Fig. 8 shows the sensitive analysis of bus access fee variable. For the same reason with Fig. 7, the walking mode proportion is excluded in Fig. 8. The choice proportion of bus mode decreases with the increase of bus fee, especially when the bus fee is over 2RMB, the choice probability of bus dropped sharply. In the whole, the decreasing speed of bus passenger flow is higher than that of other mode's increasing speed. So the conclusion that bus access mode is more sensitive to the bus access fee is drawn, especially when the latter exceeds a certain value.

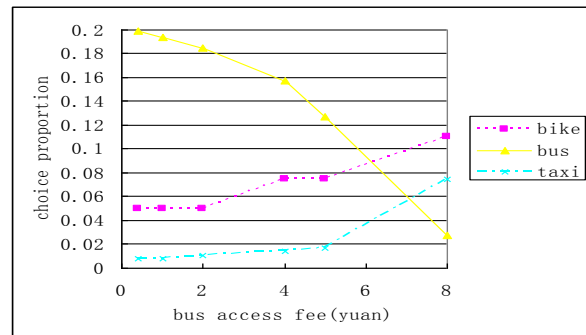


Figure 8. Analysis of sensitiveness on bus fare

5. Conclusions

By analyzing the railway lines in Beijing, this paper, in order to improve the integration of railway lines design and construction into the overall transportation system, evaluates the connections between railways and regular public transportation systems, sets up a joined nested mode choice logit model using the survey data. Conclusions from the parameters' analysis in model and sensitive analysis are as follows:

- (1) Access distance had significant impacts on the walking mode: As access distance increased, the proportion of the walking mode decreased sharply, and the appropriate access distance should be less than 2 km;
- (2) Appropriate access time for the bus mode was around 20 min, if it exceeded 20 minutes, the choice would shift to the bike and taxi modes;
- (3) The bus access mode was more sensitive to the bus access fee: In effect, given the low cost of bus fee in Beijing at the present time, the government needs to concentrate on the improvement of bus

services and comfort to maintain the increase of constant patronage.

In order to do a more in-depth and more accurate study on railway access mode choice behavior, the deeper improvement of this paper is to analyze the influence of the access mode on all the travel modes, then to explore what extent of every factor influencing on choice behaviors, which will provide more advice for policy applications and analysis of traveler's traffic mode choice characteristic.

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5/9/2009

On the parallel postulate

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Abstract: Before the origin of number theory the primitive people applied geometrical figures nearly 70,000 (seventy thousand) years ago. Still it is found in African rock caves. The exact period of the birth of geometry is not known. The propositions and constructions of classical geometry nearly dates back 2000 B.C. In around 300 B.C., Euclid of Alexandria city in Greek compiled the then existing propositions and wrote the first scientific text which is known as Elements. Euclid formulated 468 theorems based on five postulates introduced by Euclid. Among those postulates which are also known as axioms, the parallel postulate was/is a much disputed one. Euclid assumed the first four postulates as obvious. But he tried his best and trotted his mind to prove the fifth postulate as a theorem. Unfortunately he was unsuccessful in his efforts. After Euclid the famous mathematical stalwarts like Proclus, Playfair's, Ptolemy, Proclus, Al-Gauhary, Al-Haytham, Omargayam, Nasir-ad-din-at-tusi, Sacchari, Lambert, Clavius, Clairaut's, Farkas, Legender, Abuali-al-Haytham, John Walli, Hilbert, Birkhoff and Decardes, Gauss, Janos Bolyai, Lobachevsky, Riemann, Beltramy, Gayley, Klein, Poincare and others worked on this problem. Bu their research not yielded the relevant proof. In this study, the author repeated the previous history and recorded the following revolutionary result: Any three points are co-cyclic which is an equivalent statement to the fifth Euclidean postulate. [Researcher. 2009; 1(5):58-61]. (ISSN: 1553-9865).

Keywords: Euclid, elements, postulates, Non-Euclidean geometries

1. Introduction

In Elements, Euclid introduced and applied the following five postulates.

1. To draw a straight line from one point to another point.
2. To produce a finite straight line continuously in a straight line.
3. To describe a circle with any center and radius.
4. That all right angles equal to one another.
5. If a straight line falling on two straight lines makes the interior angles on the same side than two right angles, if produced indefinitely meet on the side on which are the angles less than the two right angles.

The studies devoted to the fifth postulate resulted in the invention of a number of equivalent propositions mentioned below:

1. Through a point not on a given line there passes not more than one parallel to the line.
2. Two lines that are parallel to the same line are parallel to each other.
3. A line that meets one of two parallels also meets the other.
4. If two parallels are cut by a transversal, the alternate interior angles are equal.
5. There exists a triangle whose angle sum is a straight angle.
6. Parallel lines are equidistant from one another.
7. There exist two parallel lines whose distance apart

never exceeds some finite value.

8. Similar triangles exist which are not congruent.
9. Any three points are collinear
10. Any three points are co-cyclic.
11. Through any point within any angle a line can be drawn which meets both sides of the angles.
12. There exists a quadrilateral whose angle sum is two straight angles.
13. Any two parallel lines can have a common perpendicular.
14. There exists a pair of straight lines everywhere equidistant from one another.
15. Two straight lines that intersect one another cannot be parallel to the third line.
16. There is no upper limit to the area of a triangle.
17. The sum of the angles is the same for every triangle.
18. There exists a quadrilateral of which all angles are right angles.
19. Phythagorean theorem.
20. There exists a pair of straight lines that are at constant distance from each other.
21. Given two parallel lines, any line that intersects one of them, also intersects the other.
22. If there is an acute angle such that a perpendicular drawn at every point on side will meet the other side also.

If one gives a proof for one of these 22 propositions, then Euclid fifth postulate holds. While

their attempts to prove the parallel postulate, Gauss-Bolyai- Lobachevsky developed a new field of consistent model of non-Euclidean geometry which is called hyperbolic geometry. Riemann independently found his non-Euclidean geometry which is known as elliptic geometry. In non-Euclidean geometries the fifth postulate is not applied. Both these geometries are widely applied in quantum mechanics and general theory of relativity. In this work by locating the following undisputed proof for the parallel postulate the author politely proposed for the origin of a new field of mathematical science.

2. Construction

Draw an equilateral triangle ABC as shown in Figure1. Locate the mid points D, E and F of sides BC, CA and AB respectively. Join AD. Join BE contacting AD at O. Since points B and E lie on the opposite sides of AD, BE can meet AD. Please note that Euclid uses this principle. [1, prop. 10] Join C and O. And join F and O.

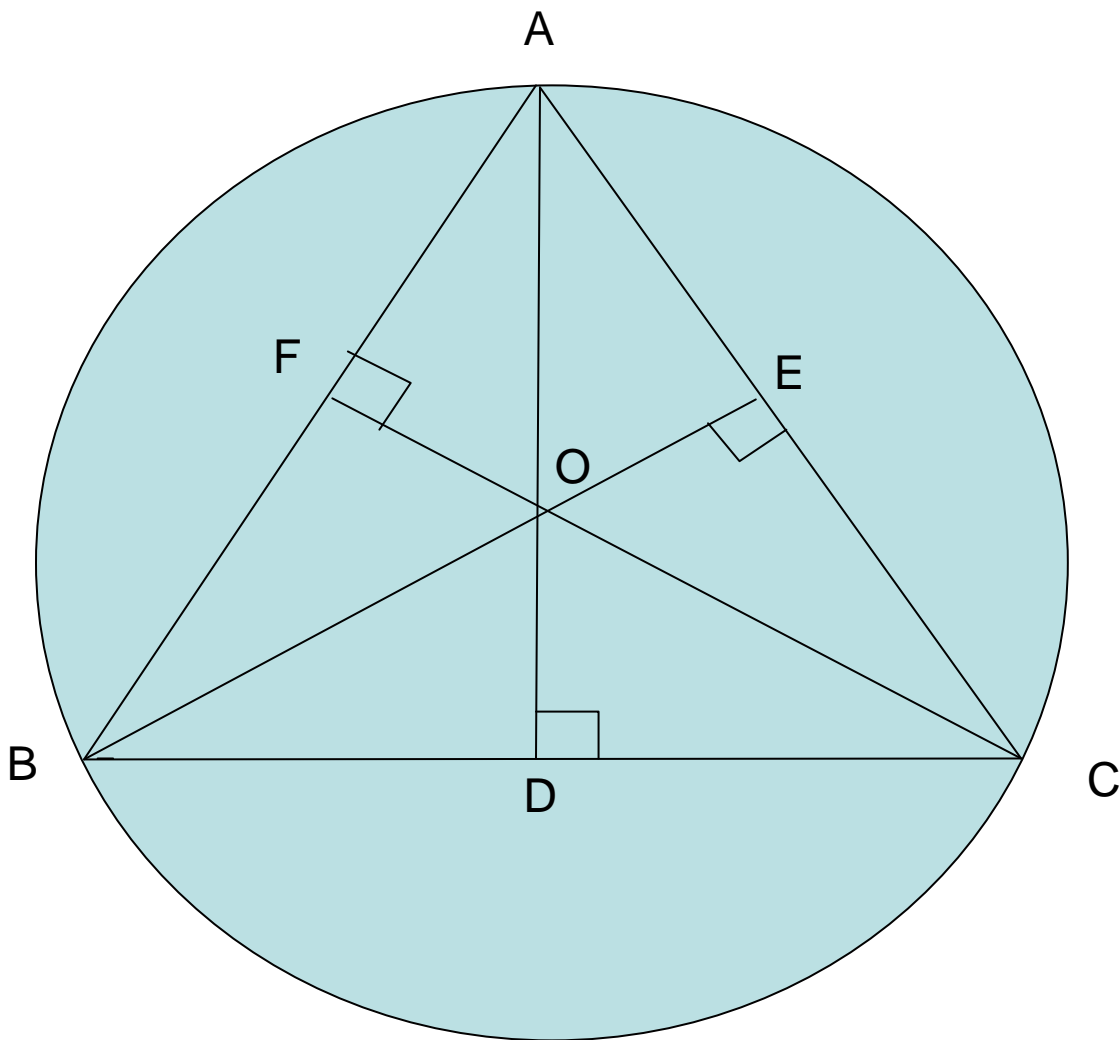


Figure 1. (Euclidean)

3. Result

Now by SSS correspondence triangles ADB, ADC, BEA and BEC are congruent [1, prop. 8]. So, the angles, $ADB = ADC = BEA = BEC = 90$ degrees. Now by SAS correspondence, triangles ODB, ODC, OEA and OEC are congruent. So, sides, $OA = OB = OC$. From this we obtain that points A, B and C are co-cyclic.

4. Discussion:

Soon after publishing the special theory of relativity in 1905, Einstein started thinking about how to incorporate gravity into his new relativistic framework. In 1907, beginning with a simple thought experiment involving an observer in free fall, he embarked on what would be an eight year search for a relativistic theory of gravity. After numerous detours and false starts, his work culminated in the November, 1915 presentation to the Prussian Academy of science of what are now known as the Einstein Field Equations. These equations specify how the geometry of space and time is influenced by whatever matter is present, and from the core of Einstein's general theory of relativity. General theory of relativity is the non-Euclidean geometric theory of gravitation. It is the current description of gravitation in modern physics. It unifies special relativity and Newton's Universal law of gravitation, and describes gravity as a GEOMETRIC PROPERTY OF SPACE AND TIME OR SPACETIME. In particular, the curvature of space time is directly related to the four momentum (mass – energy and linear momentum) of whatever matter and radiation are present. The relation is specified by the Einstein's field equations, a system of non – linear partial differential equations which are very difficult to solve. The following are the consequences of GTR:

1. Gravitational time dilation and red shift
2. Light deflection and gravitational time delay
3. Gravitational waves
4. Orbital effects and the relativity of direction
5. Precession of apsides
6. Orbital decay
7. Gravitational lensing
8. The experimental verifications of black holes and other compact objects
9. Singularities
10. Global and quasi local quantities
11. Quantum field theory in curved space time
12. Advanced concepts such as Casual structure and Global geometry

Einstein achieved the above mentioned results by applying the principles of non – Euclidean geometries in his general theory of relativity. Without

non-Euclidean concepts, the existence of general theory of relativity is an imagination. Relativity is only a body where as non-Euclidean geometries is life.

5. Conclusion

The famous French Emperor Napoleon Bonaparte used to tell time and again: The word impossible must be taken away from dictionary. In this paper, the author proved Napoleon's quotation by obtaining a result for the parallel postulate. But there are many geometrical battles which are to be won. I politely request the research community to probe into the following unsolved classical problems:

1. Squaring the circle
2. Duplicating the cube
3. Trisection of the given general angle without using protractor
4. To draw a regular septagon

Till this date the human excellence explored many interesting results in fifth postulate field. Let us note that there is no such results in the above mentioned four problems. Mother Nature does not show any partiality to both any person and any natural phenomena. I am confident that our attempts and studies in these classical problems will certainly lead us to wonderful and applicable results. The future investigations to be devoted into these problems will yield new results and give rise to new field of mathematical sciences. Present day physics is facing too many odds. Physicists are trotting their mind to solve the following challenging problems:

1. Quantum gravity
2. Understanding the nucleus
3. Fusion energy
4. Climate change
5. Turbulence
6. Glassy materials,
7. High-temperature superconductivity
8. Solar magnetism
9. Complexity
10. Consciousness
11. Are all the (measurable) dimensionless parameters that characterize the physical universe calculable in principle or are some merely determined by historical or quantum mechanical accident and uncalculable?
12. What is the lifetime of the proton and how do we understand it?
13. Is nature super symmetric, and if so, how is super symmetry broken?
14. Why does the universe appear to have one time and three space dimensions?

15 Why does the cosmological constant have the value that it has? Is it zero and is it really constant?

16. What are the fundamental degrees of freedom of M-theory (the theory whose low-energy limit is eleven-dimensional super gravity and that subsumes the five consistent superstring theories) and does the theory describe nature?

17. What is the resolution of the black hole information paradox?

18. What physics explains the enormous disparity between the gravitational scale and the typical mass scale of the elementary particles? In other words, why is gravity so much weaker than the other forces, like electromagnetism?

19. Can we quantitatively understand quark and gluon confinement in quantum chromo dynamics and the existence of a mass gap?

An outstanding invention in geometry will certainly help us to locate solutions for these unsolved problems. There will be NO impossibility provided one works hard. Yes, there is no substitute for hard work.

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5/8/2009

Image Segmentation based Quality Analysis of Agricultural Products using Emboss Filter and Hough Transform in Spatial Domain

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Abstract: Very few technologies developed less than 30 years ago have permeated our lives as much as the image processing. Development in the field of image processing especially in its field image segmentation which is used to extract regions of interest has proven wonders in various applications like Signature verification, Face recognition, Thumb impression verification, Automatic character recognition, Industrial machine vision for assembly and inspection etc. But the potential of image segmentation in the field of agriculture is yet to be exploited for the daily use. In this paper efforts are focused on the role of image segmentation in the field of agriculture to analyze the fruit quality on the basis of its color, size and weight. In the proposed algorithm, the desired conclusions/analysis can be made by comparing various inputs received (color, size, weight) with predefined parameters, which can be further used for grading, packaging and chopping of fruits in agriculture. [Researcher. 2009;1(5):62-68]. (ISSN: 1553-9865).

Keywords: Spatial domain, Frequency domain, Linear spatial filtering, Color models, Histogram, segmentation, Edge detection, Prewitt and Emboss filter, Hough transform

1. Introduction

Digital Images are electronic snapshots taken of a scene or scanned from documents, such as photographs, manuscripts, printed texts, and artwork. The digital image is sampled and mapped as a grid of dots or picture elements (pixels). Each pixel is assigned a tonal value (black, white, shades of gray or color), which is represented in binary code (zeros and ones). The binary digits ("bits") for each pixel are stored in a sequence by a computer and often reduced to a mathematical representation [1]. An image may be considered to contain sub-images sometimes referred to as regions-of-interest, ROIs, or simply regions. [2]. In searching the region of interest, the Edge detection is one of the most commonly used technique in image analysis, and there are probably more algorithms in the literature for enhancing and detecting edges than any other single subject [3] and [4]. To extract features from digital images, it is useful to be able to find simple shapes - straight lines, circles, ellipses and the like - in images. In order to achieve this goal, one must be able to detect a group of pixels that are on a straight line or a smooth curve [5] [6] and [7].

1.2. Color Models

Each color model is oriented towards either specific hardware (RGB, CMY, YIQ), or image processing applications (HSI).

1.1.1 RGB Color Model

The RGB (Red, Green, Blue) color model is an especially important one in digital image processing because it is used by most digital imaging devices (e.g., monitors and color cameras). In the RGB model, a color is expressed in terms that define the amounts of Red, Green and Blue light it contains.

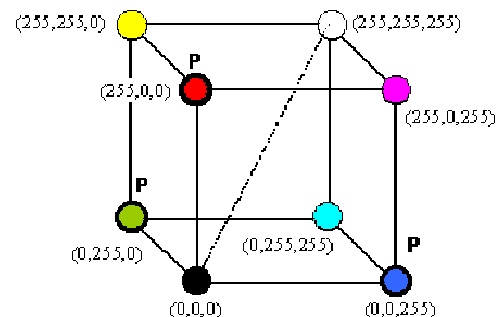


Figure 1: RGB Color Model [8]

1.1.2 HSI Color Model

The HSI (Hue, Saturation, Intensity) color model describes a color in terms of how it is perceived by the human eye. This is useful when processing images to compare two colors, or for changing a color from one to another. The HSI model is also a more useful model for

evaluating or measuring an object's color characteristics, such as the "redness" of a berry.

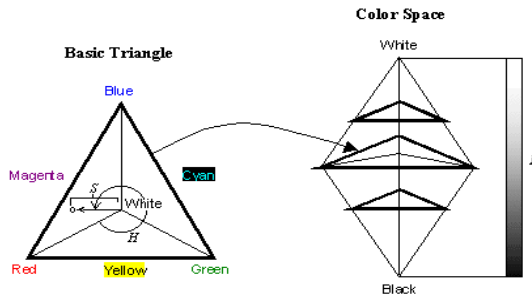


Figure 2: HSI Color Model

1.1.3 RGB to HSI Conversion

First, we convert RGB color image to HSI space beginning with normalizing RGB values:

$$r = R/R+G+B, g = G/R+G+B, b = B/R+G+B \quad (2)$$

Each normalized H, S and I components are obtained by,

$$h = \cos^{-1} \left\{ \frac{0.5[(r-g)+(r-b)]}{[(r-g)^2+(r-b)(g-b)]^{1/2}} \right\}$$

$$h \in [0, \Pi] \quad \text{for } b \leq g \quad (3)$$

$$h = 2\Pi - \cos^{-1} \left\{ \frac{0.5[(r-g)+(r-b)]}{[(r-g)^2+(r-b)(g-b)]^{1/2}} \right\} \quad h \in [\Pi, 2\Pi] \quad \text{for } b > g \quad (4)$$

$$s = 1 - 3 \cdot \min(r, g, b); \quad s \in [0, 1] \quad (5)$$

$$i = (R+G+B)/(3 \cdot 255); \quad i \in [0, 1] \quad (6)$$

For convenience h, s and i values are converted in the ranges of [0,360], [0,100], [0,255] respectively by:

$$H = h \times 180 / \Pi, S = s \times 100, I = i \times 255 \quad (7)$$

1.2. Segmentation

The techniques that are used to find the objects of interest are usually referred to as *segmentation techniques*. The most commonly used techniques of segmentation are Thresh holding, Edge Detection, Binary Mathematical Morphology and Region Growing and Splitting [9].

1.2.1 Edge Detection

Edges often occur at points where there is a large variation in the luminance values in an image, and consequently they often indicate the edges, or occluding boundaries, of the objects in a scene. **First Order Differential Methods of Edge Detection**

Most edge detection methods work on the assumption that an edge occurs where there is a discontinuity in the intensity function or a very steep intensity gradient in the image. If we take the derivative of the intensity values across the image and find points where the derivative is a maximum, we will have marked our edges (refer Figure 3).

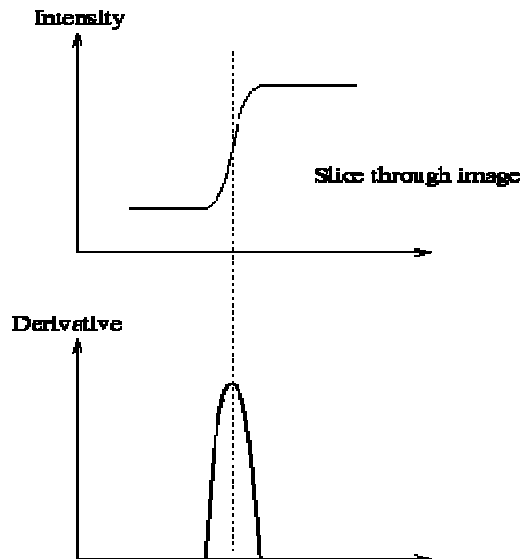


Figure 3(a): An ideal step edge and its derivative profile.

In a discrete image of pixels we can calculate the gradient by simply taking the difference of grey values between adjacent pixels.

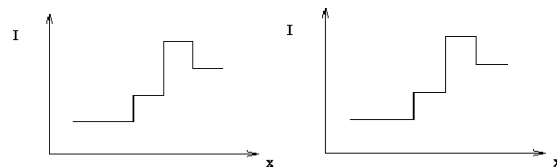


Figure 3(b): An ideal step edge and its derivative profile [10].

This is equivalent to convolving the image with the mask [-1, 1]. The gradient of the image function I is given by the vector

$$\nabla I = \left[\frac{\partial I}{\partial x}, \frac{\partial I}{\partial y} \right] \quad (8)$$

The magnitude of this gradient is given by $\sqrt{\left(\frac{\partial I}{\partial x}\right)^2 + \left(\frac{\partial I}{\partial y}\right)^2}$ and its direction by $\tan^{-1}\left(\frac{\partial I}{\partial y} / \frac{\partial I}{\partial x}\right)$.

Note, one can use any pair of orthogonal directions to compute this gradient, although it is common to use the x and y directions.

The simplest gradient operator is the *Robert's Cross operator* and it uses the masks

$$\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \& \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \quad (9)$$

Instead of finding approximate gradient components along the x and y directions it approximates gradient components along directions at 45° and 135° to the axes respectively. Thus the Robert's Cross operator uses the diagonal directions to calculate the gradient vector.

An 3×3 approximation to $\frac{\partial I}{\partial x}$ is given by the convolution mask

-1	0	1
-1	0	1
-1	0	1

This defines $\frac{\partial I}{\partial x}$ for the *Prewitt operator*, and it detects

vertical edges. The *Sobel operator* is a variation on this theme giving more emphasis to the centre cell. The

$\frac{\partial I}{\partial x}$ is given by

-1	0	1
-2	0	2
-1	0	1

Similar masks are constructed to approximate $\frac{\partial I}{\partial y}$, thus detecting the horizontal component of any edges. Both the Prewitt and Sobel edge detection algorithms convolve with masks to detect both the horizontal and vertical edge components; the resulting outputs are simply added to give a gradient map. The magnitude of the gradient map is calculated and then input to a routine that suppresses (to zero) all but the local maxima. This is known as non-maxima suppression. The resulting map of local maxima is thresholded (small local maxima will result from noise in the signal) to produce the final edge map. It is the non-maxima suppression and thresholding that introduce non-linearities into this edge detection scheme. Moreover, the output of the thresholding stage

is extremely sensitive and there are no automatic procedures for satisfactorily determining thresholds that work for all images [11].

1.2.1.1 Gradient Based Methods

An edge point can be regarded as a point in an image where a discontinuity (in gradient) occurs across some line. A discontinuity may be classified as one of these types (see figure).

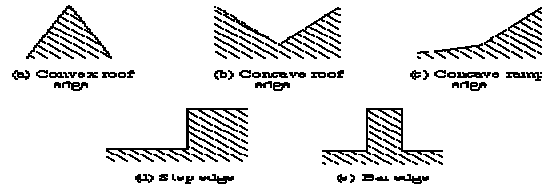


Figure 4: Points of Discontinuity in an Image [12]

Roberts

It provides simple approximation

$$G[f[i, j]] = |f[i, j] - f[i+1, j+1]| + |f[i+1, j] - f[i, j+1]| \quad (10)$$

Which becomes this after applying convolution mask:

$$G[f[i, j]] = |G_x| + |G_y| \quad (11)$$

where

$$G_x = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, G_y = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \quad (12)$$

Sobel

A way to avoid having the gradient calculated about an interpolated point between pixels is to use a 3×3 neighborhood for the gradient calculations. Consider the arrangement of pixels about the pixel $[i, j]$. The Sobel operator is the magnitude of the gradient computed by:

$$M \sqrt{s_x^2 + s_y^2} \quad (13)$$

Where the partial derivatives are computed by

$$s_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6) \quad (14)$$

$$s_y = (a_0 + ca_1 + a_2) - (a_6 + ca_5 + a_4) \quad (15)$$

with the constant $c = 2$.

Like the other gradient operators, S_x and S_y can be implemented using convolution masks:

$$S_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, S_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad (16)$$

Prewitt

The Prewitt operator uses the same equations as the Sobel operator, except that the constant $c = 1$. Therefore:

$$S_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}, S_y = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad (17)$$

Note that, unlike the Sobel operator, this operator does not place any emphasis on pixels that are closer to the center of the masks.

1.2.1.2 Laplacian-Based Edge Detection

A maximum of the first derivative will occur at a zero crossing of the second derivative. To get both horizontal and vertical edges we look at second derivatives in both the x and y directions. This is the *Laplacian* of I

$$\nabla^2 I = \frac{\partial^2 I}{\partial^2 x} + \frac{\partial^2 I}{\partial^2 y} \quad (18)$$

The Laplacian is linear and rotationally symmetric.

1.2.1.3 The Emboss Filters

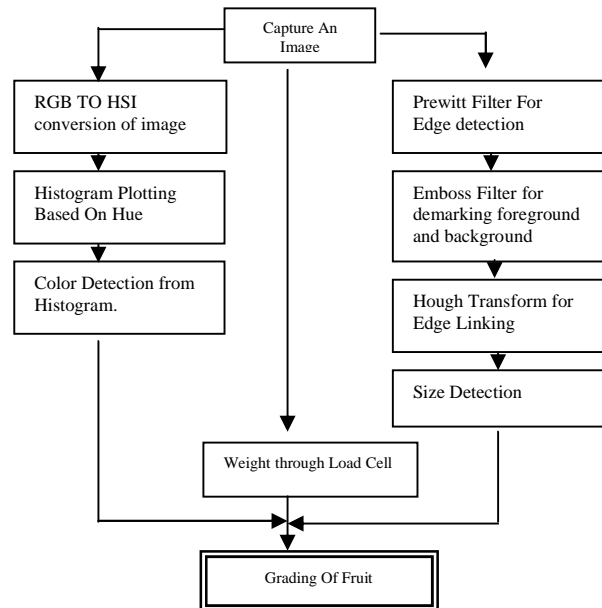
Emboss filters work somewhat like edge detection filters, with the difference that embossed images are entirely gray. Areas in the picture are detected and are given a certain “height level”, which is made visible by using grayscale borders, making the image look like it is three-dimensional. The embossing effect gives the optical illusion that some objects of the picture are closer or farther away than the background, making a 3D or embossed effect. This filter is strongly related to the previous one, except that it is not symmetrical, and only along a diagonal. Mask used is:

$$\begin{pmatrix} -1 & 0 & -1 \\ 0 & 4 & 0 \\ -1 & 0 & -1 \end{pmatrix} \quad (19)$$

Two dimensional convolution works just like one dimensional discrete convolutions, the output image y of an entering bitmap x , through a filter system of bitmap impulse response h (width and height M) is given by formula

$$y[r,c] = \frac{1}{\sum_{i,j} h[i,j]} \sum_{j=0}^{M-1M-1} \sum_{i=0} h[j,i] gx[r-j,c-i] \quad (20)$$

2. Proposed Algorithm



2.1 Color Detection:

RGB to HSI Conversion: Captured RGB image is converted to HSI (Hue, Saturation & Intensity) (Refer eqn3-7), which helps to analyze the dominant color content in the image as hue provides the exact type of color dominance.

(a) Histogram Analysis: The hue value of each pixel value of the image is extracted using function HSI (r, g, b) which returns the value of Hue, Saturation and Intensity and plotted in a graph (no of pixel vs. hue) to get the graphical color dominance in an image.

The conclusion can be made from the graphs as follows: If $0 < \text{Hue} < 40$ red color is dominant with a small component of green color but no component of blue color.

If $40 < \text{Hue} < 80$ red green color is dominant with the contribution from red color too but no blue color component.

If $80 < \text{Hue} < 120$ green color is dominant and a bit contribution from blue is present but no red color is absent.

If $\text{Hue} > 120$ Blue color is dominant with a bit contribution from green color

If the histogram is spread in all the regions this reflects the mixture of RGB is present then the density of the graph represents the color dominance.

2.2 Size Detection

This is done while applying edge detection method, which is further, followed by edge linking to get the size.

a) **Edge Detection** to define boundary is carried in following steps:

1) **Prewitt Filter** (gradient method based on first derivative operator) is used to mask with the captured bitmap of image. Result for the same is stored in convolution matrix in eqn (20).

2) Output of step 1 is then applied with **Emboss Filter** (Laplacian method based on second derivative operator) to get more refined, thin and better results immune to noise. This even depicts position of pixel (whether in foreground or background) as given in eqn 22.

b) **Edge Linking** is implemented using global method named Hough Transform.

Hough Transform for size calculation:

1. Find all of the desired points in the range
2. For each feature point
3. For each possibility i in the accumulators that passes through the feature point.
4. Increment that position in accumulator
5. Find local maxima in the accumulator
6. If desired map each maxima in the accumulator back to image space.

Above steps are implemented by changing bitmap to bitmap data, locking it and defining scan0, stride for it and rotation of 360,100,100 is given to h,s,i respectively which further checks variance in reference image and given image for R, G, B. This variance is accumulated and changed to centimeters.

$$\text{Size} = \text{variance in terms of no. of pixels} / 13$$

(to change result in cms).

Conversion of variance in terms of size depends on height of camera and the luminosity on the plane of interest

2.3 Weight Approximation

Weight parameter is passed by user in category A-heavy, B-average, C-light. Any one of the switches representing A/B/C which symbolizes weight is passed as input parameter.

2.4 Grading of Fruit

Accumulative sum of results (2.1), (2.2) and (2.3) decides the quality of captured image.

Example of the results:

Weight	Color	Size	Result
A	> 80	6-8 unit	Very good quality
B/C	>80	6-8 unit	Good quality
A	50-80	6-8 unit	Average
B/C	50-80	6-8 unit	Poor
A/B/C	<50	6-8 unit	Average
A/B/C	Any	< 6 unit	Average
A/B/C	< 50	<6 unit	Poor

3. Experimental Evaluation and Discussion

The software of the prototype had been tested using the standard 1.3 Mega pixel camera (of creative make) with suitable hardware i.e. micro controller. The camera is placed at USB port and the controller is interfaced at COM port available at the machine. Initially the standard tests with standard images had been performed. This test helps to check the plotting of the RGB Color in HSI domain and helps to locate the region of interest.

The distributed histogram is obtained from the RGB image under test. The area obtained in the histogram analysis helps us to restrict ourselves in the particular region of histogram if any particular dominance of color is to be checked in the image analysis that helps to make desired selection. The objective of color segmentation for color dominance is achieved which is stated in our problem.

Edge detection plays the vital role for any image processing software, which leads to get location of the object in particular region of the interest under the camera scanning area. The simple edge detection and the laplacian edge detection technique had tried in the system by implementing suitable convolution matrix, the results are overwhelming and the detailed outputs are shown below for the reference. Hough transformation plays the important role in calculating the size of the object in the area of interest. The image scanned (known size) with the camera is put under standard algorithm of Hough transform and we are able to get the approximate size, which is placed under the camera. This even worked successfully as per desired in the starting of the discussion. The various

experimentation outputs are explained in various steps as follows:

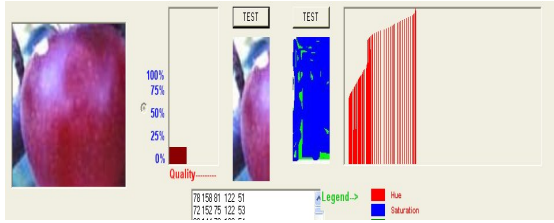


Figure 5: Histogram Analysis of an Apple.

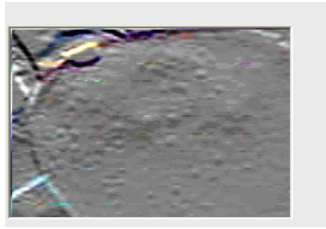


Figure 6: Edge Detection using Prewitt Filter



Figure 7: Edge detection using Emboss Filter

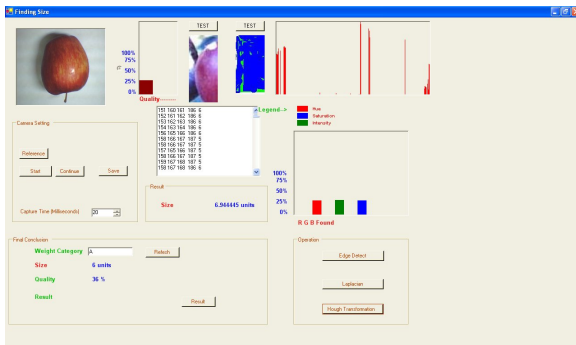


Figure 10: Size Detection using Hough Transform

4. Conclusion

The Algorithm has been designed and implemented for the image segmentation based quality analysis using Hough transform in RGB vector space. In this a new algorithm is proposed and implements the quality analysis. The captured image of the fruit is transformed

from RGB to HSI vector space, which is further utilized for to get the exact color content by plotting its histogram based on hue. The boundary of the image is found using the Edge Detection techniques by operating the same captured image with Prewitt Filter (Gradient based linear special filter) and Emboss Filter (Laplacian based linear special filter). The size of the image is calculated by applying the Hough Transform (a Global Edge Linking technique) and calculating the variance in color of an image in RGB vector space with some pre defined reference. The various algorithms viz. RGB to HSI conversion, Edge detection using Prewitt Filter/Emboss Filter followed by Edge Linking using Hough transform which helps to calculate the size of the image.

The outputs of the software using the stated algorithm are satisfactory when put the apple under test, the size and color outputs are in acceptable limits. Thus, the said algorithm can play an important role in grading, packaging and chopping of fruits in agriculture.

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Model for Predictive Analysis of the Quantity of Water Evaporated during Initial Stage Drying of Wet Clay Designated for Production of Oven Refractory

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Abstract: Model for the predictive analysis of the quantity of water evaporated during drying of clay at a temperature range 80-95°C has been derived. The model “ $E = \text{Antilog } 1.0204 \text{Log}[833/T]$ ” indicates that the quantity of evaporated water during the drying process is dependent on the drying temperature, the evaporating surface being constant. The validity of the model is rooted in the expression $N \text{Log} E = \text{Log}[A/T]$ since both sides of the expression are correspondingly approximately equal to 1. The maximum deviation of the model-predicted quantity of evaporated water from the corresponding experimental value is less than 10% which is quite within the acceptable deviation range of experimental results, hence depicting the usefulness of the model. Water evaporation per unit increase in the drying temperature evaluated from experimental and model-predicted results are 0.1140 and 0.1238 g/°C respectively, indicating proximate agreement. [Researcher. 2009;1(5):69-75]. (ISSN: 1553-9865).

Keywords: Model, Water Evaporation, Drying, Clay.

1. Introduction

It has been reported (Barsoum, 1997) that the contents of the basic clay materials are divided into three groups. The first group involves clays containing mainly the mineral kaolinite. The second groups are clays containing mineral montmorillonite, while the third group is clays which are intermediate product of disintegration of mica into kaolin. Unal (1986) reported that the structure of sinters and pellets may be divided into two parts viz, the mineral and the pores. It was stated that the properties of pellets and sinters are closely related to the mineral constituents.

Furnass (1928) discovered that voids volume in packed dispersed powder depend on the ratio of smallest size (Ss) to largest size (Ls) particle as well as the percentage of constituent monosized particles. It was concluded that the smaller the (Ss/Ls) ratio, the more continuous the distribution and the lower the void volume of the system. Singer and Singer (1963) found that on heating dried clays, water is given off. With time, a hard but porous piece forms. A swollen appearance might occur during the release of some gases, but overall shrinkage must occur when verifications set in leading to a strong dense piece.

Past report (Nwoye, 2005) has shown that chemical composition of the pellet, pelletisation parameters and firing conditions affect the shrinkage of clay pellets. He posited that the rate of chemical reaction is very much dependent on the gas-solid contact area, which is mostly governed by the porosity of the pellet. It was

stated that shrinkage of clay is probably due to volume change resulting from evacuation of water from the voids, reduction of the size of the pores as well as decrease in the interparticle separation.

It has been reported (Viewey and Larrly, 1978) that fine particles shrink more, are denser and exhibit excellent mechanical properties. Further studies (Viewey and Larrly, 1978) carried out to investigate the relationship between particle size and size distribution with linear drying shrinkage, firing shrinkage and apparent porosity shows that no visible relationship exists between particle size and linear drying shrinkage. Based on the discovered fact that finer particles shrink more, Viewey and Larrly (1978) concluded that the finer the particle size, the lesser the apparent porosity and greater the bulk density.

The behaviour of ceramic products has been found to be very dependent on their composition, grain size, grain distribution, structure of grain and pores (Arisa, 1997). Nwoye (2003) also posited that the grain size and grain distribution of the clays have significant effect on their physical and technological properties (binding ability, shrinkage and plasticity).

It has been reported (Barsoum, 1997) that pores are deleterious to the strength of ceramics not only because they reduce cross-sectioned area over which the load is applied but more importantly act as stress concentrators.

Pore deformation mechanism in shrinking Nigeria clays, was studied over a range of heating temperature

from 1000 to 1300⁰C (Nwoye, inpress) The results of the study indicate that pores pre-existing before sintering deformed by the collapsing of the wall surrounding the pores. It was discovered (Nwoye, inpress) that the wall surrounding the pre-existing pores collapsed as a result of the weakening of the clay-binder contact surface and loosening of the macro structure of the formed clays, occasioned by the response of the clay and binder to temperature increase. Nwoye (inpress) also found that binder burn-out which releases gases, elimination of gaseous product of decomposition and oxidation of some clay constituents as well as evaporation of free water between clay and binder particles, all played very vital roles in decreasing the pre-existing interparticle separation hence deforming the pores.

Nwoye (2008) studied the effect of porosity on the shrinkage behavior of clay pellets and briquettes of different porosities. The result of the investigation indicates that shrinkage which is a major cause of rupture in fired clay increased with decrease in porosity. Nwoye (2008) discovered also that the porosity of pellet/briquette plays important role in controlling and determining the shrinkage index of the pellet.

Past report (Reed,1988) has described firing as having three stages through which it proceeds; preliminary reactions which include binder burnout, elimination of gaseous product of decomposition and oxidation, sintering as well as cooling which may include thermal and chemical annealing. Barsoum (1997), Viewey and Larrly(1978) and Keey (1978) have studied the shrinkage of clay during drying. In all these works, porosity has been shown to influence the swelling and shrinkage behaviour of clay products of different geometry. Reed (1988) reported that drying occurs in three stages; increasing rate, constant and decreasing rate. He pointed out that during the increasing rate; evaporation rate is higher than evaporating surface hence more water is lost. At constant rate, the evaporation rate and evaporation surface are constant. The researcher posited that shrinkage occurs at this stage. In a similar study, Keey (1978) suggested that at this stage, free water is removed between the particles and the inter-particle separation decreases, resulting in shrinkage. During the decreasing rate, particles make contacts as water is removed, which causes shrinkage to cease.

Nwoye (2008) derived a model for calculating the volume shrinkage resulting from the initial air-drying of wet clay. The model;

$$\theta = \gamma^3 - 3\gamma^2 + 3\gamma \quad (1)$$

calculates the volume shrinkage when the value of dried shrinkage γ , experienced during air-drying of wet clays is known. The model was found to be third-order polynomial in nature. Olokoro clay was found to have the highest shrinkage during the air drying condition, followed by Ukpor clay while Otamiri clay has the lowest shrinkage. Volume shrinkage was discovered to increase with increase in dried shrinkage until maximum volume shrinkage was reached, hence a direct relationship.

Model for the evaluation of overall volume shrinkage in molded clay products (from initial air-drying stage to completion of firing at a temperature of 1200⁰C) has been derived by Nwoye et al. (2008). It was observed that the overall volume shrinkage values predicted by the model were in agreement with those calculated using conventional equations. The model;

$$S_T = \alpha^3 + \gamma^3 - 3(\alpha^2 + \gamma^2) + 3(\alpha + \gamma) \quad (2)$$

depends on direct values of the dried γ and fired shrinkage α for its precision. Overall volume shrinkage was found to increase with increase in dried and fired shrinkages until overall volume shrinkage reaches maximum.

Nwoye (2009a) derived a model for calculating the quantity of water lost by evaporation during oven drying of clay at 90⁰C. The model;

$$\gamma = \exp[(\ln t)^{1.0638} - 2.9206] \quad (3)$$

indicated that the quantity of evaporated water, γ during the drying process is dependent on the drying time t , the evaporating surface being constant. The validity of the model was found to be rooted in the expression $(\text{Log}\beta + \ln\gamma)^N = \ln t$.

Nwoye (2009b) derived a model for predictive analysis of the quantity of water evaporated during the primary-stage processing of a bioceramic material sourced from kaolin. The model;

$$\alpha = e^{(\ln t / 2.1992)} \quad (4)$$

indicates that the quantity of water α , evaporated at 110⁰C, during the drying process is also dependent on the drying time t , where the evaporating surface is constant. It was found that the validity of the model is rooted on the expression $(\ln t / \ln \alpha)^N = \text{Log}\beta$ where both sides of the expression are correspondingly approximately equal to 3. The respective deviation of the model-predicted quantity of evaporated water from the corresponding experimental value was found to be less than 22% which is quite within the acceptable deviation range of experimental results.

Model for quantifying the extent and magnitude of

water evaporated during time dependent drying of clay has been derived (Nwoye et al., 2009). The model:

$$\gamma = \exp((\ln t / 2.9206)^{1.4}) \quad (5)$$

indicates that the quantity of evaporated water γ during the drying process (at 90°C) is dependent on the drying time, t the evaporating surface being constant. It was found that the validity of the model is rooted in the expression $\ln \gamma = (\ln t / \text{Log} \beta)^N$ where both sides of the expression are correspondingly almost equal.

The present work is to derive a model for predictive analysis of the quantity of water evaporated during initial stage drying of wet clay designated for production of oven refractory. The clay mined at Otamiri (Nigeria) was processed into a wet rectangular block of brick and dried (in the oven) for 130 minutes at a temperature range 80-95°C.

Table 1: Variation of quantity of evaporated water with drying temperature [17].

E	A	T(°C)
10.00	833	80
9.45	833	85
9.11	833	88
8.86	833	90
9.60	833	95

2. Model formulation

Model formulation was achieved using experimental data derived in previous work (Nwoye, 2007) as shown in Table 1. Computational analysis of these data (Nwoye, 2007), gave rise to Table 2 which indicate that;

$$N \text{Log} E = \text{Log} [A/T] \quad (\text{approximately}) \quad (6)$$

$$\text{Log} E = \left[\frac{\text{Log}[A/T]}{N} \right] \quad (7)$$

Introducing the values of A and N into equation (7) and evaluating further

$$\text{Log} E = \left[\frac{\text{Log}[833/T]}{0.98} \right] \quad (8)$$

$$\text{Log} E = 1.0204 \text{Log}[833/T] \quad (9)$$

$$E = \text{Antilog} \left[1.0204 \text{Log}[833/T] \right] \quad (10)$$

Where

E = Weight of water lost by evaporation during the drying process (g)

A = Area of evaporating surface (mm²)

N = 0.98; (Collapsibility coefficient of binder-clay particle boundary at the drying temperature range of 80 - 95°C) determined in the experiment (Nwoye, 2007).

T = Drying temperature (°C)

Equation (10) is the derived model

3. Boundary and Initial Conditions

A rectangular shaped clay product of length 49 mm, width 17 mm, and breadth 9mm exposed to drying in the furnace while it was in wet condition was considered. Initially, atmospheric levels of oxygen are assumed. Atmospheric pressure was assumed to be acting on the clay samples during the drying process (since the furnace was not air-tight). The grain size of clay particles used was 425 μm, weight of clay and binder (bentonite) used (for each rectangular product); 100 g and 10 g respectively, quantity of water used for mixing; 6% (of total weight), range of drying temperatures used; 80-95°C, area of evaporating surface; 833mm² and drying time used (130 mins.).

The boundary conditions were: atmospheric levels of oxygen at the top and bottom of the clay samples since they were dried under the atmospheric condition. No external force due to compression or tension was applied to the drying clays. The sides of the particles and the rectangular shaped clay products were taken to be symmetries.

4. Model Validation

The formulated model was validated by direct analysis and comparison of the model-predicted E values and those from the experiment for equality or near equality.

Analysis and comparison between these E values revealed deviations of model-predicted E from those of the experimental values. This was believed to be due to the fact that the surface properties of the clay and the physiochemical interactions between the clay and binder, which were found to have played vital role during the evaporation process were not considered during the model formulation. This necessitated the introduction of correction factor, to bring the model-predicted E value to that of the corresponding experimental value.

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

$$Dv = \left[\frac{Pw - Ew}{Ew} \right] \times 100 \quad (11)$$

E_w

Where

P_w = Quantity of water evaporated as predicted by model (g)

E_w = Quantity of water evaporated as obtained from experiment (g) (Nwoye,2007)

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

$$Cf = -Dv \quad (12)$$

Therefore

$$Cf = -100 \left(\frac{P_w - E_w}{E_w} \right) \quad (13)$$

Introduction of the value of Cf from equation (13) into the model gives exactly the corresponding experimental value of E (Nwoye, 2007).

5. Results and Discussion

Results of the model derivation shows that the validity of the model is rooted in the expression $NLogE=Log[A/T]$ where both sides of the expression are correspondingly approximately equal to 1. Table 2 also agrees with equation (6) following the values of $NLogE=Log [A/T]$ evaluated from Table 1 as a result of the corresponding computational analysis.

Table 2: Variation of $NLogE$ with $Log[A/T]$

LogE	NLogE	A/T	Log[A/T]
1.0000	0.9800	10.4125	1.0176
0.9754	0.9559	9.8000	0.9912
0.9597	0.9403	9.4659	0.9762
0.9474	0.9285	9.2556	0.9664
0.9823	0.9626	8.7684	0.9429

Evaporation per unit increase in drying temperature

Water evaporated per unit increase in temperature resulting from drying of the clay at a temperature range 80-95°C was determined following comparison of the evaporation per unit increase in temperature obtained by calculations involving experimental results, and model-predicted results obtained directly from the model. Evaporation per unit

rise in the drying temperature, E_d (g/°C) was calculated from the equation;

$$E_d = E/T \quad (14)$$

Therefore, a plot of mass of water evaporated E against drying temperature T, as in Fig. 1 using experimental results in Table 1, gives a slope, S at points (10.0, 80) and (8.86, 90) following their substitution into the mathematical expression;

$$S = \Delta E/\Delta T \quad (15)$$

Eqn. (15) is detailed as

$$S = E_2 - E_1 / T_2 - T_1 \quad (16)$$

Where

ΔE = Change in the quantities of water evaporated E_2, E_1 at two drying temperature values T_2, T_1 . Considering the points (10.0, 80) and (8.86, 90) for (E_1, T_1) and (E_2, T_2) respectively, and substituting them into eqn. (16), gives the slope as $-0.1140g/°C$ which is the quantity of water evaporated per unit increase in the drying temperature during the actual experimental drying process.

Also similar plot (as in Fig. 2) using model-predicted results gives a slope. Considering points (10.9234, 80) and (9.6853, 90) for (E_1, T_1) and (E_2, T_2) respectively and substituting them into eqn. (16) gives the value of slope, S as $-0.1238g/°C$. This is the model-predicted quantity of water evaporated per unit increase in the drying temperature during the drying of the clay. The negative sign preceding both 0.1140 and 0.1238 is not part of the values of the quantities of water evaporated per unit increase in the drying temperature as obtained from the experiment (Nwoye,2007) and derived model but indicative of the inverse relationship between the quantity of water evaporated and the drying temperature as obtained in the experiment (Nwoye,2007) and the derived model which resulted to negative slopes. A comparison of these two quantities of water evaporated per unit increase in the drying temperature shows proximate agreement. This indicates a very high degree of validity for the model as a reliable tool for predicting the quantity of water evaporated as well as the evaporation per unit increase in the drying temperature during drying of Otamiri clay at a temperature range 80-95°C.

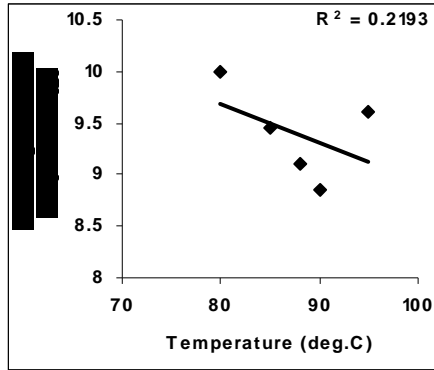


Fig. 1 Effect of drying temperature on the quantity of water evaporated as obtained from the experiment (Nwoye, 2007)

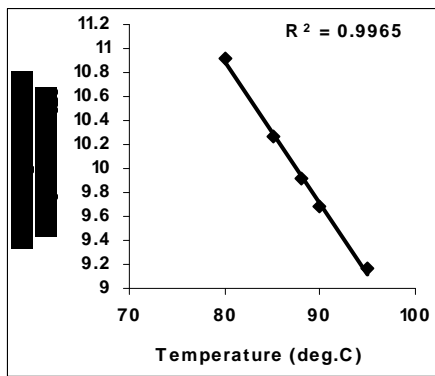


Fig. 2 Effect of drying temperature on the quantity of water evaporated as obtained from the derived model.

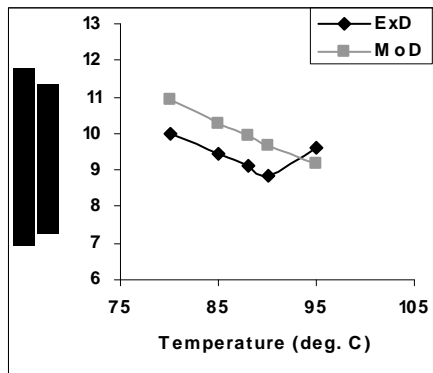


Fig. 3 Comparison of the quantities of water evaporated per unit rise in the drying temperatures as obtained from experiment (Nwoye, 2007) and derived model.

An ideal comparison of the quantities of water evaporated per unit increase in the drying temperature 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;

$$R = \sqrt{R^2} \quad (17)$$

using the r-squared values (coefficient of determination) from Figs.1 and 2 show a better correlation (0.9965) with model-predicted quantity of water evaporated per unit increase in the drying temperature than that obtained from experiment (0.2193). This suggests that the model predicts more accurate, reliable and ideal quantity of evaporated water than the actual experiment despite its deviations from experimental values. Fig. 3 shows that values of E obtained from the experiment and those from the model are generally quite close hence depicting the reliability and validity of the model. However, Fig.3 shows that the quantities of water evaporated per unit rise in the drying temperature as obtained from the experiment (Nwoye,2007), designated by the line ExD and as predicted by the model (line MoD) are in very good agreement within a drying temperature range 80-95°C. This implies that the model is most accurate with respect to the experimental data within the temperature range.

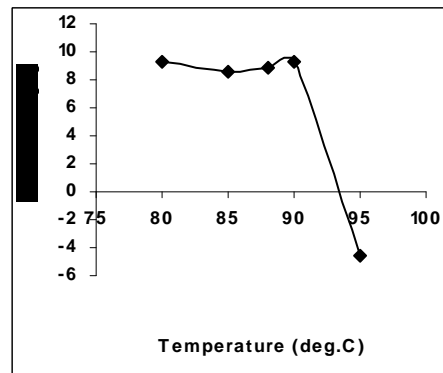


Fig. 4 Variation of deviation (from experimental values) of model-predicted quantity of water evaporated with drying temperature.

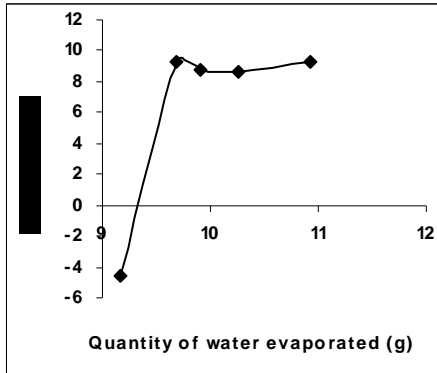


Fig. 5 Variation of deviation (from experimental values) of model-predicted quantity of water evaporated with actual quantity of water evaporated.

Effect of drying temperature on the deviation (from experimental values) of model-predicted quantity of water evaporated

It was found that the validity of the model is rooted in the expression $NLogE = Log[A/T]$ where both sides of the expression are correspondingly approximately equal to 1. Table 2 also agrees with equation (6) following the values of $NLogE = Log[A/T]$ evaluated from Table 1 as a result of the corresponding computational analysis. The respective deviation of the model-predicted quantity of evaporated water from the corresponding experimental value is less than 10% 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 quantity of water evaporated) from actual experimental values show a slight undulating

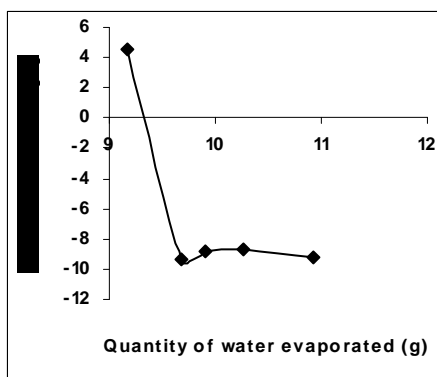


Fig. 6 Variation of correction factor (to the model-predicted quantity of water evaporated) with the actual quantity of evaporated water predicted by the model.

relationship with the drying temperature which became distinct between 88 and 95°C (in Fig. 4). Fig. 4 indicates that the highest and least deviations are 9.31 and -4.53% respectively corresponds to the drying temperatures 90 and 95°C respectively. Comparison of Figs. 2-5 shows that these percent deviations also correspond to the quantities of evaporated water 9.6853 and 9.1651 g respectively as predicted by the model. Fig.5 shows that the relationship between deviation (from experimental values) of model-predicted quantity of water evaporated and the quantity of water evaporated is also undulating between evaporated water mass of 9.1651 and 9.9109 g.

Effect of drying temperature on the correction factor to model-predicted quantity of water evaporated

Fig. 6 shows that correction factor to the model-predicted quantity of water evaporated also has an undulating relationship with the quantity of water evaporated between evaporated water mass of 9.1651 and 9.9109g. However, comparison of Figs.4-5 shows that the orientation of the curve of the correction factor against the quantity of water evaporated is opposite that of the deviation against quantity of water evaporated. This is attributed to the fact that correction factor is the negative of the deviation as shown in eqns. (12) and (13). It is believed that the correction factor takes care of the effects of the surface properties of the clay and physiochemical interaction between the clay and the binder which (affected experimental results) were not considered during the model formulation.

6. Conclusion

The model predicts the quantity of water evaporated during oven drying of Otamiri (Nigeria) clay at a temperature range 80-95°C. The validity of the model is rooted in the expression $NLogE = Log[A/T]$ where both sides of the expression are correspondingly approximately equal to 1. The maximum deviation of the model-predicted quantity of evaporated water from the corresponding experimental value is less than 10% which is quite within the acceptable deviation range of experimental results. Water evaporation per unit increase in the drying temperature evaluated from experimental and model-predicted results are 0.1140 and 0.1238g/°C respectively, indicating proximate agreement.

Further works should incorporate more process parameters into the model with the aim of reducing the deviations of the model-predicted E values from those of the experimental.

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Reproductive behaviour of wild Asian Elephants *Elephas maximus* in the Rajaji National Park, North-West India

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Abstract: The breeding behaviour of Asian Elephant (*Elephas maximus*) in the Rajaji National Park was studied during 2000-2007. Despite, the status, movement pattern, habitat utilization, feeding behaviour and man-elephant conflict, extremely rare research work has been carried out on its reproductive behaviour in the wild. During the recent past most of the wildlife corridors in the Rajaji National Park area through which elephant performs their long-term migration between Rajaji to Corbett National Park has been shrunked, which has affected the breeding performances along with genetic exchange between the elephants of different protected areas. Direct observation method was followed for conducting this study and study findings have wider implications for developing predictive models of Asian elephant conservation. Mixing of the adult bulls, selection of prospective partner to mate, smelling of genital organ and discharge of urine were few of the major features of mating behaviour in elephants. Generally 15 – 20 days were required for completion of mating process but if the environmental conditions were unfavourable it was completed by a month. The duration of coitus was observed to be 3-4 minutes, which largely depends upon presence of group members and cooperation of the prospective cow. Breeding season in Rajaji National Park was noted to be extending maximum from May to November, which through embraces the hot, rainy and beginning of cold seasons but largely the warm period. Musth phenomenon in adult male elephants was mostly observed during February to July, which was dominated by dry period. High level of parental care was also observed in elephants and serious bullfights were the attempts of mating needs. Presently large scale developmental and anthropogenic activities are responsible for habitat deterioration in this area and hence, continued protection of the Asian elephant is of paramount importance for the global conservation of this endangered species [Researcher. 2009;1(5):76-84]. (ISSN: 1553-9865).

Keywords: elephant; *Elephas maximus*, reproductive behaviour; Rajaji National Park; musth; north-west India

1. Introduction

The behaviour of wild animals is presently a subject matter of great interest leading to understanding about the nature of various wild animals, which may be helpful in their management and conservation. Behaviour of Asian elephants (*Elephas maximus*) particularly in domesticated form provide lot of recreation to the human beings and easy to understand. However, the behaviour of wild elephants is a tough task to be observed and studied in wild especially in foothills dominant areas. The Shivalik foothills (lesser Himalayan zone) are one of the world's most spectacular landscapes, encompassing the tall grasslands and the *Shorea robusta* (Sal) forests. India has between 21,000 and 25,000 Asian elephants (*Elephas maximus*) in the wild and among them Uttarakhand state harbours 1346 elephants distributed within 14 protected areas. India currently has the largest surviving population of the Asian elephant,

approximately 50 % of the total world population of the species^[1]. A number of wildlife habitats have undergone or are being threatened with fragmentation due to various anthropogenic factors and this has adversely affected the large mammal populations residing in them^[2]. Recently, developmental activities and habitat destruction have caused major decline in the abundance of the terrestrial megafauna. As most of the wild animals are presently categorized under threatened category therefore, there is increasing concern that the area-wise decline of the elephant will have unexpected and grave consequences for the long-term viability of the terrestrial ecosystems.

The Rajaji National Park was established to enhance the long-term survival of the Asian elephant in a sub tropical moist deciduous forest in India. But during the recent past natural continuous forest ranges of India has been broken up into many parts due to agriculture, urbanization, increasing road traffic and

development related activities as well as other anthropogenic activities. This situation creates many problems for various organisms living in forests especially for large size mammals like elephant. Genetic isolation, limitation of dispersal, migration and the decline of populations of animals requiring large territories are the most common problems connected with fragmentation of forests and other components of the environment.

Shivalik landscape (lesser Himalayan zone) is one of the last few places in the world where elephants exist and offers urgent need for conservation. From conservation point of view Rajaji National Park appears to be India's one of the most successful national park and its management has helped to boost the population of Asian elephant in their natural habitat. Before the Gujjar rehabilitation programme elephants must scarify the feeding grounds in order to feed on the short grasses due to domestic buffaloes being grazed^[3].

Several research studies on the breeding biology of African elephant (*Loxodonta africana*) were conducted during the recent past but only few studies has been carried out on the behavioural biology of wild Asian elephants. In recent years, due to dwindling of forest areas only few protected areas are available for wild elephants where they can be observed in their natural habitat performing their usual activities and different behaviours. The status of the elephant in the adjoining countries is equally poor. Nepal, which has the lowest country population, has lost over 80% of its elephant habitat on account of human settlement. Bangladesh, Myanmar, Cambodia, Vietnam, Laos and Sri Lanka are also losing rapidly the natural forest cover, specially the elephant habitats. In Thailand in spite of the elephant having been a protected species since the 18th century, over exploitation of the habitat and the pressure of human population has made the species highly vulnerable^[1].

The major objective of the present study was to document the reproductive behaviours of wild elephants. The present study was a part of our long term study on the behaviour of Asian elephant in sub tropical moist deciduous forests of north-west India.

2. Methods

2.1 Study Area

Rajaji National Park [29° 15' to 30° 31' North Latitude, 77° 52' to 78° 22' East Longitude] is spread over an area of 820.42 Km² in and around the Shivalik foothills, which lies in the lesser Himalayas and the upper Gangetic plains (Figure 1). Rajaji National Park (RNP) was notified in 1983 by amalgamating three erstwhile wildlife sanctuaries namely, Rajaji, Chilla and Motichur. Spread across Hardwar, Dehradun and Pauri districts of Uttarakhand state, Rajaji National Park has

been designated as a reserved area for the "Project Elephant" by the Ministry of Environment and Forests, Government of India with the sole aim of maintaining the viable population of Asian elephants in their natural habitat. The Shivalik foothills offer the most prominent geomorphic features of this tract. The river Ganges has cut across these hills at Hardwar. The Chilla forest area of the RNP lies in the east of the river Ganges and is attached by the Garhwal Forest Division. The study was conducted in Chilla (District-Pauri) forest range of the RNP. Besides, Laldhang forest range (Lansdowne forest division, LFD), Shyampur and Chiriapur forest ranges (Hardwar forest division, HFD) were also included in this study. The altitude lies between 302-1000 m asl.

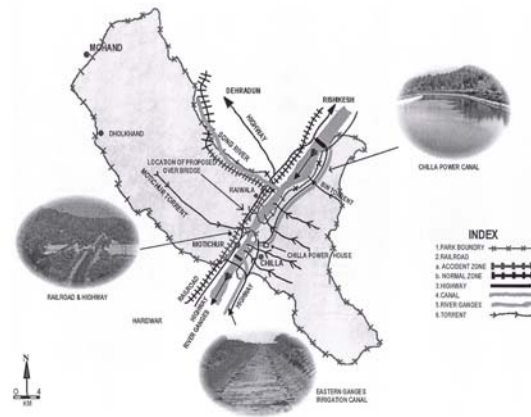


Fig. 1. Map of the study area

This protected area in India's lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of *Shorea robusta* (Sal), *Mallotus philippinensis* (Rohini), *Acacia catechu* (Khair), *Adina cordifolia* (Haldu), *Terminalia bellirica* (Bahera), *Ficus bengalensis* (Bar) and *Dalbergia sissoo* (Shisham) in its premise besides many other important fodder plant species. This entire belt is natural home of Asian elephants (*Elephas maximus*) besides many other wild animals like *Panthera tigris* (tiger), *Panthera pardus* (leopard), *Melursus ursinus* (Sloth bear), *Hyaena hyaena* (Hyaena), *Muntiacus muntjak* (Barking deer), *Axis axis* (Spotted deer), *Cervous unicolor* (Sambhar), *Sus scrofa* (Wild boar) and *Ophiophagus hannah* (King cobra).

2.2 Data Collection

For assessing the reproductive behaviour of elephant's four forest ranges (Chilla, Shyampur, Chiriapur and Laldhang) of the RNP, HFD and LFD were selected and in-depthly surveyed. All the field observations were made during 2000 to 2007. It was not possible to observe the elephants during monsoon as most of the areas are dominated with tall grasses and dry period was the best time to observe the elephants

especially near to water sources. The study area was visited at weekly intervals during which observations on elephants were made along the motorable forest track, present in between different forest habitats. Few other connected rough routes, which link the grassland habitat with motorable road were also used during the course of study. As few forest beats of the study area does not comprises of any road, therefore, study was made on foot. Although some animals were observed up to a maximum distance of 100 meter, most of the observations fell within 50 meter. Besides, all the potential habitats (water dominant areas, cool shaded areas, fodder enriched areas and rough forest routes) were also investigated on foot during early morning, mid-day and evening hours. Cool shaded trees like *Ficus bengalensis*, *Adina cordifolia* and *Ficus glomerata* and dense forest of *Mallotus philippinensis* and other favourite fodder species were examined mostly during mid day (March-June) hours as elephants generally take rest under these cover. Whereas all the water sources (perennial/annual) were investigated alternatively during evening hours.

As the elephants in RNP have been known to emerge from the forest predominantly during evenings, all sightings of elephants were made between 1500 hours and 1900 hours. Besides, observations were also done during early morning hours (0600 hours to 10 hours). Different forest blocks of concerned forest ranges were selected one after another sequentially and searched for elephants for about 10 – 12 hours (depending upon weather conditions) in a single day search. The observations started at early hours in the morning being the best time to search and observe the elephant in open areas and four hours in the afternoon i.e. before the sunset. The data collected was as part of the animal monitoring activities and the daily record was based on direct sighting of animals, indirect evidences like feeding sign, footprints impression time and fresh dung piles. The direct sighting were noted in duly prepared proforma, recording the Herd composition, age and sex, if observed in Herds and also the place of sighting, time and vegetation type. Besides, villagers of adjoining areas, Gujjars (where available), staff of forest department, the researchers from various scientific institutions and non-government organizations and other individuals working on this problem, were also interviewed. Field binocular was also used for observing their mating without disturbing the animal from an adequate and safe distance.

Identification of the elephants was important to verify their movement as in the same area there was a possibility that the same Herd was observed in the different forest beats. Therefore, distinctive features, with certain identification marks of individual elephants were noted like; shape of the ears, tusk size and shape, scars and tubercles on the body, tail length, total number

of individuals (all ages separately), body mass and nature of herd or solitary bull.

3. Results

Elephant is a highly social animal with group instinct and generally one group consists of 5 to 15 individuals, which comprises of adult cows, sub adult cows, juveniles and calves (newly born). Adult bull elephants are rarely seen within any group, they were observed to join the groups for only breeding purposes. Adult bull elephants prefer solitary life and they utilize wide range of feeding grounds and move more as compared to groups. As RNP area falls under sub tropical moist deciduous forest type; therefore, feeding and breeding parameters are dependent on availability of natural food and water. Several studies have conducted on the breeding habits of elephants but still little is known about the actual breeding biology of Asian elephants in the wild.

3.1 Mating behaviour

Like many other animals elephants also show the phenomenon of love play, which includes mixing of bull elephants in the groups, selecting prospective partner to mate, smelling of genital organs, sniffing the urine and dung, touching the trunk especially temporal gland and discharge of urine. The whole process was observed to happen within 15-20 days but sometimes it also took one month if environmental conditions are unfavourable (scarcity of fodder and water and high rate of movements). Sometime it was also observed that the adult cow within a group does not accept the bulls in their groups, at that time groups produce loud noise and reflects their weirdness. Long duration of love play and secretion of urine are important factors, which promotes the successful mating. The males are capable of making a second crossing after about 45 minutes and may do the copulation act 4 to 5 times a day^[2].



Fig. 2. Elephants during coitus at Chilla forest of the Rajaji National Park

The duration of coitus was observed to be 3-4 minutes depending upon presence of group members and cooperation of the cow elephant. The contact promoting was important factor, which includes separation from groups and mounting of bull elephant but several times false mating were also occurred, which expands the conception duration. The total time required for love play and actual act may take one or two hours. In younger bulls, which are afraid of grown up leaders, the whole act may be brisk and is completed in a short period^[2]. When cow comes under heat, exhibits her approval for the conception and at the same time both of them respond equally towards each other and the process of smelling of genital organ by male was observed to be quite frequent. As per the observations of the study it was not compulsory that the bulls, which are in musth condition only exhibits healthy sexual contacts, mating bulls are often observed to have no signs of musth phenomenon, besides the fact that the bulls those are in musth are quite aggressive then those who do not exhibits the phenomenon of musth and can dominate over other males.

Mating was observed mostly inside the dense forest zones especially in those areas, which are enriched with water (Fig 2). Whenever the mating process was completed (10 to 15 days) bull elephants leave the group and starts to live solitary life. Longer stay of bull elephants with a group was also observed during the study period but at the same time they also leaved the group for a short period of time to perform movement on a wide range as the group movement was always restricted to some extent (03 kilometers). Examinations of genital organ with trunk, hugging, touching of temporal region of males and sniffing the dung are important pre-contact promoting behaviours of male and female elephants^[3].

3.2 Breeding season

Most of the newborn calves were observed during January to May, which corresponds to the wet as well as dry season. The gestation period in Asian elephants varies from 18 to 23 months and if an average value of twenty months is taken as the gestation period, then the breeding season seems to be maximum to extend from May to November, which through embraces the hot, rainy and beginning of cold seasons, but can be taken up by and large as - warm period. On the basis of these observations, it would appear that there are some particular months of breeding. The important ultimate factors that influence the animal's reproductive cycle are probably the seasonal availability of food and water^[4]. Since, there is never any extreme shortage of food in RNP area therefore; the breeding season of elephant's was never so pronounced and drastic. Numerous

perennial and seasonal rivers and streams further ensure the yearlong availability of fresh water.

It was also observed during the study period that in few of the places, elephants utilize the same feeding grounds round the year (recognised groups). Elephants inter-change the forests of Rajaji and Corbett National Park as their part of traditional migration. But presently in few of the areas their traditional feeding grounds and corridors are denied to them, which have causes man–elephant conflict. The long-term effects will include genetic isolation, habitat fragmentation within the same forest and enhancement in the human–elephant conflict in adjoining areas. Genetic isolation of elephant populations may also increase the chances of replacement of interbreeding to intrabreeding, and thereby reduce the population persistence even for wide ranging wildlife species^[5]. Kotdwar – Lansdowne road runs parallel to the river Kho and crosses the Rajaji-Corbett corridor, the major movement track of northwestern elephant population between the Yamuna and river Sharda. This road serves as the major transport link between Pauri town and Kotdwar area. The presence of traffic on the road, construction of steep retaining walls and the presence of human population along the entire corridor area have almost restricted the migration of elephants^[6].

3.3 Musth phenomenon

The subject of 'musth' in elephants has for many years been of much controversy among various elephant workers. The exact biological purposes of 'musth' are still unknown. The subject of sex in elephants is one, which evokes curiosity and surprise, since, for a long period there was very little accurate information^[2]. Male Asian elephants show periodically the phenomenon of musth, which is characterized by enlargement and discharge of the temporal glands (Fig 3). This gland is a paired organ found on either side of the head, located just beneath the skin in the subcutaneous fascia, above the zygomatic arch. During the musth period the gland gets enlarged and few of the silent morphological features could be seen frequently in adult males like discharge of the temporal gland secretion, excessive bulging out of the perennial part, frequent erection of penis as well as dribbling of urine. All healthy males will exhibit musth over 20-25 years and the duration ranges from 3 weeks to 3 months^[7]. Few of the adult bulls were recognized to be in musth during the study period in late winters and in peak summer. As per the field observation it seems that majority of such cases were met especially from February to July, which are predominance by dry period. At that time they are quite aggressive and destructive and frequently release loud noise and their trumpeting was quite frequent.



Fig. 3. A bull elephant in musth



Fig. 4. A newly born (02 hours old) elephant calf at Rajaji National Park.

3.4 Parental care

Elephants are highly social animals and show parental care behaviour. Newly born babies are kept under high care by their elder ones for about 10 to 15 years and the mother nurses and suckle the calf beyond 2 to 3 years (Fig 4). At the same time calf started to feed on smooth vegetation under the care of their elders. When the male elephant has attained the age of 16, they prefer solitary life and separates from the herd. All the members within a group exhibit an equal responsibility to care the newly born infants but adult cow elephants are more careful towards calves as compared to bull elephants. Once an elephant herd marched to the lake with a baby elephant, which was almost motionless, virtually lifted by the mother and another cow elephant. There are many incidents of such type, which were observed during the study period. It was also observed that any herd when feeding, spreads within 50-100 meters (depending on herd size) and at that time adult bull separates from herd but the calves move with their elder one (adult cows or sub-adult cows). Calves also sometimes show play behaviour, when they are in water, they splash mud and play by entangling their trunk with other. Similarly, When calves fed or bath and when they are crossing any water stream, their elder ones are too much careful of them.

3.5 Bull fights

Serious fights, which are a rare occurrence, are conducted with tremendous vigor. These fights consist of a series of head rams where by the tusks clash and the trunks wrap around each other (Fig. 5). Several times these fights were observed during the course of study. Serious fights were accounted highest for Chilla (2002) followed by Shyampur (2004) and Barkot (2006) whereas two major fights, one in 1999 and another in 2007 were also observed during the field observations but both of these were result less.

Tremendous trumpeting was observed during such incidences and sometimes tusks have played the major role in killing one of the combatants through penetrating the elephant. Elephants' fight could be continues till death of anyone of them or until one of them ran away. Tusks are often broken during elephant fight, revealing how much energy was involved. Male-male aggression were also denoted by several workers and called them as "pseudo fights". The aggression is basically for the mating purpose, besides few other biological requirements like joining of group and feeding.

4. Discussion

During the recent past extensive work has been carried out on the movement pattern, habitat utilization and feeding biology of Asian elephants^[1,5,8,9,10] but the work on its behavioural biology has remained neglected. Therefore, less information is available in relation to behavioural pattern of elephants in the wild. The adult / sub-adult (excluding solitary sub-adult bulls) sex-ratio of the elephants in Hardwar, Chilla and Motichur forest ranges of the RNP was 100 females : 22.4 males, which was a good elephant population along with ratio 1 : 4.4 (male: female)^[11]. Apparently it shows a very good sexual ratio, however, under field conditions, it is impossible to represent the accurate sex ratio especially in sub tropical forests, which are having dense vegetation cover and continuous undulating foothills in its regime.

The age at which elephant's attained sexual maturity was the matter of affair and depends often on the nutrition that is available to them. In many mammals the puberty and maintenance of fertility are influenced by growth rate and conditions^[12]. Among the elephants the ability to breed depends not only on the attainment of a minimum critical body weight but more importantly, on the size and their relative position in the social hierarchy. In the Asian elephant, the young male

may reach sexual maturity as early as 7 or 8 years^[13]. The female cow reached of age for breeding when they are 12 to 14 years old and adult males get mature when they are 14 to 15 years old. Rare exceptions are also there in their mating processes^[2].

Rainfall is another major factor, which influence the breeding behaviour in elephants and rainfall by stimulating the new growth of forest cover could influence the breeding performance by raising the plane of nutrition. There is a definite correlation between the rainfall and the timing in conception, which is more pronounced as one move away from the equator, and the rainy seasons become more pronounced^[14]. The courting is another long drawn-out process, which may last for days, weeks or months. During the contact promoting and pre-copulatory processes, besides mutual smelling of genital organs bull elephant also follow the prospective cow (within a group) for a short period. It was also observed during the present investigation that courtship might occur either within or away from the herd.



Fig. 5. Bull Fight at Mundal forest

As pregnancy advances, the females may be observed to remain slightly away from the herd and avoids climbing on high hills. Its movements become comparatively slower and urinate frequently. Such a female maintains a distance from the advances of other eligible males and demonstrates defensive behaviour keeping her ears low and tail tucked in between her hind legs^[15]. Such incident was also observed in Kharkhari forest beat of Hardwar forest range and Khara forest beat of the Chilla forest where the pregnant cow was observed often moving at some distance from the herd and also feeding separately on the rich nutritious fodder species, but occasionally the cow also made her to re-group the herd. When the time of delivery advances the cow elephant becomes very restless and shows signs of suffering from a motionless pain. Discharge from the vaginal organ and slowly releasing milk from her tits

(when cow attained final pregnancy stage) are common symptoms observed.

The breeding season from June to September, which corresponds to the dry season was observed in Way Kambas Game Reserve^[8]. Elephants do not have breeding season and cow elephants have an oestrus cycle of 20-27 days with a mean of 22 days, whereas gestation period is 18 to 22 months^[7]. In the present study breeding was observed to extend from May to November, which though embraces the hot, rainy and beginning of cold season. The breeding season was observed to be rainy season in Way Kambas Game Reserve, Sumatra^[8], but it is just opposite in Ruhuna National Park in Sri Lanka where births were confined to the wet season, while breeding took place in the dry season^[16]. This may be due to the fact that Way Kambas Game Reserve and Ruhuna National Park are located on to the south and north of the equator, respectively and so changes in the reproductive pattern may be linked to their relative geographic positions. Reproductive performance was known to vary with age, season, locality, population density and plane of nutrition^[14].

The gestation period might vary from 17 to 23 months on account of several reasons. Since in elephants males are carried longer and are heavier at birth than the female, therefore, number of births also depends upon sex^[15]. The hereditary factors also influence the length of gestation besides environmental factors probably also contributes to variation. However, this represents merely a stage in physiological maturity. The sociological maturity that refers to the animal's ability to compete with others for oestrus females may take much longer time – upto 17 or 18 years^[3,13,17]. Likewise, females may reach sexual maturity as early as 7 years of age under a high plane of nutrition, while sexual maturity could be delayed until 10 years or more if the animals are living in less productive marginal habitats. The reproductive performance of the females falls off sharply by the time they are about 50 years of age, whereas this is equivalent to the human menopause and the associated selection for survival of grand mothers, who help in the care of the young one and there by reduce infant mortality^[18].

The birth-spot is normally selected closer to the water source and was generally nearer to the grassy patch. The size of the birth-spot was variable depending upon the size of the herd and constant paddling of the elephants makes this spot quite smooth. During the period of delivery the spot was well guarded by all the members of the herd, including the adult males. Normally, one calf was born at a time but twins are also known. The calf was able to stand on its legs within an hour, but the herd with the new born baby will continue to stay in the area for two to three days, probably the time required for the newborn calf for able movement. Trunk plays a major role in upliftment, touching and

shifting of the new borne calf and the mother was extremely protective to her young one and during the first few weeks, keeps it quite near or directly under her belly as she walks about. The mother suckles the calf at an interval of every 15-20 minutes during the first fortnight^[15].

Whenever the group was moving, the infants also tend to remain very close to their mothers and, if any disturbance was there, the adults form a group with the infants in the center. At such times, the infants are frequently restrained from straying by the adults, who will extend their trunks around an infant that was about to move away and pull it back. In a group containing infants, there are frequently more adult females than infants. In such instances, all females appear to share equally in the care of the young one. Whenever the group of females was feeding in a relatively stationary position, older infants frequently stray from them and indulge in fairly extensive play behaviour^[19]. Since the habitat of the elephants has been shrinking rapidly and also been fragmented, there was no mating between the elephants of different herds within different protected habitats.

Feeding and breeding are the most important ecological factors, which are directly linked with the survival of any species. The RNP represents one of the important sub-tropical moist deciduous protected area for elephants in north-west India. At present, observations from this study indicated that the elephant population is below the park carrying capacity since there are no obvious signs of any over utilization and habitat deterioration. The long-term survival of elephants and the viability of the park itself as a self sustaining eco-system would depend very much on wise management practices that incorporate both socio-economic as well as ecological considerations.

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Model for Predictive Analysis of the Shrinkage Sustained in Fired Clay Materials Relative to the Resultant Fired Bulk Density

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Abstract: Model for predictive analysis of the shrinkage sustained in fired clay materials relative to its fired bulk density has been derived. These materials were prepared using different grain sizes; <100µm, 100-300µm, 300-1000 µm and their respective mixtures. The derived model;

$$S = \left[\exp(e^\gamma) \right]^{0.9615}$$

was found to be dependent on the resultant bulk density of the clay body following firing at a temperature of 1200°C. The validity of the model is rooted on the expression; $\ln[(S)^{1.04}] = e^\gamma$ where both sides of the expression are correspondingly approximately equal to 3. The maximum deviation of the model-predicted shrinkage from the corresponding experimental values is 12% which is within the acceptable range of deviation limit for experimental results. [Researcher. 2009;1(5):85-88]. (ISSN: 1553-9865).

Keywords: Model, Shrinkage, Clay Materials, Fired Bulk density, Drying.

1. Introduction

Firing of clay has been found to proceed in three stages; preliminary reactions which include binder burnout, elimination of gaseous product of decomposition and oxidation, sintering as well as cooling which may include thermal and chemical annealing (Reed,1988). Barsoum (1997), Viewey and Larrly(1978) and Keey (1978) studied the shrinkage of clay during drying. In all these works, porosity was shown to influence the swelling and shrinkage behaviour of clay products of different geometry. Reed (1988) posited that drying occurs in three stages; increasing rate, constant and decreasing rate. He pointed out that during the increasing rate; evaporation rate is higher than evaporating surface hence more water is lost. At constant rate, the evaporation rate and evaporation surface are constant. The researcher posited that shrinkage occurs at this stage. In a similar study, Keey (1978) suggested that at this stage, free water is removed between the particles and the inter-particle separation decreases, resulting in shrinkage. During the decreasing rate, particles make contacts as water is removed, which causes shrinkage to cease.

Nwoye (2008) derived a model for calculating the volume shrinkage resulting from the initial air-drying of wet clay. The model;

$$\theta = \gamma^3 - 3\gamma^2 + 3\gamma \quad (1)$$

calculates the volume shrinkage when the value of dried shrinkage γ , experienced during air-drying of wet clays is known. The model was found to be third-order polynomial in nature. Olokoro clay was found to have the highest shrinkage during the air drying condition, followed by Ukpor clay while Otamiri clay has the lowest shrinkage. Volume shrinkage was discovered to increase with increase in dried shrinkage until maximum volume shrinkage was reached, hence a direct relationship.

Model for the evaluation of overall volume shrinkage in molded clay products (from initial air-drying stage to completion of firing at a temperature of 1200°C) has been derived by Nwoye et al. (2008). It was observed that the overall volume shrinkage values predicted by the model were in agreement with those calculated using conventional equations. The model;

$$S_T = \alpha^3 + \gamma^3 - 3(\alpha^2 + \gamma^2) + 3(\alpha + \gamma) \quad (2)$$

depends on direct values of the dried γ and fired shrinkage α for its precision. Overall volume shrinkage was found to increase with increase in dried and fired shrinkages until overall volume shrinkage reaches maximum.

Nwoye (2009) derived a model for calculating the quantity of water lost by evaporation during oven drying of clay at 90°C. The model;

$$\gamma = \exp[(\ln t)^{1.0638} - 2.9206] \quad (3)$$

indicated that the quantity of evaporated water, γ during the drying process is dependent on the drying time t , the evaporating surface being constant. The validity of the model was found to be rooted in the expression $(\text{Log}\beta + \ln\gamma)^N = \text{Int}$.

Model for predictive analysis of the quantity of water evaporated during the primary-stage processing of a bioceramic material sourced from kaolin has been derived by Nwoye et al (2009a). The model;

$$\alpha = e^{(\text{Int}/2.1992)} \quad (4)$$

indicates that the quantity of water α , evaporated at 110°C , during the drying process is also dependent on the drying time t , where the evaporating surface is constant. It was found that the validity of the model is rooted on the expression $(\text{Int}/\ln\alpha)^N = \text{Log}\beta$ where both sides of the expression are correspondingly approximately equal to 3. The respective deviation of the model-predicted quantity of evaporated water from the corresponding experimental value was found to be less than 22% which is quite within the acceptable deviation range of experimental results.

Model for quantifying the extent and magnitude of water evaporated during time dependent drying of clay has been derived (Nwoye et al.,2009b). The model;

$$\gamma = \exp((\text{Int}/2.9206)^{1.4}) \quad (5)$$

indicates that the quantity of evaporated water γ during the drying process (at 90°C) is dependent on the drying time, t the evaporating surface being constant. It was found that the validity of the model is rooted in the expression $\ln\gamma = (\text{Int}/\text{Log}\beta)^N$ where both sides of the expression are correspondingly almost equal.

The present work is to derive a model for predictive analysis of the shrinkage sustained in fired clay materials (made from Otamiri clay) relative to the resultant fired bulk density.

2. Model Formulation

Results of the experiment previously carried out (Nwoye,2006) were used for the model derivation. These results as shown in Table 1 indicate that;

$$\ln\left[S^N \right] = e^\gamma \quad (\text{approximately}) \quad (6)$$

Introducing the value of N in to equation (6) and taking exponential of both sides reduced it to;

$$S^{1.04} = \left[\exp(e^\gamma) \right] \quad (7)$$

Dividing the indices of both sides of equation (7) by 1.04 reduces it to;

$$S = \left[\exp(e^\gamma) \right]^{1/1.04} \quad (8)$$

$$S = \left[\exp(e^\gamma) \right]^{0.9615} \quad (9)$$

Where

$N = 1.04$; Particle packing index for Otamiri clay at 1200°C (determined in the experiment (Nwoye,2006))

(γ) = Resultant fired bulk density of the clay material at 1200°C (g/cm^2)

Equation (9) is the derived model

3. Boundary and Initial Conditions

Consider a rectangular shaped clay product of length 70mm, width 17mm, and breadth 9 mm exposed to drying in the furnace while it was in wet condition. Initially, atmospheric levels of oxygen are assumed. Atmospheric pressure was assumed to be acting on the clay samples during the drying process (since the furnace is not air-tight). The grain sizes for the clay materials used are, $<100 \mu\text{m}$, $100\text{-}300 \mu\text{m}$, $300\text{-}1000 \mu\text{m}$ and their respective mixtures. Firing temperature; 1200°C , exposure time of clay body during firing; 18hrs, range of apparent porosity and water content of the clay body following firing; 21.92-23.66% and 25.59-26.28% respectively. The boundary conditions are: atmospheric levels of oxygen at the top and bottom of the clay samples since they are dried under the atmospheric condition. No external force due to compression or tension was applied to the drying clays. The sides of the particles and the rectangular shaped clay products are taken to be symmetries.

4. Model Validation

The formulated model was validated by direct analysis and comparison of the model-predicted S values and those from the experiment (Nwoye, 2006) for equality or near equality.

Analysis and comparison between these S values reveal deviations of model-predicted S from those of the experimental values. This is believed to be due to the fact that the surface properties of the clay and the physiochemical interactions between the clay and binder, which were expected to have played vital role during the evaporation of water were not considered during the model formulation. This necessitated the introduction of correction factor, to bring the model-predicted S value to that of the corresponding experimental value.

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

$$Dv = \left(\frac{S_M - S_{exp}}{S_{exp}} \right) \times 100 \quad (10)$$

Where

S_M = Shrinkage sustained in clay body as predicted by derived model

S_{exp} = Shrinkage sustained in clay body as obtained from experiment (Nwoye,2006)

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

$$Cf = -Dv \quad (12)$$

Therefore

$$Cf = -100 \left(\frac{S_M - S_{exp}}{S_{exp}} \right) \quad (13)$$

Introduction of the value of Cf from equation (13) into the model gives exactly the corresponding experimental value S_{exp} .

5. Results and discussions

The model is equation (9). It was found that the model is dependent on the resultant bulk density of the fired clay materials. The validity of the model was found to be rooted on the expression; $\ln[(S)^{1.04}] = e^\gamma$ where both sides of the expression are correspondingly approximately equal to 3. Table 2 also agrees with equation (6) following the values of $\ln[(S)^{1.04}]$ and e^γ evaluated from Table 1 as a result of corresponding computational analysis. Fig. 1 shows appreciable close alignment of the curves from model-predicted values of shrinkage (S_{mod}) and that from the corresponding

experimental values (S_{exp}). It is strongly believed that the degree of alignment of these curves is indicative of the proximate agreement between both experimental and model-predicted shrinkages sustained in the clay material. Table 3 shows that the maximum deviation of the model-predicted shrinkage from the corresponding experimental values is less than 12% which is within the acceptable range of deviation limit for experimental results.

Conclusion

The model predicts the shrinkage sustained in fired clay materials relative to its resultant fired bulk density. The model is dependent on the fired bulk density, which resulted from the firing of the clay material. The validity of the model is rooted on the expression; $\ln[(S)^{1.04}] = e^\gamma$ where both sides of the expression are correspondingly approximately equal to 3. The maximum deviation of the model-predicted shrinkage from the corresponding experimental values is less than 12% which is within the acceptable range of deviation limit for experimental results.

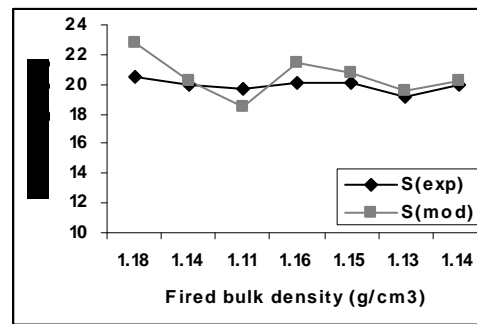


Fig.1: Comparison of the shrinkages sustained in the clay body as obtained from experiment (Nwoye, 2006) and derived model.

Table1: Variation of fired bulk density and volume shrinkage with grain size of Otamiri clay fired at 1200°C. (Nwoye, 2006).

Grain size (µm)	γ	S (%)
(A) <100	1.18	20.52
(B) 100-300	1.14	19.93
(C) 300-1000	1.11	19.63
A + B	1.16	20.16
A + C	1.15	20.08
B +C	1.13	19.17

Table 2: Variation of $\ln[(S)^{1.04}]$ with e^γ

$S^{1.04}$	$\ln[S^{1.04}]$	e^γ
23.1560	3.1423	3.2544
22.4640	3.1119	3.1268
22.1125	3.0961	3.0344
22.7337	3.1238	3.1899
22.6399	3.1197	3.1582
21.5738	3.0715	3.0957
22.5109	3.1140	3.1268

Table 3: Deviations (from experimental values) of model-predicted volume shrinkage and the associated correction factors

Dv (%)	Cf (%)
+11.37	-11.37
+1.43	-1.43
-5.77	+5.77
+6.54	-6.54
+3.76	-3.76
+2.34	-2.34
+1.23	-1.23

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Aldosterone

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Abstract: Aldosterone is a mineralocorticoid hormone, a type of hormone that is essential to life because it regulates the amounts of electrolytes in the body. The adrenal cortex, where aldosterone is produced, is part of the adrenal gland. High levels of aldosterone can cause high blood pressure, muscle cramps and weakness. Low levels may indicate disease, such as diabetes. Often, aldosterone levels vary between the sexes and may be affected by the amount of sodium in a person's diet. [Researcher. 2009;1(5):89-93]. (ISSN: 1553-9865).

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

1. Introduction

Aldosterone is a mineralocorticoid hormone, a type of hormone that is essential to life because it regulates the amounts of electrolytes in the body. Aldosterone is secreted by the adrenal cortex and responsible for the reabsorption of sodium into the bloodstream. Aldosterone also stimulates the excretion of potassium. Aldosterone is the chief regulator of sodium, potassium, and chloride metabolism, thus controlling the body's water and electrolyte balances.

The adrenal cortex, where aldosterone is produced, is part of the adrenal gland. Aldosterone regulates sodium and potassium levels in animals, helping to maintain both blood pressure and bodily fluids. If aldosterone levels in the body are out of sync, symptoms can result.

High levels of aldosterone can cause high blood pressure, muscle cramps and weakness. Low levels may indicate disease, such as diabetes. Often, aldosterone levels vary between the sexes and may be affected by the amount of sodium in a person's diet. Women often have significantly higher levels of aldosterone when pregnant.

The hormone renin, which is produced in kidney, helps to regulate the release of aldosterone, and renin levels are often compared with aldosterone levels for diagnostic purposes. An aldosterone test may be performed to determine the cause of high or low blood potassium or of certain conditions, such as heart failure or kidney disease.

Aldosterone is an important regulator of Na⁽⁺⁾ and K⁽⁺⁾ transport in the distal nephron modulating the surface expression of transporters through the action of the mineralocorticoid receptor as a ligand-dependent transcription factor. Aldosterone stimulates the rapid activation of protein kinase-based signalling cascades that modulate the genomic effects of the hormone. Evidence is accumulating about the multi-factorial regulation of the epithelial sodium channel

(ENaC) by aldosterone (Thomas, McEneaney et al. 2008).

Aldosterone is a hormone that increases the reabsorption of sodium and water and the release of potassium in the kidneys. This increases blood volume and therefore, increases blood pressure. Many drugs, such as spironolactone, lower blood pressure by blocking the aldosterone receptor. Aldosterone is part of the renin-angiotensin system. Jerome Conn first described the syndrome of autonomous and excessive aldosterone secretion or "primary aldosteronism."

Aldosterone is a steroid hormone produced by the outer-section of the adrenal cortex in the adrenal gland, and acts on the distal tubules and collecting ducts of the kidney to cause the conservation of sodium, secretion of potassium, increased water retention, and increased blood pressure. The overall effect of aldosterone is to increase reabsorption of ions and water in the kidney.

Aldosterone is an adrenal hormone that regulates sodium, fluid, and potassium balance. Contrary to the historical belief, recent studies indicate that primary aldosteronism is a common cause of hypertension with a prevalence of 5-10% among general hypertensive patients. Various animal models have demonstrated that aldosterone in association with a high salt diet results in target-organ inflammation and fibrosis. Similarly, cross-sectional and observational human studies have demonstrated the association of aldosterone with development and severity of hypertension, congestive heart failure, coronary artery disease, chronic kidney disease, and metabolic syndrome. Several interventional studies have also demonstrated the beneficial effects of mineralocorticoid receptor antagonists in these disease processes, particularly hypertension, heart failure, and post myocardial infarction, further supporting the role of aldosterone in their pathogenesis (Gaddam, Pimenta et al. 2009).

When sodium intake diminishes, both the kidney and distal colon contribute directly to sodium homeostasis. In response to a diet with low amounts of sodium, the body hormonal profile changes to produce different effects on crypt-colon permeability and absorption and in the pericryptal sheath surrounding distal colonic crypts. This adaptation produces an increase in Na absorption, a decreased crypt-wall permeability, and an activation of the growth of pericryptal myofibroblasts. The separate roles of the 2 main hormones implicated in the process, aldosterone and angiotensin II, until now have been unclear. Experiments conducted on adrenalectomized rats on low- and high-sodium diets, implanted with osmotic pumps perfusing either aldosterone or angiotensin II, allow us to discriminate between the effects of these hormones. In the distal colon, aldosterone acts as a trophic agent on the myofibroblasts layer and is the key hormone controlling colonic permeability, but angiotensin II alone has no discernable direct role in the process (Cristia, Moreto et al. 2007).

Aldosterone plays a pivotal role in sodium and water homeostasis, in particular in patients with heart failure or high blood pressure. These medications, when used on top of a standard therapy, improve the outcome of patients with heart failure and are also effective in lowering blood pressure of hypertensive patients. The major risk associated with the use of these antagonists is hyperkalemia, which can be prevented in avoiding their prescription in patients with impaired renal function. Eplerenone has the advantage, compared with spironolactone, to be better tolerated in terms of "hormonal" adverse effects (Waeber 2006).

The adrenal cortex is the outer layer of the adrenal gland, a component of the endocrine system of the body which regulates and produces hormones. The inside of the adrenal gland is known as the adrenal medulla or simply medulla. The medulla and the cortex perform very different functions, and each is critical to healthy life. A variety of medical conditions can interfere with the function of the adrenal cortex, including Cushing's syndrome and Addison's disease. Using cholesterol as a base, the adrenal cortex creates a number of compounds with a variety of uses, many of which play a role in metabolism and blood chemistry.

The adrenal glands are located on top of the kidneys. The cortex is yellow in healthy individuals, and the gland itself has a star-like shape. There are three separate layers in the adrenal cortex, each of which is responsible for synthesizing different chemicals for use by the body. The cells in each layer have slightly different structures, reflecting their different functions, and the difference can clearly be

seen with the assistance of a high powered microscope.

On the outside of the adrenal cortex, the zona glomerulosa makes mineralcorticoids such as aldosterone. The next layer, the zona fasciculata, makes glucocorticoids like cortisol, while the inner layer, known as the zona reticularis, makes androgens such as testosterone. The levels of production are varied, depending on the person and his or her physical condition. Men, for example, tend to produce more testosterone than women, and this hormone plays a critical role in physical development, and people under stress make more cortisol.

Dysfunction in either area of the adrenal gland can lead to a variety of symptoms, including fatigue, weight changes, hirsutism, vomiting, nausea, specific food cravings, hypoglycemia, and low blood pressure. In some cases, multiple parts of the endocrine system are involved, creating a cascading effect as the body's overall hormonal balance is severely disrupted, and in other instances, problems occur with the adrenal gland alone. Patients who suffer from adrenal insufficiency or overproduction have a number of treatment options, depending on the cause of the condition.

When problems do emerge with the adrenal glands, doctors try to resolve the underlying cause before resorting to measures such as supplementing the body's natural level of production with specific hormones, or removing the adrenal glands so that they cannot continue to overproduce. Because many conditions can involve the adrenal gland, extensive medical testing may be required to get to the bottom of the problem.

2. Structure

The chemical structure of aldosterone is shown in Figure 1.

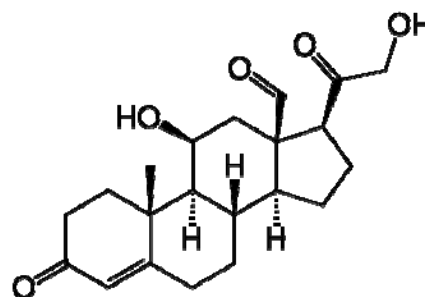


Figure 1. Chemical structure of aldosterone

Aldosterone antagonist refers to drugs which antagonise the action of aldosterone at mineralocorticoid receptors. This group of drugs is often used as adjunctive therapy, in combination with other drugs, for the management of chronic heart failure. Spironolactone, the first member of the class,

is also used in the management of hyperaldosteronism and female hirsutism. Members of this class in clinical use include: Spironolactone, Eplerenone, Canrenone. The chemical structure of aldosterone antagonists is shown in Figure 2.

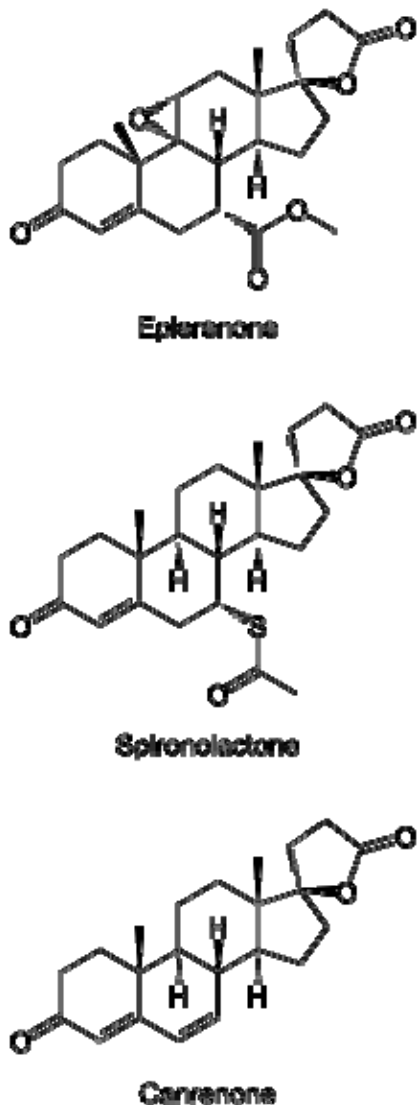


Figure 2. Chemical structure of aldosterone antagonists

Homo sapiens isolate 10 aldosterone synthase (CYP11B2) gene promoter region (187 bp DNA):

```

1  gatcaatitt gcaatgaact aaatctgtgg tataaaaata
aagtctatta aaagaatcca
61  aggtccctc tcactcagc ataagataaa gtccccatcc
atfttactcc tctcagcct
121 ggagaaagga gaggccaggt cccaccacct tcaccagca
tggaccacca gtccagacc
181 cacgct

```

```

/PCR_primers="fwd_seq:  gtgtcagggcaggggta,
rev_seq: aggcgtggggtctggact"

```

Aldosterone Receptor Antagonist (34 bp DNA):

```

1  gggaggtacc ttctggcag cgggcagta ctc
(Sakamoto J, Fukumoto S, Oura T, Aldosterone
Receptor Antagonist. Takeda Chemical Industries
Ltd).

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3. Synthesis

The corticosteroids are synthesized from cholesterol within the adrenal cortex. Most steroidogenic reactions are catalysed by enzymes of the cytochrome P450 family. They are located within the mitochondria and require adrenodoxin as a cofactor.

Aldosterone and corticosterone share the first part of their biosynthetic pathway. The last part is either mediated by the aldosterone synthase (for aldosterone) or by the 11β -hydroxylase.

4. Aldosterone synthesis is stimulated by several factors:

- (1) Increase in the plasma concentration of Angiotensin III, a metabolite of Angiotensin II.
- (2) Increased plasma angiotensin II, ACTH, or potassium levels, which are present in proportion to plasma sodium deficiencies. The increased potassium level works to regulate aldosterone synthesis by depolarizing the cells in the zona glomerulosa, which opens the voltage-dependent calcium channels. The level of angiotensin II is regulated by angiotensin I, which is in turn regulated by the hormone renin. Potassium levels are the most sensitive stimulator of aldosterone.
- (3) The ACTH stimulation test is sometimes used to stimulate the production of aldosterone along with cortisol to determine if primary or secondary adrenal insufficiency is present.
- (4) ACTH has only a minor role in regulating aldosterone production; with hypopituitarism there is no atrophy of the zona glomerulosa.
- (5) Plasma acidosis stimulates the aldosterone synthesis.
- (6) Stretch receptors stimulates the aldosterone synthesis. If decreased blood pressure is detected, the adrenal gland is stimulated by these stretch receptors to release aldosterone, which increases sodium reabsorption from the urine, sweat and the gut. This causes increased osmolarity in the extracellular fluid which will eventually return blood pressure toward normal.
- (7) Adrenoglomerulotropin stimulates secretion of aldosterone.
- (8) The secretion of aldosterone has a diurnal rhythm.

5. Function

Aldosterone is the primary of several endogenous members of the class of mineralocorticoids in human. Deoxycorticosterone is another important member of this class. At the late distal tubule and collecting duct, aldosterone has three main actions:

- (1) Acting on the nuclear mineralocorticoid receptors within the principal cells of the distal tubule and the collecting duct of the kidney nephron, it increases the permeability of the apical membrane to potassium and sodium and activates the basolateral Na^+/K^+ pumps, stimulating ATP hydrolysis leading to phosphorylation of the pump and a conformational change in the pump exposes the Na^+ ions to the outside. The phosphorylated form of the pump has a low affinity for Na^+ ions, hence reabsorbing sodium (Na^+) ions and water into the blood, and secreting potassium (K^+) ions into the urine. (Chlorine anions are also reabsorbed in conjunction with sodium cations to maintain the system's electrochemical balance.)
- (2) Aldosterone stimulates H^+ secretion by intercalated cells in the collecting duct, regulating plasma bicarbonate levels and its acid/base balance.
- (3) Aldosterone may act on the central nervous system via the posterior pituitary gland to release vasopressin (ADH) which serves to conserve water by direct actions on renal tubular reabsorption.
- (4) Aldosterone is responsible for the reabsorption of about 2% of filtered sodium in the kidneys, which is nearly equal to the entire sodium content in human blood under normal glomerular filtration rate (GFR).

Aldosterone, most probably acting through mineralocorticoid receptors, may positively influence neurogenesis in the dentate gyrus.

6. Control of aldosterone release

Control of aldosterone release from the Adrenal Cortex:

- (1) The role of the renin-angiotensin system: Angiotensin is involved in regulating aldosterone and is the core regulation. Angiotensin II acts synergistically with potassium, and the potassium feedback is virtually inoperative when no angiotensin II is present. A small portion of the regulation resulting from angiotensin II must take place indirectly from decreased blood flow through the liver due to constriction of capillaries. When the blood flow decreases so does the destruction of aldosterone by liver enzymes.
- (2) The role of sympathetic nerves: The aldosterone production is also affected to one extent or

another by nervous control which integrates the inverse of carotid artery pressure, pain, posture, anxiety, fear, hostility and stress, etc. Anxiety increases aldosterone, which must have evolved because of the time delay involved in migration of aldosterone into the cell nucleus. Thus, there is an advantage to an animal anticipating a future need from interaction with a predator since too high a serum content of potassium has very adverse effects on nervous transmission.

- (3) The role of baroreceptors: Pressure in the carotid artery decreases aldosterone.
- (4) The role of the juxtaglomerular apparatus: The amount of aldosterone secreted is a direct function of the serum potassium as probably determined by sensors in the carotid artery.
- (5) The plasma concentration of sodium: Aldosterone is a function of the inverse of the sodium intake as sensed via osmotic pressure. The slope of the response of aldosterone to serum potassium is almost independent of sodium intake. Aldosterone is much increased at low sodium intakes, but the rate of increase of plasma aldosterone as potassium rises in the serum is not much lower at high sodium intakes than it is at low. Thus, the potassium is strongly regulated at all sodium intakes by aldosterone when the supply of potassium is adequate, which it usually is in primitive diets.
- (6) Adrenocorticotrophic hormone (ACTH) regulations: The pituitary peptide ACTH, also has some stimulating effect on aldosterone probably by stimulating deoxycorticosterone formation which is a precursor of aldosterone. Aldosterone is increased by blood loss, pregnancy, and possibly by other circumstances such as physical exertion, endotoxin shock, and burns.
- (7) Aldosterone feedback: Feedback by aldosterone concentration itself is of a non morphological character (that is other than changes in the cells' number or structure) and is poor so the electrolyte feedbacks predominate short term.

7. Location of receptors

Unlike neuroreceptors, classic steroid receptors are intracellularly located. The aldosterone/MR receptor complex binds on the DNA to specific hormone response element, which leads to gene specific transcription.

Some of the transcribed genes are crucial for transepithelial sodium transport, including the three subunits of the epithelial sodium channel, the Na^+/K^+ pumps and their regulatory proteins serum and glucocorticoid-induced kinase, and channel-inducing factor respectively.

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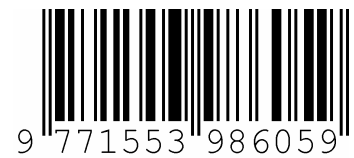
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