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Vice-Chancellor

NAAC Accredited B++

**Vice-Chancellor**



## Message

I am glad to present the current issue of our University Academic Journal- VIDYA. The Journal would speak volumes of the appreciable research activities on almost all fronts of academics in the university academic ambience. I express my pleasure over the enthusiastic interest among the academia of the University. As usual, the current issue will attract the attention of its readers not only within the University and also outside. I congratulate the efforts put in preparing this issue and making it so informative.

Digital India is a campaign launched by the Government of India to improve online infrastructure and Internet connectivity and making the country digitally empowered in the field of technology. Gujarat University has taken initiatives to provide next generation Wifi services to create a digital campus which will provide lightning speed internet connectivity and innovative sources. I urge everyone to join us in fostering a healthy, peaceful and engrossing atmosphere at the University campus, colleges and affiliated institutions. We have a mammoth task of employing higher education as a means of attaining peace and development. All are invited to contribute actively and enrich the University with your intellectual resources, rich experiences and fruitful suggestions.

With Best Wishes

  
(Dr. M.N. PATEL)

## From The Editors Desk

At the outset, I would like to express my deep sense of gratitude to the Honorable Vice Chancellor, Dr. M. N. Patel for appointing me as the Chief Editor of Vidya Academic Journal of Gujarat University.

“Vidya” has entered in the 11th successful year with this issue. The team of Vidya has tried it’s best to amass and fetch to highlight the research and academic achievements of the staff members and research scholars of the Gujarat University.

Among the recent initiatives of government “Make In India” has attracted widespread attention and debate. The major objective behind the initiative is to focus on job creation and skill enhancement. Most of us like to lead settled lives and are averse to taking risks. A major clean up of our mindset is essential before we can “Make In India” campaign succeed. The system has to identify and encourage risk takers. Our young generation has to be motivated to think out of the box. To start a movement ,you need a strategy that inspires, empowers and enable in equal measure. Our Hon. Vice Chancellor, Dr. M. N. Patel is supporting this cause by starting a Gujarat University Staff and an Entrepreneurship Programme (GUSEC). This is the first support system for non-tech innovations in different subjects such as Science, Arts, Commerce, Law, Medical etc.

I hope that readers will get benefit from the information provided in the current edition. I welcome inputs and suggestions in making this effort better.

With Best Wishes.



**Prof. (Dr.) Meenu Saraf**

When learning is purposeful

Creativity Blossoms

When Creativity Blossoms

Thinking Emanates

When Thinking Emanates

Knowledge is Fully Lit

When Knowledge is Fully Lit

Economy Flourishes

- **A.P.J. Abdulkalam**

Original Paper

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## **Effect Of Music On Growth & Physiology Of Selected Plants**

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### **Abstract**

This study is an attempt to understand the effect of music on plant growth and behavior. Eight medicinal and ornamental plants were subjected to two different types of music rhythmic and soft-melodious music. The control set of plants were not exposed to any particular music. The music was played using normal speakers for three hours, each day. The parameters such as difference in height of the plant, number of leaves, flowering time, number of flowers, estimation of metabolites (protein, starch, phenols, reducing and non-reducing sugars and chlorophyll) were all monitored. The results showed that when plants were exposed to music, their growth speeded up and also there was increase in concentration of metabolites as compared to control plants.

Keywords: Plant growth, Soft-melodious music, plant height, metabolites

### **Introduction**

Music is an art form that not only is a powerful medium of communication but also has a positive impact on living beings well being. The researches in this area are underway to assess the influence of music on growth, development and metabolic processes in plants. Music is of four types-Positive music can be relaxing, calming, and mentally invigorating. Positive music is not about lyrics, but about the music itself. On the other hand, Negative music is a music that expresses or stimulates negative emotions like anger, frustration, depression, hatred and fear. Rhythmic music is a kind of music which has the rhythms like classical, violin, instrumental etc. Non-rhythmic music does not have the rhythms like rock music, pop, country, jazz etc.

Music is a vibratory phenomenon. Air particles are set in motion and these air particles in

turn set matter that is within hearing distance into motion. This is called vibration sympathy: When the vibrations of sound affect the airwaves, the airwaves affect other matter that they come into contact with in a manner that is in sympathy with the originating source. There are two main properties of a regular vibration - the amplitude and the frequency - which affect the way it sounds. Amplitude is the size of the vibration, and this determines how loud the sound is. Frequency is the speed of the vibration, and this determines the pitch of the sound. It is only useful or meaningful for musical sounds, where there is a strongly regular waveform (Tompkins and Bird, 1989).

A property of living things is that they respond to stimuli. Music affects human behavior in many ways and can summon emotions. It reduces fatigue, increases muscular endurance, speeds up voluntary activities, and it can manipulate the electrical conductivity in the human body.

Plants are complex multicellular organisms considered as sensitive as humans for initial assaying of effects and testing new therapies. Sound is known to affect the growth of plants and plants respond to music the same as humans do (Benford, 2002; Dossey, 2001; Kristen, 1997).

Music actually consists of sound waves that travel through the air at varying frequencies and finally reaching our ear drums to be recognized as sound and music. When the plant is exposed to the same music, it also receives the same sound waves and could in fact be receiving some form of stimuli.

Music causes drastic changes in plants metabolism. Plants enjoy music, and they respond to the different types of music and its wave-length. Music containing hardcore vibrations could be devastating to plants (Weinberger and Graefe, 1973).

Little work has been done in this field wherein the plants have been subjected to different types of sound and the effects being monitored and analyzed. On the basis of literature review the present study was an attempt to test the effect of music on plants in terms of plant growth, development and metabolism. Eight medicinal and ornamental plants selected for the experiments are as follows:

1. *Tagetes erecta* L.
2. *Catharanthus roseus* L.
3. *Trachyspermum ammi* L.
4. *Duranta repens* L.
5. *Hibiscus rosa-sinensis* L.
6. *Epipremnum aureum* L.
7. *Dendranthema grandiflora* L.
8. *Ocimum sanctum* L.

## **Materials and Methods**

### **Selected Plants and Experimental Design**

Eight plants were selected and collected from the 'Van Chetna Kendra' Nursery, Gandhinagar. These plants were grown in the pots in Botanical garden of Department of Botany, Gujarat University, Ahmedabad. To investigate the effect of music on plants, two sets were prepared for the experiment. One set of selected eight plants was exposed to the music and other set of same eight plants was kept as control which was not exposed to any music.

### **Music Type and Frequency**

The music which was selected for the treatment of plants was a kind of soft music. There were twelve soft songs selected with the average frequency of 100Hz.

### **Source Of Music**

Music was applied by the normal speakers which were attached to the mobile phone. Distance between the speakers and the pots were about 35cm.

### **Duration Of Music**

Plants are treated with music for the 1 month of duration, in which music was applied for 3 hours daily to the plants.

### **Environmental Conditions**

Equal amount of water was poured in each set of pots with an interval of every two days. The plants were placed in a botanical cage under normal environmental conditions like light, temperature and humidity.

### **Date And Season Of Grown Plant**

Plants were grown in pots in December 2013 and the music treatment was given from for about two months.

### **Collection Of Data**

Data was collected on the first day, and then at an interval of 15 days for two months.

Basically the whole experiment was divided into three main parts:

1. Effect of music on growth parameters of plants.
2. Phytochemical screening.
3. Estimation of various metabolites.

### **Parameters Studied**

To study the effect of music on plant growth, several parameters studied are:

1. Height of the plant
2. Number of leaves
3. Flowering time
4. Number of flowers
5. Phytochemical screening
6. Estimation of metabolites( Protein, Phenols, Starch, Total sugar and reducing sugar, Chlorophyll)

### **Phytochemical Analysis**

Preparation of Extract:

The fresh plants were collected and washed separately under running tap water for removing soil and dust particles. Plant material was air dried for two days and then powdered in a mixer grinder. Then this powder was soaked in (10gm/100ml) of solvent (methanol) overnight. The material was filtered and the extracts were pooled and evaporated to get the concentrated extract.

The qualitative preliminary phytochemical analysis of the extracts of all plant part isolated from methanol solvent was performed by following standard methods given by Harborne.

### Estimation Of Metabolites

Standard methods were followed for estimation of metabolites

- (a) Total Sugars and reducing sugar by Nelson, 1944
- (b) Starch by Chinoy, 1939
- (c) Total proteins by Bradford, 1976
- (d) Total phenols by Bray et al., 1954
- (e) Total Chlorophyll by Arnon, 1973

### Result and Discussion

The result of this experiment is divided into three parts:

1. Effects of Music on plant growth
2. Phytochemical Screening
3. Biochemical analysis

Effect Of Music On Plant Growth

Sound is known to affect the growth of plants. Here the height increased (Fig. 1), the number of leaves also increased (Fig. 2), the number of flowers also increased (Fig. 3). The flowering time was advanced so the plants showed early flowering (Table 1).

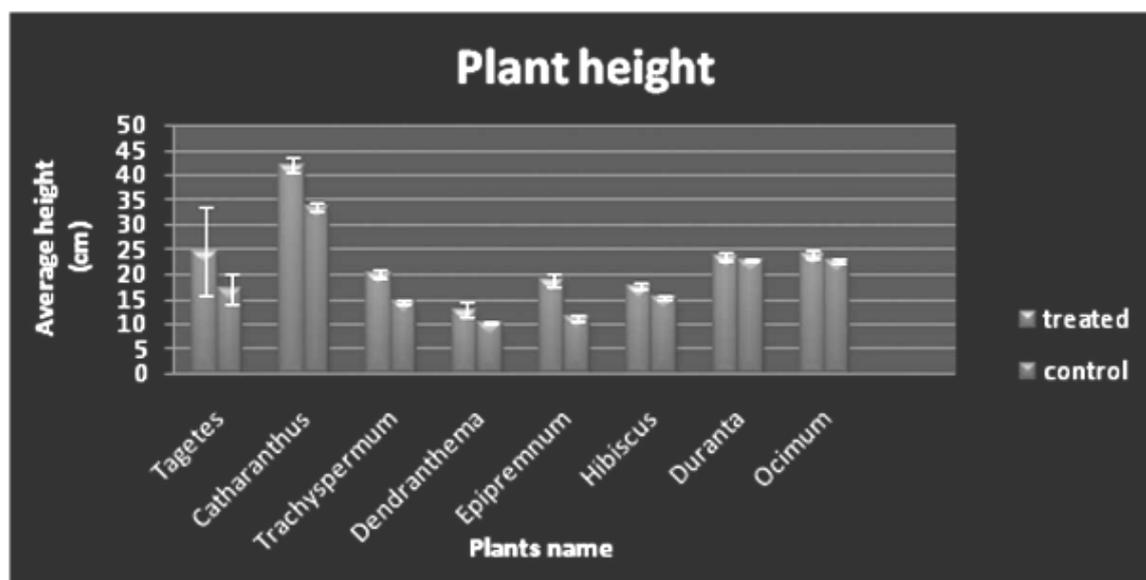


Fig. 1: Showing the height of Treated and Control plants

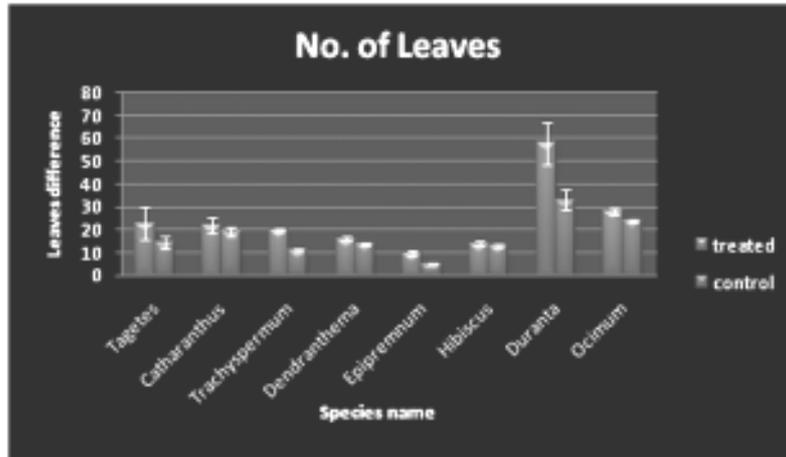


Fig. 2: Showing the Number of leaves of Treated and Control plants

Table 1. Showing Flowering time of Treated and Control plants

S.NO	SET NAME	PLANTS NAME	DAY OF OCCURENCE OF BUD	DAY OF OCCURENCE OF FLOWER
1.	TREATED (With music)	<i>Tagetes erecta</i> L.	19 <sup>th</sup> day	25 <sup>th</sup> day
2.		<i>Catharanthus roseus</i> L.	25 <sup>th</sup> day	28 <sup>th</sup> day
3.		<i>Dendranthema grandiflora</i>	21 <sup>st</sup> day	29 <sup>th</sup> day
4.		<i>Hibiscus rosa-sinensis</i> L.	No bud	No flower
1.	CONTROL (Without music)	<i>Tagetes erecta</i> L.	21 <sup>st</sup> day	29 <sup>th</sup> day
2.		<i>Catharanthus roseus</i> L.	26 <sup>th</sup> day	30 <sup>th</sup> day
3.		<i>Dendranthema grandiflora</i>	30 <sup>th</sup> day	No flower
4.		<i>Hibiscus rosa-sinensis</i> L.	No bud	No flower

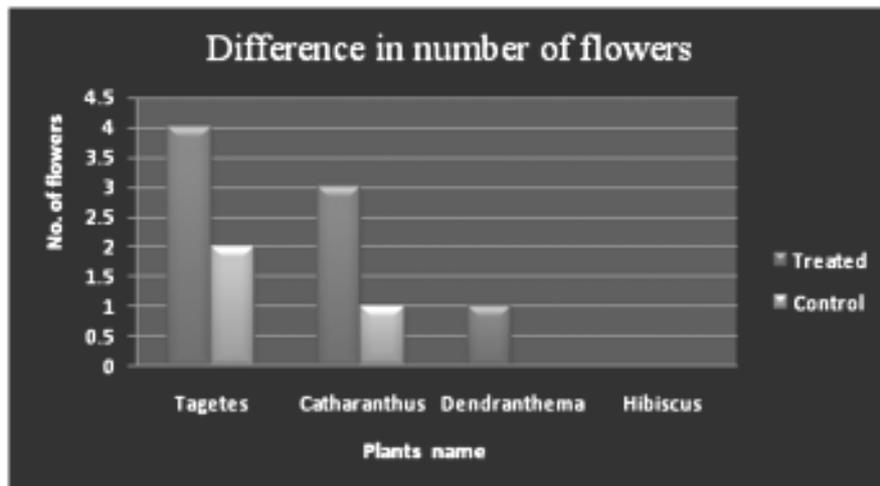


Fig 3: Number of flowers of Treated and Control plants

**Phytochemical Screening**

The extracts were subjected to preliminary phytochemical qualitative screening for the presence or absence of various primary or secondary metabolites.

Hence, several metabolites like Total sugar (Fig 4), Reducing sugar (Fig 5), Phenols (Fig 6), Starch (Fig 7), Protein (Fig 8), Chlorophyll (Fig 9) were found to be more in plants treated with music as against the control plants that were not exposed to music.

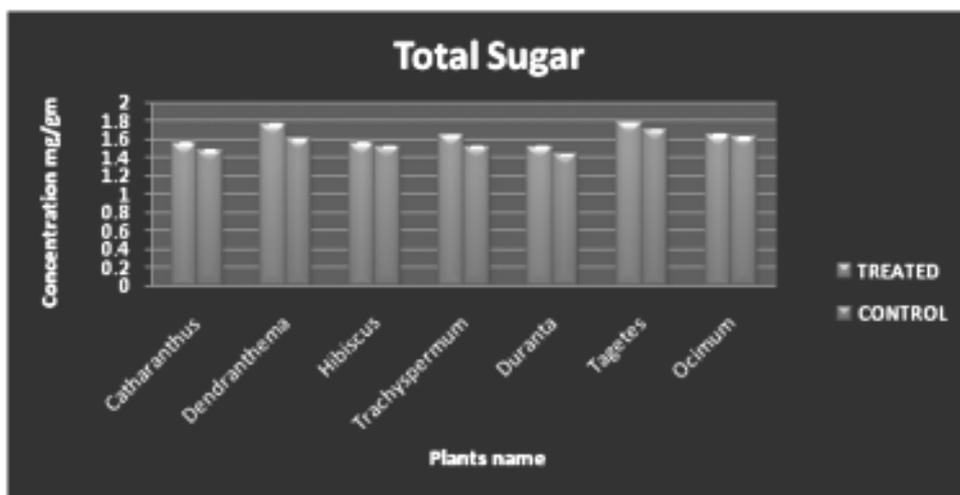


Fig 4: Comparison of total sugar between Treated and Control.

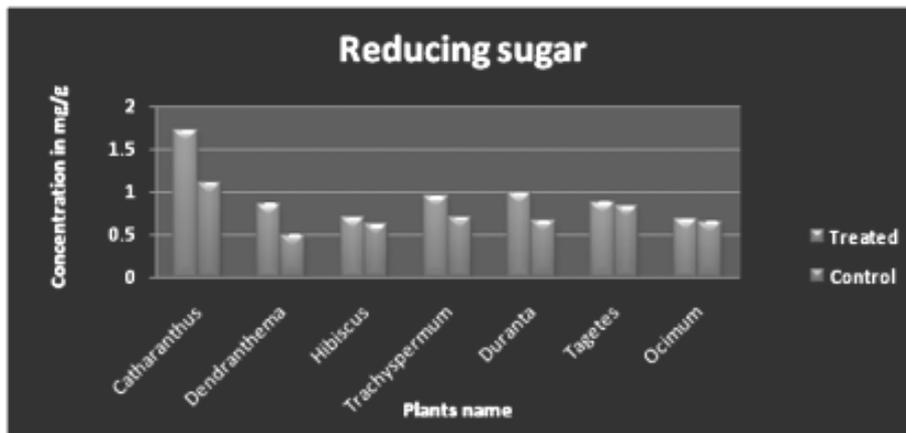


Fig 5: Comparison of reducing sugar between Treated and Control.

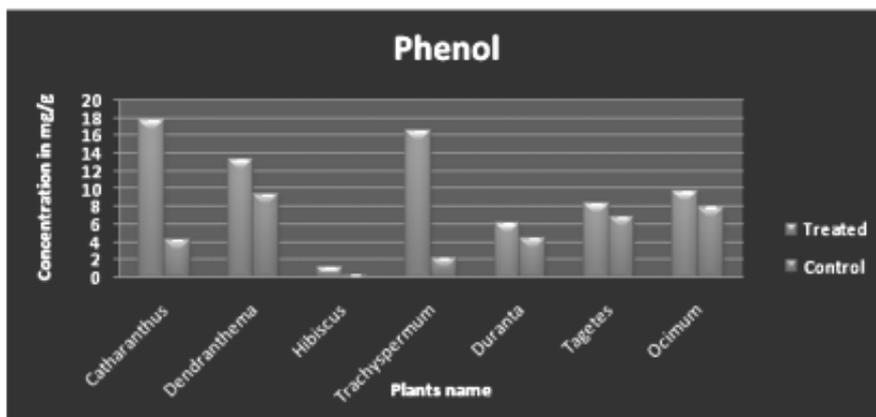


Fig 6: Comparison of Phenols between Treated and Control



Fig 7 : Comparison of starch between Treated and Control

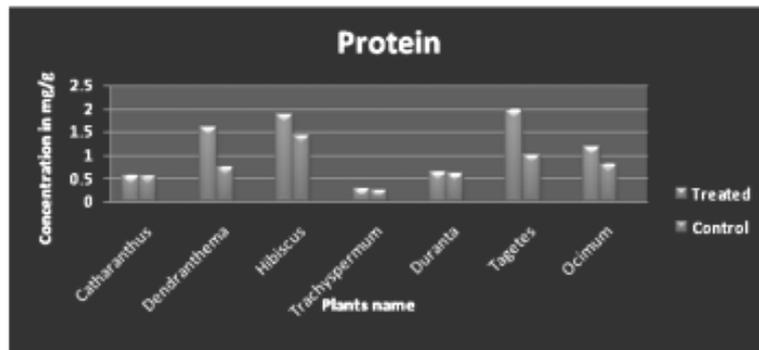


Fig 8: Comparison of protein between Treated and Control.

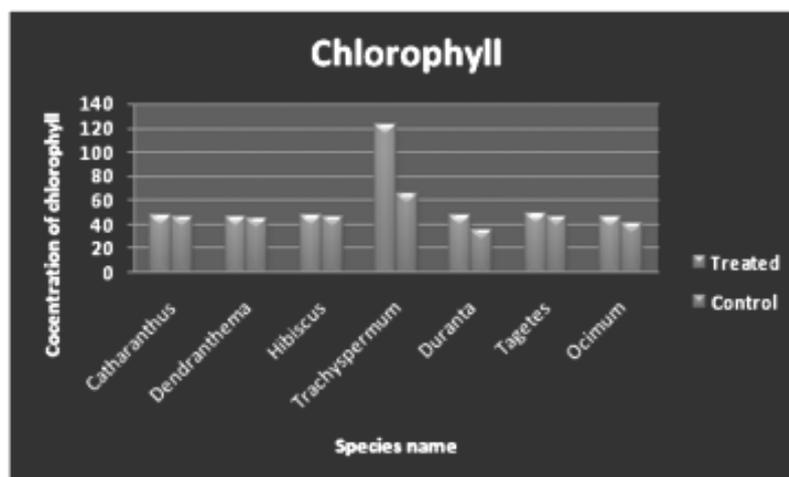


Fig 9 : Graphical representation of total chlorophyll

**Discussion**

Music, more than entertainment, has played an instrumental role in healing and harmonizing the mind, body and spirit. For thousands of years, the Vedic, China, India, Turkey and Greece culture has used sound and music for body and mind balancing, health enhancement, and encouragement of heightened awareness (Bailey-Lloyd, 2003-2004). According to Burbank, 1868; and Creath and Schwartz, 2004, Science is now showing that these sounds actually do influence the growth of plants. This experiment also shows that plants respond to sounds in pro-found ways which not only influence their overall health but also increase the speed of growth and the size of the plants.

According to Chatterjee et al, 2013, if plants are exposed to the music, then the height of the plant would increase and they become more and much healthier. In this experiment the height of the plants increased in treated plants. Music therapy also increases the number of leaves and the number of flowers as compared to the plants which are not treated with music. Singh, 1962 showed that the flowers appeared one week earlier in treated set than the control one and that holds true for this experiment also.

Plants actually pick up the sound vibrations which have the different frequency and generally plants respond best to frequency of 100Hz. As the basic science says that sound needs a medium to travel so in this case air is the medium for travel of musical sounds from source to the plants. In a similar manner, the pressure from a sound wave creates vibration that is picked by plants. Plant does not hear the music but feels the vibrations. According to Dan Carlson, if the frequency of the sound is between 100Hz to 500Hz, then it causes stomata of the plants to open and absorbs nutrients more efficiently.

The protoplasm-the living matter is in the form of translucent substance, is always in a state of perpetual movement. The vibration picked up by the plant will speed up this protoplasmic movement in the cells. This stimulation will then affect the system and may improve on its performance such as the manufacture of the more nutrients that will give a stronger and better plant. Music is actually influencing the plant growth and in a similar manner, it affecting the plants biochemically also. In this experiment, phytochemical screening shows the increase of various metabolites like sugars, Phenols, starch, amino acids, protein and carbohydrates. According to Mynn et al, 2009 chlorophyll is the most important green pigment of the plants. Music increases the amount of chlorophyll and starch content in the plants. Hence, the photosynthetic rate also increases which help the plants to grow better, on the other hand, starch is the product of the photosynthesis so if rate of photosynthesis increases then amount of starch also increases. This will result in an increase in the amount of energy which is used by the plants cell for various functions. Due to this plant height and number of leaves increases.

Music therapy also helps in increasing the amount of total sugar and reducing sugars in the plants. This will maintain the growth of the plant and thus control the plant metabolism. On playing music to the plants also increases the amount of concentration of protein and phenols. Proteins are the basic instruments for expression of the genetic information as it controls the genetic expressions. Even phenols have been found to be stimulatory for flowering, bud formation and nitrate assimilation.

So, if music really affecting the plant growth then this concept can be very beneficial for the future aspects. Farmers can utilize the concept of music therapy to yield a higher and better quality of crops. In nursery also, music can be applied to speed up the seed germination and make the plants healthier. Even in home also music helps in indoor plants growth.

### **Conclusions**

When melodious music therapy is applied to the plants, then plants shows positive results. There was a positive change in the plant growth. Plants grow faster when exposed to the music. Our preliminary studies clearly indicate that the plant is able to differentiate between “some sound” and “no sound”. For plants, melodious music was proving to be beneficial. Music also greatly influences the concentration of various metabolites. Hence this concept can be very useful in the field of Biochemistry, Horticulture, Physiology and ecology. Music can be used in plant nurseries to speed-up seed germination and help us grow healthier plants.

It can be concluded that plants grow faster with exposure to melodious music. This knowledge can be applied in agriculture to increase the yield and may help to solve the problem of starvation and world hunger in the future.

### References

- Baudoux D. (2000): Aroma therapy. *Indian journal of fibre and textile research* 55-325.
- Benford M S. (2002): Implications of plant genome research to alternative therapies: A case for radiogenic metabolism in humans. *J. Theoretic* 4: 1-14.
- Bradford MM (1976). A rapid and sensitive method for the quantation of microgram quantities of proteins utilizing the principle of protein- dye binding. *Analytical Biochemistry* 72:248-254.
- Bray HG and Thorpe WVT (1954). Analysis of phenolic compounds of interest in metabolism. *Biochemical Analysis*; 1: 2752.
- Chatterjee J, Jalan A, Singh A. (2013): Effect of sound on plant growth. *Asian journal of plant science and research* 3(4):28-30.
- Chinoy JJ, (1939): A new colorimetric method for the determination of starch applied to soluble starch, natural starches and flour, part-I, colorimetric determination of soluble starch. *Mikrochemie*; 26:132.
- Coglan A. (1994): Good vibrations give plants excitations. *New Scientist* 142: 10.
- Collins ME. and Foreman, JEK. (2001): The effect of sound on the growth of
- Creath K. and G. E. Schwartz (2004): Measuring effects of music, noise and healing energy using a seed germination bioassay. *J. of Alt. and Comp. Med.* 10(1): 113-122.
- Dasgupta N, Ranjan S, Jain R (2012): Antibacterial activity of leaf extract of marigold. *Journal of pharmacy research*, 3(4):28-30.
- Dossey L. (2001): Being green: On the relationships between people and plants. *Altern Ther* 7: 12-16, 132-140.
- Galston A. W. and C L. Slayman (1979): The not-so-secret life of plants. *Am. Sci.* 67: 337-344.
- Govindaswami C. and Srinivasan R. (2012): In vitro antibacterial activity and phytochemical analysis of *Catharanthus roseus* L. *Asian pacific journal of tropical biomedicine* S155-S158
- Klein R. M. and P. C. Edsall (1965): On the reported effects of sound on the growth of plants. *Bioscience* 15: 125-126.
- Kristen U. (1997): Use of higher plants as screens for toxicity assessment. *Toxicol in Vitro* 11: 181-191.
- Muir W. (2011): The effect of different types of music on plants.
- Nelson N. (1944): A photometric adaption of the Somogyi's meyhod for the determination of glucose. *Journal of Biological Chemistry*; 153: 375-380.
- Plants. *Cana Acoustics* 29:3-8.
- Retallack D. (1973): *The sound of Music and Plants*. Santa Monica, CA: De Vorss & Co.
- Retallack D. and F. Broman (1973): Response of growing plants to the manipulation of their environment. In: *The Sound of Music and Plants*. Santa Monica, CA: De Vorss & Co. 82-94.
- Singh A; Jalan, A; and Chatterjee, J (2013): Effect of sound on plant growth. *Asian journal of plant and science*, 3(4):28-30.
- Teleweki F. W. (2006): "A Unified Hypothesis of Mechanoperception in Plants" *American Journal of Botany*, Volume 93 (October) pages 1466-1476.

Tompkins P. and C. Bird (1973): The harmonic life of plants. In: The Secret life of plants. New York: Harper and Row 145-162.

Wang X, Wang D, Wang C, Duan, T. Yoshiharu and S. Akio (2003): Effect of sound wave on the metabolism of Chrysanthemum roots. Colloids and Surfaces. Biointerfaces. 29: 115-118.

WEBLINKS [www.staurtxchange.com](http://www.staurtxchange.com) (retrieved on 21st April, 2014)

Weinberger P. and G. Das (1972): The effect of an audible and low ultrasound frequency on the growth of synchronized cultures of *Scenedesmus obtusiusculus*. Can J. Botany 50: 361-366.

Weinberger P. and M. Measures (1978): Effects of the intensity of audible sound on the growth and development of Rideau winter wheat. Can J. Botany 57: 1036-1039.

Weinberger P. and U. Graefe (1973): The effect of variable-frequency sounds on plant growth. Can J. Botany 51: 1851-1856. [www.health-from-nature.in](http://www.health-from-nature.in) (retrieved on 21st April, 2014).



Review Paper

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## **Rhizosphere Microbial Community Structure: A Review**

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### **Abstract**

Microbial communities play an essential role in the functioning of plants by influencing their physiology and development. While many members of the rhizosphere microbiome are beneficial to plant growth, also plant pathogenic microorganisms colonize the rhizosphere striving to break through the protective microbial shield and to overcome the innate plant defence mechanisms in order to cause disease. Although the importance of the microbial community associated with rhizosphere has been widely recognized to enhance plant growth including soil structure formation; decomposition of organic matter; toxin removal; and the cycling of carbon, nitrogen, phosphorus, potassium, ion chelation and sulphur. Thus these rhizospheric microbial community can be exploited for commercial application as Biofertilizer and Biocontrol agents.

### **Introduction**

Microorganisms may comprise of mixed populations of naturally occurring microbes in soil that can be applied as inoculants to increase soil microbial diversity. Investigations have shown that the inoculation of efficient microbial community to the soil ecosystem improves soil quality, soil health, growth, yield and quality of crops. These microbial populations may consist of selected species of microorganisms including plant growth promoting rhizobacteria, cyanobacteria, plant disease suppressive bacteria and fungi, soil toxicant degrading microbes, actinomycetes and other useful microbes (Kavino et al. 2007) Efficient and potential soil microbial biota is required for sustainable agriculture practices and some of them have other potential applications. It is an added dimension to optimizing soil and crop management practices such as crop rotation, organic

amendments, conservation tillage, crop residue recycling, soil fertility restoration, maintenance of soil quality and the biocontrol of plant diseases. If used adequately, microbial communities can significantly benefit the agriculture practices. In this review Microbial diversity with relation to plant and its role in agro ecosystem would be discussed (Pandey et al. 2012).

A fundamental shift is taking place worldwide in agricultural practices and food production. Today, the drive for productivity is increasingly combined with the desire and even the demand for sustainability. Sustainable agriculture involves successful management of agricultural resources to satisfy human needs while maintaining environmental quality and also conserving natural resources for future. Improvement in agricultural sustainability requires the optimal use and management of soil fertility and its physico-chemical properties. Both rely on soil biological process and soil biodiversity. This implies management practices that enhance soil biological activity and thereby buildup long term soil productivity and crop health. Such practices are of major concern in almost all lands to avoid degradation and in restoration of degraded lands and in regions where high external input agriculture is not feasible (Lavania, et al. 2006).

Plants are always in immediate contact with microorganisms including different tissues of leaves and roots and also as endophytes presents within plant tissues. These microorganisms are actively associated with plant in their development, nutrient supply, plant growth promotion and protection against pathogens. There exist multiple diversity of microorganisms including bacteria, fungi, mycorrhiza, symbiotic and non-symbiotic nitrogen fixers. Here we have described some of the microbial diversity based on their significant role in plant growth (Goh et al. 2013).

### **Role Of Microbes In Soil**

Microorganisms in soil are critical to the maintenance of soil function in both natural and managed agricultural soils because of their involvement in such key processes as soil structure formation; decomposition of organic matter; toxin removal; and the cycling of carbon, nitrogen, phosphorus, potassium, ion chelation and sulphur (Massol et al. 1995). In addition, microorganisms play key roles in suppressing soil borne plant diseases and in promoting plant growth (Doran et al. 1996). Soil microbial communities are often difficult to fully characterize because of their immense phenotypic and genotypic diversity, heterogeneity, and crypt city. With respect to the latter, bacterial populations in soil top layers can go up to more than  $10^9$  cells/g of soil (Cockell et al. 2009), and most of these cells are generally unculturable. The fraction of the cells making up the soil microbial biomass that have been cultured and studied in any detail are often less than 5% (Borneman and Triplett. 1997). As direct DNA-based methods offer the possibility to assess the total microbial diversity present, thus bypassing the limitations of cultivation-based studies, recent years have seen the rapid development of such cultivation-independent methods for analyzing the microbial communities in soil (Massol et al. 1995). The direct methods have become indispensable in such studies; however, one needs to be caution about what information they are giving (VonWintzingerode et al. 1997). Functional diversity is an aspect of the overall microbial diversity in soil, and encompasses a range of activities. The relationship between microbial diversity and function in soil is largely unknown, but biodiversity has been assumed to influence ecosystem stability, productivity and resilience towards stress and disturbance in plant.

### **Bacterial Diversity**

Bacteria an important portion of the microbial diversity, represent one of the three domains in the phylogenetic tree (Archaea, Bacteria and Eukarya) (Olsen et al. 1994). Though bacteria are found almost everywhere, Rhizosphere is a region of soil which is in immediate contact with plants portion directly influenced by root exudates and considered as the most active region of soil where maximum microbial community resides. Rhizospheric region of soil plays a very important role in growth and development of plants. Bacteria are the major portion of biomass in the soil and are responsible for some essential nutrient cycling processes of carbon, nitrogen and sulfur. In addition to the bacterial diversity, intra specific diversity also persists. The bacterial diversity is not static, due to the high reproduction capacity associated with the short life cycle and high cell multiplication rates, which leads to the high adaptation value, and fast responses to environmental change (Konstantinidis et. al 2006).

A broad diversity of bacteria can interact with plants, composing bacterial communities with important roles in plant growth and development (Hallmann et al. 1997). There are various interactions associated with bacteria and plant which can vary according to the host plant in a process (Salvaudon et al. 2008). Bacterial populations are distributed in the rhizosphere, within epiphytic and endophytic communities.

Classification of bacteria as Epiphytic and endophytic depends on their colonization on plant surface and inner tissues of plants, respectively. Endophytes are those microbes which are isolated from the internal tissues of plant after disinfecting the outer surface (Hallmann et al. 1997). However, in addition to these definitions according to their essentiality in niche endophytes can be characterized into types one “passenger” endophytes, bacteria that eventually invade internal plant tissues by stochastic events and second “true” endophytes, those with adaptive traits enabling them to strictly live in association with the plants (Haridim et al. 2008). The microbial cells in the rhizosphere, plant-surface or endophyte communities are variable. The analysis of these communities could lead to the conclusion that there is a strict specificity for their habitation and niche colonization. However, a more realistic situation is represented by the gradient of bacterial population distribution along and within the plants. If a didactic approach is applied to explain bacterial communities associated with plants and plant tissues, it would divide these bacteria into distinct communities, with separation between epiphytic and endophytic communities in accordance with plant organs, such as roots, stems and leaves.

All these bacterial diversities present in soil have distinct role, such as supplying nutrient to the plant, enhancing plant growth by producing plant growth hormones, inhibition of plant pathogens, and all such bacteria are referred as plant growth promoting bacteria which can have symbiotic association or non-symbiotic association with plant some examples are listed in Table 1

Plant growth promoting rhizobacteria (PGPR) enhancing growth and development of crop/ fruit plants (Singh et al. 2011)

<b>PGPR</b>	<b>Plant Growth Parameters</b>
<i>Rhizobium leguminosarum</i>	Growth promotion of canola and lettuce
<i>Pseudomonas putida</i>	Early developments of canola seedlings
<i>Azospirillum brasilense</i> and <i>A. irakense</i> strains	Growth of wheat and maize plants
<i>P. fluorescens</i> strain	Growth of pearl millet
<i>P. putida</i> strain	Growth and development of tomato plant
<i>Azotobacter</i> and <i>Azospirillum</i> strains	Growth and productivity of canola
<i>P. alcaligenes</i> PsA15, <i>Bacillus polymyxa</i> BcP26, and <i>Mycobacterium phlei</i> MbP18	Enhance uptake of N, P and K by crop in nutrient deficient
<i>Pseudomonas</i> , <i>Azotobacter</i> and <i>Azospirillum</i> strains	Stimulates growth and yield of chick pea ( <i>Cicer arietinum</i> )
<i>R. leguminosarum</i> (Thal-8/SK8) and <i>Pseudomonas</i> sp. strain 54RB	Improve the yield and phosphorus uptake in wheat Plant
<i>P. putida</i> strains R-168 and DSM-291 and	Improves seed germination, seedling growth yield of maize Plant
<i>P. fluorescens</i> strains R-98 and DSM-50090 <i>A. brasilense</i> DSM-1691 <i>A. lipoferum</i> DSM-1690 and <i>P. putida</i> strain R-168	Seed germination, growth parameters of maize plant
<i>P. fluorescens</i> strain R-93, <i>P. fluorescens</i> DSM 50090, <i>P. putida</i> DSM291, <i>A. lipoferum</i> DSM 1691, <i>A. brasilense</i> DSM 1690 <i>P. fluorescens</i> strains, CHA0 and Pfl	Increase growth, leaf nutrient contents and yield of banana plants

### **Fungal Diversity**

Fungi are an important component of the soil microbiota typically constituting more of the soil biomass than bacteria, depending on soil depth and nutrient conditions (Ainsworth and Bisby, 1995). Many important plant pathogens (e.g. smuts and rusts) and plant growth promoting microorganisms (e.g., ecto- and endo-mycorrhizae) are fungi. The saprobic fungi represent the largest proportion of fungal species in soil and they perform a crucial role in the decomposition of plant structural polymers, such as, cellulose, hemicellulose, and lignin, thus contributing to the maintenance of the global carbon cycle. In addition, these catabolic activities enable fungi to grow on inexpensive substrates.

Fungal diversity in soil plays a significant role such as water dynamics, nutrient cycling, disease

suppression and decomposition. Fungi usually have a symbiotic mutualistic association they are mainly member of Zygomycota, Ascomycota or Basidiomycota in these symbioses, the host plant receives mineral nutrients, while the fungus obtains photosynthetically derived carbon compounds (Fortin et al. 2002). At least seven different fungi – plants associations have been recognized, with distinct morphological patterns, involving different groups of organisms (Brundrett et al. 1996). The most common ones are: i) vesicular arbuscular mycorrhizas (VAM), in which Zygomycetes fungi produce arbuscules, hyphae and vesicles among root cortex cells, between cell wall and plasmatic membrane; ii) ectomycorrhizas (ECM), where Basidiomycetes and other fungi form a mantle around roots and a so called Hartig net among root cells; iii) orchid mycorrhizas, where fungi produce coils of hyphae within roots (or stems) of orchidaceous plants; (iv) ericoid mycorrhizas, developing hyphal coils in outer cells of Ericales hair roots (Stone et al. 2000). Factors that can influence the establishment and persistence of mycorrhizal associations are various, besides symbiont compatibility: external factors edaphic or microclimatic conditions, presence of further soil organisms, nutrient competition; and internal factors organism phenology. Infective propagules must be present when root growth activity occurs, since roots have a limited period of susceptibility.

Fungi and other microbes in the soil and are critical to decomposing organic residues and recycling soil nutrients. Most soil fungi decompose recalcitrant organic residues high in cellulose and lignin. Carbon use efficiency of fungi is about 40–55% so they store and recycle more C (10:1 C: N ratio) and less N (10%) in their cells than bacteria. Fungi are more specialized but need a constant food source and grow better under no-till conditions. Arbuscular Mycorrhizal (AM) fungi produce an amino polysaccharide called glomalin. Glomalin surrounds the soil particles and glues macroaggregate soil particles together and gives soil its structure. AM fungus store and recycle N and P in the soil and have a symbiotic relationship with most plants, greatly increasing the N and P extraction efficiency and improving soil structure and water retention (Fortin et al. 2002).

### **Mycorrhizal Diversity**

*Glomus* forms largest genus of arbuscular mycorrhizal fungi (AMF). All species present in the species shows symbiotic relationships with plant roots. The establishment entire mechanism of symbiosis involves a sequence of recognition mechanism, following to the morphological and physiological integration of the two organisms (Logi et al. 1998). The life cycle of an AMF begins with spore germination, and follows with a pre-symbiotic mycelia growth phase, hyphal branching, appressorium formation, root colonisation, and finally arbuscule formation takes place (Giovannetti et al. 1994).

There are mainly of two types of mycorrhiza ecto- and endomycorrhizas. The ectomycorrhizas are characterized by an extracellular fungal growth associated with the root cortex and are more common in temperate and boreal forest trees, also found to be over 5000 species mainly within the Basidiomycetes (Covacevich et al. 2007). The tropical trees such as pine and eucalyptus plants, however, have also been found to appear ectomycorrhizal associations. The endomycorrhizas are characterized by inter-and intracellular fungal growth in root cortex, forming specific fungal growth, referred to as vesicles and arbuscules. This characteristic growth gives the endomycorrhiza the alternate name, vesicular arbuscular mycorrhiza. Mycorrhizal association in plants is widely distributed. About 80% of all terrestrial plant species form this type of symbiosis association and 95% of the world's present species of vascular plants belong to families that are characteristically

mycorrhizal (Quilambo et al. 2000). The arbuscular mycorrhizal fungi (AMF) belong to taxonomic order called Glomales.

Mycorrhiza shows symbiotic association between fungi and plant roots and is unlike either fungi or roots alone. Most trees and agricultural crops depend on or benefit substantially from mycorrhizae. The exceptions are many members of the Cruciferae family (e.g., broccoli, mustard), and the Chenopodiaceae family (e.g. lambsquarters, spinach, beets), which do not form mycorrhizal associations. The level of dependency on mycorrhizae varies greatly among varieties of some crops, including wheat and corn.

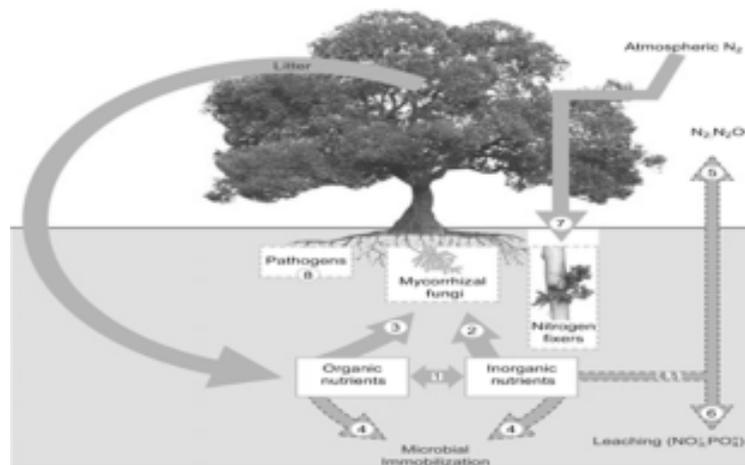
Land management practices affect the formation of mycorrhizae. The number of mycorrhizal fungi in soil will decline in fallowed fields or in those planted to crops that do not form mycorrhizae. Frequent tillage may reduce mycorrhizal associations, and broad spectrum fungicides are toxic to mycorrhizal fungi. Very high levels of nitrogen or phosphorus fertilizer may reduce inoculation of roots. Some inoculums of mycorrhizal fungi are commercially available and can be added to the soil at planting time (Banerjee et al. 2006). VAM fungi play crucial roles in both natural and agricultural situations, including Native ecosystems such as forests where fertilization of extensive land areas with large quantities of P is not practical, agricultural systems in which the high P-fixing capacities of soils and the unavailability or high cost of P fertilizer limits crop production, situations in which it is essential to reduce soil fertilizer application rates significantly because of environmental concerns, situations in which phosphate rock is readily available and used instead of superphosphate (Habte et al. 2000).

### **Beneficial Role Of Soil Microbes**

Biological nitrogen fixation is considered as one of the major mechanisms by which plants get benefited from soil microorganisms. According to an estimate, global contribution of biological nitrogen fixation is  $180 \times 10^6$  metric tons per year. Of this contribution, 83% comes from symbiotic associations of microbes, while the rest part of it is provided by free living or associative systems (Ashraf et al. 2013). Archaea and bacteria are the only living forms that are capable of fixing the atmospheric nitrogen and enrich the soil with this form of nitrogen (Robertson et al. 2009). These include symbiotic nitrogen fixers (Rhizobium in legumes, Frankia in non-leguminous trees) and non-symbiotic nitrogen fixers such as Azoarcus, Acetobacter diazotrophicus, Azotobacter, Azospirillum, cyanobacteria etc. Plants require an adequate supply of nutrients for their proper growth and development. Plants growing on the soils enriched with nutrients may still exhibit nutrient deficiencies due to unavailability of these mineral nutrients. However, plant growth promoting rhizobacteria are actively involved in the solubilization of important minerals such as phosphorous, iron, thereby enhancing the availability of these essential nutrients to plants (Glick et al. 1995). The positive role of PGPR in stimulating the plant growth by improving solubilization (releasing siderophores or organic acid) and nutrient uptake by the plants has been well documented in the literature (Glick et al. 1995).

Based on their activities Ahemad (2014) classified PGPR as biofertilizers (increasing the availability of nutrients to plant), phytostimulators (plant growth promoting, usually by the production of phytohormones), rhizoremediators (degrading organic pollutants) and biopesticides (controlling diseases, mainly by the production of antibiotics and antifungal metabolites). Bashan and Holguin (1998) proposed the division of PGPR into two classes: biocontrol-PGPB (plant-growth-promoting-

bacteria) and PGPB. This classification may include beneficial bacteria that are not rhizosphere bacteria but it does not seem to have been widely accepted. When studying beneficial rhizobacteria, the original definition of PGPR is generally used: it refers to the subset of soil and rhizosphere bacteria colonizing roots in a competitive environment, e.g. in non-sterilized or non-autoclaved field soils (García et al. 2003). Furthermore, in most studied cases, a single PGPR will often reveal multiple modes of action including biological control (García et al. 2003). Microorganisms like bacteria, fungi, actinomycetes, algae and protozoa exhibit various properties which are helpful in nutrient cyclin



Schematic

### Nitrogen Cycling.

Among various important gases of Earth's atmosphere,  $N_2$  is the most abundant gas which possesses the property of non-reactivity. Nitrogen ( $N_2$ ) is one of the basic necessities of living world. It comprises the formation of amino acids and proteins. Various organic compounds are derived from nitrogen fixation process. Biological nitrogen fixation is an important part of the wide range of protective responses aimed at deterring microbial processes.

The conversion of molecular nitrogen to ammonia is an enzyme catalyzed reaction which is the base of nitrogen fixation process. This enzyme is nitrogenase, an oxygen labile enzyme complex and found produced by free living and symbiotic diazotrophs (Rubio and Ludden 2005). Diazotrophs are ubiquitous in earth's soils and waters and exhibit a range of metabolic life styles (Masepohl and Klipp 1996).

### Non-Symbiotic Nitrogen Fixation

Free-living bacteria are found in soils that are free from the direct influence of plant roots and thus do not associate with plants. The amount of Nitrogen which is fixed by these microbe depends on their potential for accessibility to energy sources, i.e., substrates to generate adenosine triphosphate (ATP) and micronutrients required for the synthesis and functioning of nitrogenase (Reed et al. 2011). BNF by free-living diazotrophs is also limited by the severe oxygen sensitivity of nitrogenase (Postgate et al. 1998).

Due to their ability to fix  $N_2$ , diazotrophs can have a competitive advantage over non- $N_2$  fixing bacteria in the rhizosphere and prevail in it particularly when soil N is limited (Dobereiner and Pedrosa, 1987). In addition to enhancing their own growth, rhizosphere diazotrophs like *Acetobacter*, *Azoarcus*, *Azospirillum*, *Azotobacter*, *Beijerinckia*, *Burkholderia*, *Enterobacter*, *Herbaspirillum*, *Klebsiella*, *Paenibacillus* and *Pseudomonas*) have been shown to enhance the growth of the plants. These include agriculturally-important species such as plants like rice, wheat, barley, potato and several vegetable crops (Chanway et al. 2014).

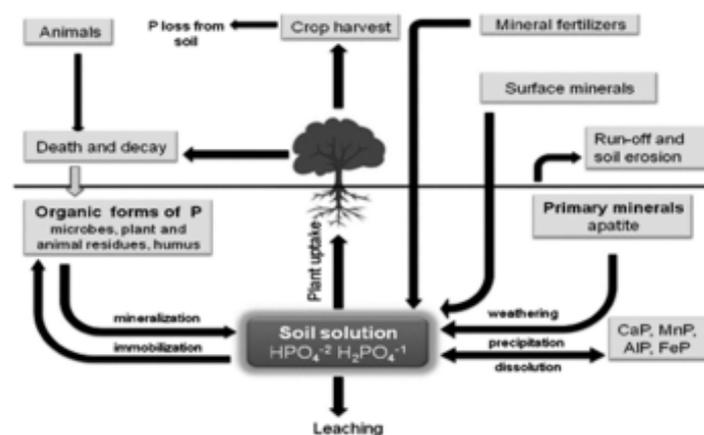
### Symbiotic Nitrogen Fixation

The term symbiosis generally denotes the mutual beneficial partnership between two organisms. Bacteria known collectively as Rhizobia are famous for their abilities to induce nodules on the roots of legume plants. In legume root nodule symbiosis, the legume is the bigger partner while the rhizobium is the smaller partner, often referred as microsymbiont. Within these nodules, the differentiated ‘‘bacteroid’’ forms fix atmospheric nitrogen and the resultant ammonia being used as the source of fixed nitrogen (Kanthé et al. 2012). The genus rhizobium has been placed in bergey’s manual of determinative bacteriology in such diverse families as azotobacteriaceae, mycobacteriaceae, myxobacteriaceae and pseudomonadaceae.

### Phosphorus Cycling

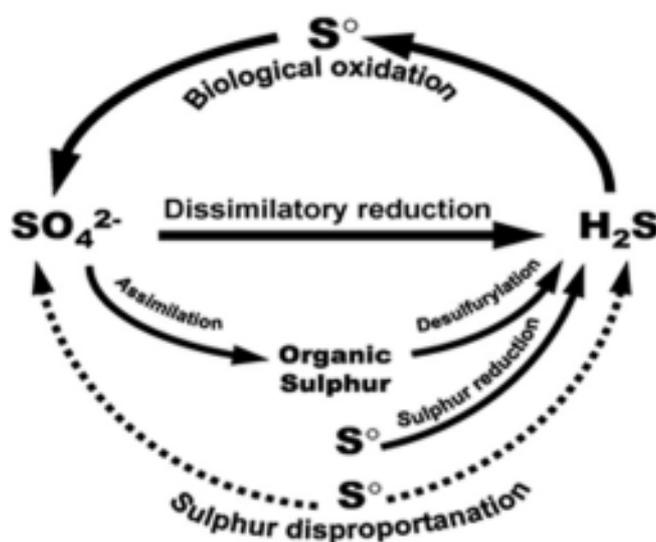
Phosphorus (P), being the second most important plant growth-limiting nutrient following nitrogen, is copiously available in both forms in soils, viz. organic and inorganic (Khan et al. 2009). Regardless of the large reservoir of P, the actual availability of its forms to the plant, is usually low. Richardson (2000) reported that most soils are poor in accessible phosphorus and phosphate compost signifies a high cost to the farmer; subsequently, it is intriguing to exploit soil microorganisms utilized as inoculum for the mobilization of phosphorus in poor soils. This low accessibility of phosphorous to plants is on the grounds that the dominant part of soil P is found in insoluble structures, while the plants assimilate it just in two solvent structures, the monobasic and the dibasic ions (Bhattacharyya and Jha 2012).

Use of phosphate solubilizing microorganisms assume imperative part in solubilizing the insoluble forms of phosphorus. Strains from genera *Pseudomonas*, *Bacillus*, *Rhizobium*, *Aspergillus* and *Cephalosporium* are among the phosphate solubilizers.



### Sulphur Cycling

Microorganisms assume an essential part in the worldwide cycle of different components, for example, sulfur, nitrogen, carbon and iron. Sulfur happens in mixed bag of oxidation states with three oxidation conditions of -2 (sulfide and decreased natural sulfur), 0 (essential sulfur) and +6 (sulfate) being the hugest in nature. Compound or natural operators help change of sulfur starting with one state then onto the next. A biogeochemical cycle which portrays these changes contains numerous oxidation-reduction responses. Hydrogen sulphide, a reduced type of sulfur, can be oxidized to sulfur or sulfate by a mixed population of microorganisms. Sulfate, can be again converted to sulfide by sulfate reducing microorganism (Ishimoto et al. 1954).



Sulphate reducing bacteria fall into three major branches: (i) the subclass of proteobacteria (more than 25 genera), (ii) the Gram positive bacteria (Desulfotomaculum, Desulfosporosinus), (iii) branches formed by Thermodesulfobacterium and Thermodesulfovibrio.

### Pottassium Solubilization

Potassium uptake of plants can be increased by using potassium solubilizers as bio-inoculants further increasing the crop production. Also co inoculation with other bio inoculants like Phosphate solublizers has also shown positive co-relation with yields of crops. Muentz showed the first evidence of microbial involvement in solubilization of rock potassium (Muentz et al. 1890). Microorganisms like Aspergillus niger, Bacillus extroquens and Clostridium pasteurianum were found to grow on muscovite, biotite, orthoclase microclase and mica in vitro (Archana et al. 2013). Different bacterial species like silicate bacteria were found to dissolve potassium, silicates and aluminium from insoluble minerals produces acids like citric acid, formic acid, malic acid, oxalic acid. These organic acids produced, enhance the dissolution of potassium compounds by supplying protons and by complexing Ca<sup>2+</sup> ions. Previous work has shown organic compounds produced by micro-organisms such as acetate, citrate and oxalate can increase mineral dissolution in soil (Sheng, 2003). Solubilization of potassium occurs by complex formation between organic acids and

metal ions such as  $\text{Fe}^{2+}$ ,  $\text{Al}^{3+}$  and  $\text{Ca}^{2+}$  (Styriakova et al. 2003).

### **Ironchelation**

Certain microbes oxidize ferrous iron to ferric state which hasten as ferric hydroxide around cells. These microorganisms usually known as iron microbes are typically non filamentous and round or bar molded like *Galionella*, *Siderophacus*, *Siderocapsa*, *Ferribacterium*, *Sideromonas* and so forth filamentous structures taking after green growth are likewise experienced like *Leptothrix* (Pringsheim et al. 1949), *toxothrix* etc. These microorganisms assume to play no critical part in cultivable soil.

Iron is an essential growth element for all living organisms. The scarcity of bioavailable iron in soil habitats and on plantsurfaces foments a furious competition (Loper and Henkels 1997). Under ironlimiting conditions PGPB produce low molecular weight compounds called siderophores to competitively acquire ferric ion (Whipps et al. 2001). Siderophores (Greek: "iron carrier") are small, high affinity iron chelating compounds secreted by microorganisms such as bacteria, fungi and grasses. Microbes release siderophores to scavenge iron from these mineral phases by formation of soluble  $\text{Fe}^{3+}$  complexes that can be taken up by active transport mechanisms. Many siderophores are non-ribosomal peptides, although several are biosynthesised independently (Challis et al. 2005). Siderophores are also important for some pathogenic bacteria for their acquisition of iron (Miethke and Marahiel 2007). Siderophores are amongst the strongest binders to  $\text{Fe}^{3+}$  known, with enterobactin being one of the strongest of these (Raymond, Dertz and Kim 2003). Distribution of siderophore producing isolates according to amplified ribosomal DNA restriction analysis (ARDRA) groups, reveals that most of the isolates belong to Gram negative bacteria corresponding to the *Pseudomonas* and *Enterobacter* genera, and *Bacillus* and *Rhodococcus* genera are the Gram positive bacteria found to produce siderophores

### **Other Trace Nutrients**

Plants require trace nutrients like, iron, manganese, copper, zinc etc. Non availability of these trace metals in soil may result in the manifestation of specific symptoms on plant parts.

Manganese is obligated to oxidation in soil relying upon pH, oxygen supply and natural matter substance of soil. In acidic soils it is available in a bivalent state in which state it is effortlessly accessible for assimilation by plants. In unbiased and alkaline soils, manganese occurs in trivalent or tetravalent state when the component is not effortlessly accessible for retention by plants. The change of manganous to manganic particles may be a microbiological methodology including microscopic organisms, for example, *azotobacter*, *chroococcum*, *pseudomonas flourescens*, *P.trifolii*, *leptothrix* sp., *aerobacter* sp., *proteus* sp., *corynebacterium* sp., *flavobacterium* sp., *chromobacterium* sp., *metallogenium* sp., and a few other unidentified ones (Ghiorse et al. 1984).

### **Harmful Role Of Soil Microorganisms**

Some soils are inhospitable to plant pathogens, by limiting either the survival or the growth of the pathogens. Such soils are known as pathogen- or disease-suppressive and are found throughout the world. Suppressiveness has been defined as either "general" or "specific," indicating either the absence or presence of information about the mechanisms involved. General suppression often reduces fungal and nematode attacks, whereas specific suppression is often effective against only one or a few pathogens.

Suppressive soils are further differentiated in accordance with their longevity in “long-standing suppression” and “induced suppression” (Chabrol et al. 1988). Long-standing suppression is a biological condition naturally associated with the soil, its origin is not known, and it appears to survive in the absence of plants. Induced suppression is initiated and sustained by crop monoculture or by the addition of inoculum of target pathogen.

### **Commercial Applications Of Plant Growth Promoting Rhizobacteria**

#### **Microbes as Biofertilizer**

Plant growth promoting rhizobacteria as natural manures, a gathering of biofertilizers comprising helpful rhizobacteria recognized as PGPR, are strains from genera of *Pseudomonas*, *Azospirillum*, *Azotobacter*, *Bacillus*, *Burkholderia*, *Enterobacter*, *Rhizobium*, *Erwinia* and *Flavobacterium* (Rodriguez and Fraga, 1999). Free-living PGPR guarantee to act as biofertilizers (Podile and Kishore 2007). Secondary metabolites from PGPR upgrade root development, prompting a root framework with vast surface region and expanded number of root hairs (Mantelin and Touraine 2004). Numerous studies and overviews reported plant development advancement, expanded yield, uptake of N and some different components through PGPR immunizations (Glick et al. 2007).

#### **Microbes as Biocontrol Agents**

The PGPR is a gathering of rhizosphere colonizing microbes that creates substances to expand the development of plants and/or secure them against illnesses (Harish et al., 2009). PGPR may ensure plant safety against pathogens. These incorporate, the capacity to deliver siderophores to chelate iron, to combat against contagious metabolites, for example, anti-microbials, parasitic cell divider lysing proteins, or hydrogen cyanide that stifle the development of contagious pathogens (Persello Cartieaux et al., 2003).

#### **References**

- Ahemad, M., & Kibret, M. (2014). Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective. *Journal of King Saud University-Science*, 26(1), 1-20.
- Archana, D. S., Nandish, M. S., Savalagi, V. P., & Alagawadi, A. R. (2013). Characterization of potassium solubilizing bacteria (KSB) from rhizosphere soil. *BIOINFOLET-A Quarterly Journal of Life Sciences*, 10(1b), 248-257.
- Ashraf, M. A., Asif, M., Zaheer, A., Malik, A., Ali, Q., & Rasool, M. (2013). Plant growth promoting rhizobacteria and sustainable agriculture: a review. *African Journal of Microbiology Research*, 7(9), 704-709.
- Banerjee, M. R., Yesmin, L., & Vessey, J. K. (2006). Plant-growth-promoting rhizobacteria as biofertilizers and biopesticides. *Handbook of microbial biofertilizers*. Food Products Press, New York, 137-181.
- Bashan, Y., & Holguin, G. (1998). Proposal for the division of plant growth-promoting rhizobacteria into two classifications: biocontrol-PGPB (plant growth-promoting bacteria) and PGPB. *Soil Biology and Biochemistry*, 30(8), 1225-1228.
- Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. *World Journal of Microbiology and Biotechnology*, 28(4), 1327-1350.

- Borneman, J., & Triplett, E. W. (1997). Molecular microbial diversity in soils from eastern Amazonia: evidence for unusual microorganisms and microbial population shifts associated with deforestation. *Applied and environmental microbiology*, 63(7), 2647-2653.
- Brundrett, M., Bougher, N., Dell, B., & Grove, T. (1996). Working Ylith Mycorrhizas in Forestry and Agriculture.
- Chabrol, M., Powlson, D. S., & Hornby, D. (1988). Uptake by maize (*Zea mays* L.) of nitrogen from <sup>15</sup>N-labelled dazomet, <sup>15</sup>N-labelled fertilizer and from the soil microbial biomass. *Soil Biology and Biochemistry*, 20(4), 517-523.
- Challis, G. L. (2005). A widely distributed bacterial pathway for siderophore biosynthesis independent of nonribosomal peptide synthetases. *Chembiochem*, 6(4), 601-611.
- Chanway, C. P., Anand, R., & Yang, H. (2014). Nitrogen fixation outside and inside plant tissues. *Advances in Biology and Ecology of Nitrogen Fixation*, 3-23.
- Cockell, C. S., OLSSON-FRANCIS, K., Herrera, A., & Meunier, A. (2009). Alteration textures in terrestrial volcanic glass and the associated bacterial community. *Geobiology*, 7(1), 50-65.
- Covacevich, F., Echeverría, H. E., & Aguirrezabal, L. A. (2007). Soil available phosphorus status determines indigenous mycorrhizal colonization of field and glasshouse-grown spring wheat from Argentina. *Applied Soil Ecology*, 35(1), 1-9.
- Dias, A. C., Costa, F. E., Andreote, F. D., Lacava, P. T., Teixeira, M. A., Assumpção, L. C., ... & Melo, I. S. (2009). Isolation of micropropagated strawberry endophytic bacteria and assessment of their potential for plant growth promotion. *World Journal of Microbiology and Biotechnology*, 25(2), 189-195.
- Dobereiner, J., & Pedrosa, F. O. (1987). *Nitrogen-fixing bacteria in nonleguminous crop plants*. Science Tech Publishers.
- Doran, J. W., & Parkin, T. B. (1994). *Defining and assessing soil quality. Defining soil quality for a sustainable environment*, (definingsoilqua), 1-21.
- Fortin, J. A., Bécard, G., Declerck, S., Dalpé, Y., St-Arnaud, M., Coughlan, A. P., & Piché, Y. (2002). Arbuscular mycorrhiza on root-organ cultures. *Canadian journal of botany*, 80(1), 1-20.
- García, J. L., Probanza, A., Ramos, B., & Mañero, F. G. (2003). Effects of three plant growth-promoting rhizobacteria on the growth of seedlings of tomato and pepper in two different sterilized and nonsterilized peats. *Archives of Agronomy and Soil Science*, 49(1), 119-127.
- Ghiorse, W. C. (1984). Biology of iron-and manganese-depositing bacteria. *Annual reviews in microbiology*, 38(1), 515-550.
- Giovannetti, M., & Gianinazzi-Pearson, V. (1994). Biodiversity in arbuscular mycorrhizal fungi. *Mycological Research*, 98(7), 705-715.
- Glick, B. R. (1995). The enhancement of plant growth by free-living bacteria. *Canadian Journal of Microbiology*, 41(2), 109-117.
- Glick, B. R., Todorovic, B., Czarny, J., Cheng, Z., Duan, J., & McConkey, B. (2007). Promotion of plant growth by bacterial ACC deaminase. *Critical Reviews in Plant Sciences*, 26(5-6), 227-242.
- Goh, C. H., Vallejos, D. F. V., Nicotra, A. B., & Mathesius, U. (2013). The impact of beneficial

- plant-associated microbes on plant phenotypic plasticity. *Journal of chemical ecology*, 39(7), 826-839.
- Habte, M. (2000). Mycorrhizal fungi and plant nutrition. *Plant nutrient management in Hawaii's soils, approaches for tropical and subtropical agriculture. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Manoa, Hawaii*, 127-131.
- Hallmann, J., Quadt-Hallmann, A., Mahaffee, W. F., & Kloepper, J. W. (1997). Bacterial endophytes in agricultural crops. *Canadian Journal of Microbiology*, 43(10), 895-914.
- Hardoim, P. R., van Overbeek, L. S., & van Elsas, J. D. (2008). Properties of bacterial endophytes and their proposed role in plant growth. *Trends in microbiology*, 16(10), 463-471.
- Harish, S., Michael, D. P., Bensely, A., Lal, D. M., & Rajadurai, A. (2009). Mechanical property evaluation of natural fiber coir composite. *Materials characterization*, 60(1), 44-49.
- Hawksworth, D. L., Kirk, P. M., Sutton, B. C., & Pegler, D. N. (1996). Ainsworth & Bisby's dictionary of the fungi. *Revista do Instituto de Medicina Tropical de São Paulo*, 38(4), 272-272.
- Ishimoto, M., Koyama, J., & Nagai, Y. (1954). A cytochrome and a green pigment of sulfate-reducing bacteria. *Bulletin of the Chemical Society of Japan*, 27(8), 564b-565.
- Kanthe, P. S., Patil, B. S., Bagali, S., Deshpande, A., Shaikh, G. B., & Aithala, M. (2012). Atherogenic index as a predictor of cardiovascular risk among women with different grades of obesity. *Int J Collab Res Int Med Public Health*, 4(10), 1767-1774.
- Kavino, M., Harish, S., Kumar, N., Saravanakumar, D., & Samiyappan, R. (2008). Induction of systemic resistance in banana (*Musa spp.*) against Banana bunchy top virus (BBTV) by combining chitin with root-colonizing *Pseudomonas fluorescens* strain CHA0. *European Journal of Plant Pathology*, 120(4), 353-362.
- Khan, A. A., Jilani, G., Akhtar, M. S., Naqvi, S. M. S., & Rasheed, M. (2009). Phosphorus solubilizing bacteria: occurrence, mechanisms and their role in crop production. *J Agric Biol Sci*, 1(1), 48-58.
- Konstantinidis, K. T., Ramette, A., & Tiedje, J. M. (2006). Toward a more robust assessment of intraspecies diversity, using fewer genetic markers. *Applied and environmental microbiology*, 72(11), 7286-7293.
- Lavania, M., Chauhan, P. S., Chauhan, S. V. S., Singh, H. B., & Nautiyal, C. S. (2006). Induction of plant defense enzymes and phenolics by treatment with plant growth-promoting rhizobacteria *Serratia marcescens* NBRI1213. *Current microbiology*, 52(5), 363-368.
- Logi, C., Sbrana, C., & Giovannetti, M. (1998). Cellular events involved in survival of individual arbuscular mycorrhizal symbionts growing in the absence of the host. *Applied and Environmental Microbiology*, 64(9), 3473-3479.
- Loper, J. E., & Henkels, M. D. (1997). Availability of iron to *Pseudomonas fluorescens* in rhizosphere and bulk soil evaluated with an ice nucleation reporter gene. *Applied and Environmental Microbiology*, 63(1), 99-105.
- Mantelin, S., & Touraine, B. (2004). Plant growth-promoting bacteria and nitrate availability: impacts on root development and nitrate uptake. *Journal of experimental Botany*, 55(394), 27-34.
- Masepohl, B., & Klipp, W. (1996). Organization and regulation of genes encoding the molybdenum

nitrogenase and the alternative nitrogenase in *Rhodobacter capsulatus*. *Archives of microbiology*, 165(2), 80-90.

Massol-Deya, A. A., Odelson, D. A., Hickey, R. F., & Tiedje, J. M. (1995). Bacterial community fingerprinting of amplified 16S and 16–23S ribosomal DNA gene sequences and restriction endonuclease analysis (ARDRA). In *Molecular microbial ecology manual* (pp. 289-296). Springer Netherlands.

Miethke, M., & Marahiel, M. A. (2007). Siderophore-based iron acquisition and pathogen control. *Microbiology and Molecular Biology Reviews*, 71(3), 413-451.

Müntz, A. (1890). Sur la decomposition des roches et la formation de la terre arable. *CR Acad Sci*, 110, 1370-1372.

Olsen, Gary J., Carl R. Woese, and Ross Overbeek. "The winds of (evolutionary) change: breathing new life into microbiology." *Journal of bacteriology* 176, no. 1 (1994): 1.

Pandey, V. C., Singh, K., Singh, J. S., Kumar, A., Singh, B., & Singh, R. P. (2012). *Jatropha curcas*: a potential biofuel plant for sustainable environmental development. *Renewable and Sustainable Energy Reviews*, 16(5), 2870-2883.

Persello-Cartieaux, F., Nussaume, L., & Robaglia, C. (2003). Tales from the underground: molecular. *Plant, Cell & Environment*, 26(2), 189-199.

Podile, A. R., & Kishore, G. K. (2007). Plant growth-promoting rhizobacteria. In *Plant-associated bacteria* (pp. 195-230). Springer Netherlands.

Postgate, J. (1998). The origins of the unit of nitrogen fixation at the University of Sussex. *Notes and Records of the Royal Society*, 52(2), 355-362.

Pringsheim, E. G. (1949). The filamentous bacteria *Sphaerotilus*, *Leptothrix*, *Cladothrix*, and their relation to iron and manganese. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 233(605), 453-482.

Quilambo, O. A. (2000). Functioning of peanut (*Arachis hypogaea* L.) under nutrient deficiency and drought stress in relation to symbiotic associations.

Raymond, K. N., Dertz, E. A., & Kim, S. S. (2003). Enterobactin: an archetype for microbial iron transport. *Proceedings of the National Academy of Sciences*, 100(7), 3584-3588.

Reed, K. A., & Jablonowski, C. (2011). Impact of physical parameterizations on idealized tropical cyclones in the Community Atmosphere Model. *Geophysical Research Letters*, 38(4).

Richardson, A. E. (2001). Prospects for using soil microorganisms to improve the acquisition of phosphorus by plants. *Functional Plant Biology*, 28(9), 897-906.

Robertson, G. P., & Vitousek, P. M. (2009). Nitrogen in agriculture: balancing the cost of an essential resource. *Annual Review of Environment and Resources*, 34, 97-125.

Rubio, L. M., & Ludden, P. W. (2005). Maturation of nitrogenase: a biochemical puzzle. *Journal of bacteriology*, 187(2), 405-414.

Singh, J. S., Pandey, V. C., & Singh, D. P. (2011). Efficient soil microorganisms: a new dimension for sustainable agriculture and environmental development. *Agriculture, ecosystems & environment*, 140(3), 339-353.

Stone, J. K., Bacon, C. W., & White, J. F. (2000). An overview of endophytic microbes: endophytism defined. *Microbial endophytes*, 3, 29-33.

Štyriaková, I., Štyriak, I., Galko, I., Hradil, D., & Bezdicka, P. (2003). The release of iron-bearing minerals and dissolution of feldspars by heterotrophic bacteria of *Bacillus* species. *Ceram. Silik.*, 47, 20-26.

Von Wintzingerode, F., Rainey, F. A., Kroppenstedt, R. M., & Stackebrandt, E. (1997). Identification of environmental strains of *Bacillus mycoides* by fatty acid analysis and species-specific 16S rDNA oligonucleotide probe. *FEMS microbiology ecology*, 24(3), 201-209.

Whipps, J. M. (2001). Microbial interactions and biocontrol in the rhizosphere. *Journal of experimental Botany*, 52(suppl 1), 487-511.



Original Paper

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## **Food Preservation Through Dehydration**

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### **Abstract**

Food preservation involves all those processes that can be used singly or in combination for optimum utilization and value addition. Theoretically all agricultural produce can be preserved but practically there are limitations. The products that get naturally dried are easily preserved while others need special treatment. Dehydration is one of the easiest methods to preserve agricultural produce. Experiments were designed to standardize methods for optimum value of selected fruits through dehydration.

Keywords: Dehydration, Fruits, value addition

### **Introduction**

Dehydration is one of most important complementary treatment and food preservation technique in the processing of dehydrated foods, since it presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decrease the energy costs. Dehydration results in increased shelf-life, little bit loss of aroma in dried and semidried food stuffs, lessening the load of freezing and to freeze the food without causing unnecessary changes in texture. It has been reported that dehydration reduced up to 50% weight of fresh vegetables and fruits.

Dehydration involves the immersion of foods in osmotic solution such as salts, and concentrated sugars, which some extent to dehydrates the food. Osmotic dehydration which improves the sensorial and nutritional properties, preserve and improve the organoleptic properties of foods. Osmotic dehydration is used with other drying methods such as freezing and deep microwave drying.

to make available better quality final product. However, higher temperature has the significant effect on the structure of tissues and cause flavor deterioration and enzymatic browning at temperature above 45oC.

### Material and Methods

Fresh fruits LIKE Apples, Bananas, Mangoes, Papayas, Chिकोos and Pineapples were purchased from the market. They were cut into uniform pieces and then they were blanched. For this first they were dipped into hot water then immediately they rinsed with cold water. Then they were strained well. The fruits were then cut into small biting sized chunks. Three sets of fruit chunks are made. The chunks were transferred to air tight containers and were subjected to dehydration in the following sets. One set was untreated so was called as control. The second set of the same was dried with salt i.e., salt was used as a preservative. The third set of the same fruit was dried with sugar i.e., sugar was used as a preservative. Then these sets were kept for dehydration by different methods like dehydration with sun method, dehydration with microwave method and dehydration using freeze drying as a method. The sets were observed after one and then again after two months. The aspects identified were time taken for dehydration, change in texture, colour, aroma, aesthetic value and taste.

### Results and Discussion

The fruits chunks which are dehydrated with different dehydration methods Show significantly different texture, colour, odour and taste. The same fruit chunk takes different time to dehydrate in different dehydration methods e.g, Orange took 1 day in microwave for drying while it took 4 days when it was sun dried, and the same fruit took 5 weeks to become freeze dried. The results of all selected fruits chunks are given below in tabulated form which gives the information about the texture, colour, taste, odour.

Table: 1 Showing the texture of dehydrated apple chunks

	Control		Salt Sugar
Sun dried	Average	Excellent	Excellent
Microwave	Average	Good	Excellent
Freeze dried	Excellent	Excellent	Excellent

Table: 2 Showing the of colour of dehydrated apple chunks

	Control	Salt	Sugar
Sun dried	Average	Excellent	Excellent
Microwave	Average	Average	Good
Freeze dried	Excellent	Excellent	Excellent

Table: 3 Showing the taste of dehydrated apple chunks

	Control		Salt Sugar
Sun dried	Average	Average	Excellent
Microwave	Average	Average	Excellent
Freeze dried	Good	Average	Excellent

Table: 4 Showing the Odour of dehydrated apple chunks

	Control	Salt	Sugar
Sun dried	Average	Average	Excellent
Microwave	Good	Good	Good
Freeze dried	Average	Average	Average

Table: 5 Showing the time taken by dehydrated apple chunks

	Control	Salt	Sugar
Sun dried	2 Days	2 Days	2 Days
Microwave	1 Day	1 Day	1 Day
Freeze dried	3 Week	3 Week	3 Week

Table: 6 Showing the texture of dehydrated banana chunks

	Control		Salt Sugar
Sun dried	Average	Good	Average
Microwave	Average	Good	Average
Freeze dried	Average	Average	Average

Table: 7 Showing the colour of dehydrated banana chunks

	Control		Salt Sugar
Sun dried	Average	Good	Average
Microwave	Average	Average	Average
Freeze dried	Average	Average	Average

Table: 8 Showing the taste of dehydrated banana chunks

	Control	Salt	Sugar
Sun dried	Average	Average	Excellent
Microwave	Average	Excellent	Excellent
Freeze dried	Average	Average	Good

Table: 9 Showing the Odour of dehydrated banana chunks

	Control		Salt Sugar
Sun dried	Good	Good	Excellent
Microwave	Good	Good	Excellent
Freeze dried	Average	Average	Average

Table: 10 Showing the Time-taken by dehydrated banana chunks

	Control	Salt	Sugar
Sun dried	2 Days	2 Days	2 Days
Microwave	1 Day	1 Day	1 Day
Freeze dried	4 Weeks	4 Weeks	4 Weeks

Table: 11 Showing the Texture of dehydrated orange chunks

	Control	Salt	Sugar
Sun dried	Average	Average	Average
Microwave	Good	Good	Good
Freeze dried	Excellent	Excellent	Excellent

Table: 12 Showing the Colour of dehydrated orange chunks

	Control	Salt	Sugar
Sun dried	Average	Average	Average
Microwave	Good	Good	Good
Freeze dried	Excellent	Excellent	Excellent

Table: 13 Showing the Taste of dehydrated orange chunks

	Control	Salt	Sugar
Sun dried	Average	Average	Average
Microwave	Average	Average	Good
Freeze dried	Excellent	Good	Excellent

Table: 14 Showing the Odour of dehydrated orange chunks

	Control		Salt Sugar
Sun dried	Good	Good	Good
Microwave	Good	Good	Good
Freeze dried	Average	Average	Average

Table: 15 Showing the Time-taken by dehydrated orange chunks

	Control	Salt	Sugar
Sun dried	4 Days	4 Days	4 Days
Microwave	1 Day	1 Day	1 Day
Freeze dried	5 Weeks	5 Weeks	5 Weeks

Table: 16 Showing the Texture of dehydrated papaya chunks

	Control	Salt	Sugar
Sun dried	Good	Good	Good
Microwave	Average	Average	Average
Freeze dried	Excellent	Excellent	Excellent

Table: 17 Showing the Colour of dehydrated papaya chunks

	Control	Salt	Sugar
Sun dried	Good	Good	Good
Microwave	Good	Good	Excellent
Freeze dried	Excellent	Excellent	Excellent

Table: 18 Showing the Taste of dehydrated papaya chunks

	Control	Salt	Sugar
Sun dried	Good	Average	Excellent
Microwave	Good	Average	Excellent
Freeze dried	Excellent	Average	Excellent

Table: 19 Showing the Odour of dehydrated papaya chunks

	Control	Salt	Sugar
Sun dried	Excellent	Excellent	Excellent
Microwave	Excellent	Excellent	Excellent
Freeze dried	Average	Average	Average

Table: 20 Showing the Time-taken of dehydrated papaya chunks

	Control	Salt	Sugar
Sun dried	2 Days	2 Days	2 Days
Microwave	1 Day	1 Day	1 Day
Freeze dried	3 Weeks	3 Weeks	3 Weeks

Table: 21 Showing the Texture of dehydrated pineapple chunks

	Control	Salt	Sugar
Sun dried	Average	Good	Good
Microwave	Excellent	Good	Excellent
Freeze dried	Excellent	Excellent	Excellent

Table: 22 Showing the Colour of dehydrated pineapple chunks

	Control		Salt Sugar
Sun dried	Average	Average	Average
Microwave	Good	Good	Good
Freeze dried	Excellent	Excellent	Excellent

Table: 23 Showing the Taste of dehydrated pineapple chunks

	Control		Salt Sugar
Sun dried	Average	Good	Good
Microwave	Good	Excellent	Excellent
Freeze dried	Excellent	Excellent	Excellent

Table: 24 Showing the Odour of dehydrated pineapple chunks

	Control	Salt	Sugar
Sun dried	Good	Good	Good
Microwave	Excellent	Excellent	Excellent
Freeze dried	Average	Average	Average

Table: 25 Showing the Timetaken of dehydrated pineapple chunks

	Control	Salt	Sugar
Sun dried	1 Day	1 Day	1 Day
Microwave	1 Day	1 Day	1 Day
Freeze dried	3 Weeks	3 Weeks	3 Weeks

#### Significance Of Value Addition

Dehydration is very significant method of food preservation. Standardisation of methods help in the preservation of extra agricultural produce for future use. These fruit chunks can be utilized in many ways. They can be used them as a mouth freshner, in mocktails, juices, with corn flakes, ice cream, puddings, desserts, cookies etc.

#### References

- Bongirwir, D.R. and Sreenivasan, A. 1977. Studies on osmotic dehydration of Bananas. J. Food Sci. Technol. India pp.104-112
- Colin, D. 1992.Recent trends in fruit and vegetable processing.Food Science and technology today 7(2):111-116
- Desrosier, N.W. and Desrosier, J.N. 1977Technology of food preservationAVI Publishing Co. Westport, Conn.



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## **Isolation Of Tannase Producing Fungi And Optimization Of Culture Conditions For Tannase Production By Fungus tws-3**

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### **Abstract**

The tannase also known as tannin acyl hydrolase (TAH, E.C 3.1.1.20)), is a hydrolytic enzyme that acts on tannins. Primary screening for tannase was carried out from different soil samples. Six fungal isolates were obtained on the basis of zone of clearance produced on plates containing tannic acid. Among the isolates, fungus TWS-3 produced the highest 0.96 U/ml of tannase in submerged condition at 30°C, 150 rpm on a rotary shaker after 48 h. As inoculum  $2 \times 10^7$  numbers of spores were found optimum for enzyme production. 1.0 gm% tannic acid showed the maximum tannase production. Among the other supplementary carbon sources tested, glucose was found as the best and it produced 2.51 U/ml of tannase with amla juice as a source of tannins. Ammonium chloride at 0.3 gm% showed the highest 3.45 U/ml of enzyme production among the organic and inorganic nitrogen sources tested. The tannase produced was partially purified by ammonium sulphate precipitation and 20-70% fraction gave 43.53 U/mg specific activity with 6.8 fold purification.

Keywords: Screening, tannase, tannic acid, amla juice, ammonium sulphate precipitation

### Introduction

The enzyme tannase (E.C 3.1.1.20) also known as tannin acyl hydrolase (TAH), is a hydrolytic enzyme that acts on tannin such as tannic acid, methyl gallate, ethyl gallate, n- propylgallate, and isoamyl gallate. Tannase is responsible for the hydrolysis of ester and depside linkages in tannins to liberate gallic acid and glucose (Belur and Mugeraya, 2011). Such enzymes are naturally produced by ruminant animals, plants and microorganisms such as filamentous fungi belonging to the genera *Aspergillus* and *Penicillium*. The genus *Aspergillus* is considered as the best producer, followed by *Penicillium*, both standing out as great decomposers of tannins and have better thermal and pH stability (Lekha and Lonsane, 1994, Sabu et al., 2005).

Tannins are naturally-occurring plant polyphenols with proteins and other polymers such as cellulose, hemicellulose and pectin to form stable complexes. Tannins are found in leaves, bark, galls and wood. Tannins have important role in plant immunity and protect them from microbial attacks (Aguilar et al., 2001). Plants are rich sources of gallic acid either in free form or as a part of tannin molecule. Industrial production of gallic acid (3,4,5-trihydroxybenzoic acid) is generally accomplished by the bioconversion of tannic acid by tannase. Gallic acid is mostly used in the pharmaceutical industry for production of antibacterial drug trimethoprim. It is also used in the manufacturing of gallic acid esters such as propyl gallate, which is widely used as food antioxidant in the manufacture of pyrogallol, in leather industry and as a photosensitive resin in semiconductor production. Pyrogallol is used in staining fur, leather and hair, and also as a photographic developer (Kar et al., 1999).

Tannase has potential applications especially in the beverage industry and instant teas and coffees, as well as in the production of gallic acid and clarification of fruit juice rich in tannins, aiming to reduce the astringency of such products (Selwal and Selwal, 2012). Tannase is used in the treatment of tannery effluents and pretreatment of tannin rich of animal feed (Aguilar et al. 2007).

In the present study, isolation of tannase producing fungi, optimization of culture conditions and partial purification of enzyme is reported.

### Materials and Methods

Tannic acid, rhodanine, Potato dextrose agar medium and agar powder were purchased from Hi-Media laboratories Pvt. Ltd. Gallic acid was bought from Sloca Research Laboratories Pvt. Ltd. Folin-phenol reagent and ammonium sulfate were purchased from SRL. All other chemicals used were of analytical grade.

### Isolation Of Tannase Producing Microorganisms

The tannase producing microorganisms were isolated from different soil samples like fertile soil, amla litter soil, jamun leaves litter soil, tea waste dump soil etc. Ten different soil samples collected from various places of Anand district, Gujarat were screened for tannase producing microorganisms. For primary screening of tannase producers, medium containing (% w/v) tannic acid-1.0,  $\text{NaNO}_3$ -0.3,  $\text{KH}_2\text{PO}_4$ -0.1,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ -0.05,  $\text{KCl}$ -0.05,  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ -0.001, Agar- 3.0, pH- 4.5 was used. Approximately 1.0 g of soil sample was added in sterile distilled water and shaken vigorously. Then, the suspended soil particles were allowed to settle down and supernatant was used as suspension. It was diluted appropriately and 0.1 ml was spreaded on the tannic acid

agar plates and incubated at 30°C for 48 h. Growth of colonies and zone of clearance produced upon tannic acid hydrolysis was checked for isolation of tannase producing microorganisms.

#### **Tannase Assay**

Tannase activity was measured by chromogen formation between gallic acid and rhodanine (Sharma et al., 2000). The reaction mixture containing 0.25 ml of 0.01 M, methyl gallate in 0.05 M citrate buffer, (pH 5.0) and 0.25 ml of appropriately diluted enzyme was incubated at 50 °C in waterbath for 10 min. After that 0.2 ml of 0.5 M potassium hydroxide (KOH) was added to stop the reaction. Then, 0.3 ml of methanolic rhodanine 0.667% (w/v) was added. In a control tube, KOH was added first with the substrate methyl gallate and after that enzyme was added. The reaction mixture was diluted by adding 4.0 ml distilled water and absorbance was measured at 520 nm. The amount of gallic acid produced was estimated from a standard calibration curve of 0 – 200 µg. One unit was defined as the amount of enzyme that produced one µmol of gallic acid per min under assay conditions.

Protein concentration was determined by Folin phenol reagent method (Lowry et al, 1951) with bovine serum albumin as a standard (0-100 µg/ml).

#### **Tannic Acid Estimation**

Tannic acid compounds were estimated using the Folin and Ciocalteu reagent. To 100 µl of appropriately diluted sample, 1.5 ml of 20% (w/v) sodium carbonate and 0.5 ml of Folin-phenol reagent were added. The mixture was kept at room temperature for 1 h and absorbance was measured at 725 nm. The amount of tannic acid was determined from a standard calibration curve of 0 – 100 µg.

#### **Preparation Of Spore Suspension**

For fungal tannase production, young spore suspension was prepared and directly used as inoculum. To prepare spore suspension, isolated fungal cultures were grown on potato dextrose agar slant at 30°C upto 4 days for sporulation. 10 ml sterile distilled water containing 0.1 (v/v %) Tween 80 was added to harvest the spores from slant. The slant cultures were vortexed properly to obtain spore suspension. Spore count was carried out using Neuber's Chamber after appropriate dilution of the prepared spore suspension. The prepared spore suspension was directly used as inoculum for submerged tannase production.

#### **Screening Of Tannase Producing Isolates**

Five fungal isolates were isolated on the basis of zone of clearance on the tannic acid agar plates and they were further screened for tannase production in shake flask cultures. Five fungal isolates viz. ALS-1, ALS-2, ALS-3, TWS-1 and TWS-3 were inoculated in sterile 50 ml tannic acid medium as mentioned above except ager in 250 ml Erlenmeyer flask and incubated at 30°C, 150 rpm on a rotary shaker. Extracellular tannase production was checked after 24 h up 96 h. To estimate tannase from the samples, fungal biomass was separated using Whatman No.1 filter paper and filtrate was analyzed. The isolated fungal cultures were maintained on potato dextrose agar slants at 4°C by periodic transfer.

#### **Optimization Of Inoculum Size**

Fungus TWS-3 showed the highest tannase production among the five isolates in shake flask

culture. Therefore, it was selected for further optimization studies. The inoculum size for TWS-3 was optimized for submerged tannase production. As the inoculum size  $1 \times 10^7$ ,  $2 \times 10^7$  and  $1 \times 10^8$  number of spores were inoculated in 50 ml tannic acid medium and incubated at  $30^\circ\text{C}$ , 150 rpm for 48 h on a rotary shaker. After incubation, tannase production was checked from the filtrate.

### **Optimization Of Tannic Acid Concentration**

As tannase production was induced in presence of tannic acid, its different concentrations were tested for enzyme production. Tannic acid (w/v/%) was added at 0.3%, 0.6%, 1.0%, 1.5% concentrations keeping other components same as tannic acid medium. Prepared sterile media flasks were inoculated by fresh spore suspension with final count of  $2 \times 10^7$  spores/ml. The inoculated culture flasks were incubated at  $30^\circ\text{C}$ , 150 rpm on a rotary shaker for 48 h. After incubation, the fungal biomass was separated by the filtration and filtrate was analyzed for tannase production.

### **Preparation Of Amla Juice**

100 gm of fresh amla (Indian gooseberry) was washed thoroughly and chopped with a clean knife to remove seeds. It was crushed in a jar of juicer-mixer. The crushed amla pulp was filtered through cheese cloth. The filtered amla juice obtained was stored at  $0^\circ\text{C}$  until further use.

### **Effect Of Supplementary Carbon Sources On Tannase Production**

To check the effect of various carbon sources on tannase production, tannic acid medium was supplemented with carbon source. Fungus TWS-3 was tested for tannase production using different carbon sources viz. glucose, fructose, sucrose and starch at 0.3 gm%. In a separate experiment, 1 gm% tannic acid was replaced by amla juice (12.5 ml) supplemented with 0.3 gm% glucose in the production medium. Each 250 ml flask containing 50 ml media were inoculated by fresh spore suspension. The inoculated culture flasks were incubated at  $30^\circ\text{C}$ , 150 rpm for 48 h on a rotary shaker. After incubation, the fungal biomass was separated by the filtration and filtrate was analyzed for tannase production.

### **Effect of Nitrogen Sources On Tannase Production**

Effect of different organic and inorganic nitrogen sources was tested on tannase production. In this set of experiments 1 gm% tannic acid was replaced by amla juice (12.5 ml) in the tannic acid medium. To check the effect of nitrogen sources, 0.2 gm%  $\text{NaNO}_3$  was replaced by ammonium chloride, ammonium sulfate, ammonium nitrate as inorganic nitrogen sources and peptone and yeast extract as organic nitrogen sources. Prepared sterile media flasks were inoculated by fresh spore suspension. The inoculated culture flasks were incubated at  $30^\circ\text{C}$ , 150 rpm on a rotary shaker for 48 h. After incubation, the fungal biomass was separated by the filtration and analyzed for tannase production.

For tannase production, ammonium chloride was found as the best among the nitrogen sources tested. In subsequent experiment, different concentrations of ammonium chloride (w/v %) i.e. 0.1%, 0.2%, 0.3%, 0.4% and 0.5% were tested.

### **Enzyme Precipitation**

The optimized medium containing amla juice - 12.5 ml, glucose - 0.2 gm%, ammonium chloride - 0.2 gm%,  $\text{KH}_2\text{PO}_4$  - 0.1 gm%,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  - 0.05 gm%, KCl - 0.05 gm%, pH 4.5 was inoculated with young spore suspension and incubated at  $30^\circ\text{C}$ , 150 rpm for 48 h for tannase production. After

incubation, the medium was filtered to remove the fungal biomass and filtrate obtained was subjected to ammonium sulphate precipitation. To 90 ml of crude enzyme 20 gm% ammonium sulphate was added slowly in an ice bath with gentle stirring and kept for 2 h. The precipitated proteins were separated at 8000rpm for 15 min in refrigerated centrifuge. The first protein pellet obtained was dissolved in 0.5 M acetate buffer, pH 5.0 and stored at 4°C until further use. The remaining supernatant was further precipitated to achieve 20-70 gm% ammonium sulphate saturation in an ice bath and kept overnight to facilitate protein precipitation. Then, it was centrifuged at 8000rpm for 15 min to separate the precipitated proteins. The second protein pellet was dissolved in 0.5 M acetate buffer, pH 5.0 and stored at 4°C. Both the precipitated protein fractions were carefully transferred to dialysis bags and dialyzed against acetate buffer, 0.5 M, pH-5 at 4°C. The buffer assembly with dialysis bags was stirred gently using a magnetic stirrer to enhance solute exchange. Dialysis was carried out overnight with three buffer changes.

Amount of enzyme tannase and protein was determined in crude as well as in both the fractions of ammonium sulphate precipitation. For concentrated tannase, specific activity and fold purification was calculated.

## Results and Discussion

### Isolation Of Tannase Producing Organisms

Screening is defined as the detection and isolation of desired microorganisms from a large microbial population by using highly selective methods. The plate screening method is a qualitative, simple and rapid screening procedure for tannase production. Fungi producing tannase showed zone of clearance surrounding the colonies (Fig. 1). These clear zones were formed due to the hydrolysis of tannic acid to gallic acid and glucose.

We got five fungal isolates producing clear zone on plate with tannic acid and named them according to their soil source like amla litter soil (ALS), tea waste dump soil (TWS). Among the isolates namely ALS-1, ALS-2, ALS-3, TWS-1 and TWS-3, zone of clearance produced by TWS-3 and ALS-2 is shown in Figure 1.

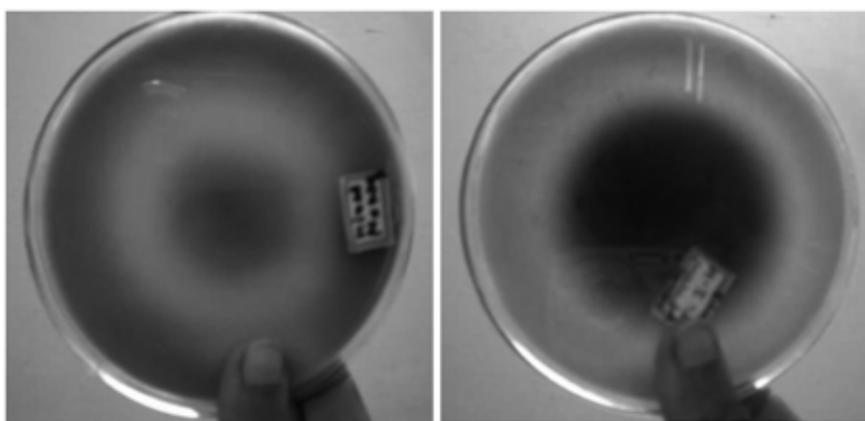


Figure 1 - Zone of clearance produced by fungi TWS-3 and ALS-2

### Screening Of Tannase Producing Isolates

Five fungal cultures viz. TWS-1, TWS-3, ALS-1, ALS-2 and ALS-3 were selected for further tannase production on the basis of plate assay. All the cultures were inoculated with spore suspension ( $1 \times 10^7$  spores/ml) in 250 ml flask containing 50 ml of tannic acid medium. The inoculated flasks were incubated at  $30^\circ\text{C}$ , 150 rpm for 96 h and were analysed for tannase production at 24 h time interval. Tannase production by these five isolates is shown in Table 1. Fungal culture TWS-3 produced the highest quantity of tannase (0.96 U/ml) after 48 h and hence it was selected for further studies.

Incubation time (h)	Tannase production (U/ml)				
	ALS-1	ALS-2	ALS-3	TWS-1	TWS-3
24	0.016	0.027	0.25	0.18	0.49
48	0.099	0.42	0.63	0.34	0.96
72	0.045	0.18	0.30	0.19	0.63
96	0.032	0.02	0.26	0.04	0.25

Table 1: Tannase production from five fungal isolates

### Optimization Of Different Inoculum Size

The effect of inoculum size was studied for optimal tannase production using TWS-3. The different inoculum size was tested as number of spores  $1 \times 10^7$ ,  $2 \times 10^7$  and  $1 \times 10^8$  inoculated for enzyme production in 250 ml flask containing 50 ml of tannic acid medium and incubated at  $30^\circ\text{C}$ , 150 rpm for 48 h on a rotary shaker.  $2 \times 10^7$  no. of spores as inoculum showed the maximum tannase production of 1.09 U/ml (Table 2). It may be because of formation of very good small pellets of fungus which is different in other two cases.

Inoculum size	Tannase (U/ml)
$1 \times 10^7$	0.52
$2 \times 10^7$	1.09
$1 \times 10^8$	0.86

Table 2: Tannase production with different inoculum size

### Optimization Of Tannic Acid

As tannic acid is hydrolysable tannin and so it is the most suitable carbon source used for tannase production. The different concentrations of tannic acid were checked in the medium to get higher tannase production. The addition of 1 gm% tannic acid was proved as the best for tannase production (Table 3) and the highest extracellular tannase of 1.07 U/ml was produced after 48 h.

Tannic acid (gm %)	Tannase (U/ml)
0.3	0.40
0.6	0.85
1.0	1.07
1.5	0.60

Table 3: Effect of Tannic Acid on enzyme production

Banerjee and Pati (2007) reported 1.0 gm% tannic acid as optimum for tannase produced by *Aureobasidium pullulans* DBS66. In other report, 2 gm% tannic acid showed maximum tannase production using *Asp. japonicus* in Czapeck's Dox medium (Bradoo et al. 1997). Sharma et al. (2007) reported 5 gm% tannic acid for maximum tannase production using *Asp. niger*.

#### Effect Of Supplementary Carbon Sources

Various carbon sources were tested at 0.3 gm% in addition to tannic acid in the medium to maximize tannase production. TWS-3 produced considerable amount of tannase with all the tested supplement any carbon sources viz. glucose, fructose, sucrose and starch (Table 4). Addition of glucose produced 1.88 U/ml of tannase showed about 75% increase in enzyme production. When glucose and amla juice (in replacement of 1 gm% tannic acid) combination was checked for tannase production, 2.51 U/ml of tannase was produced indicating 134% increase in enzyme. As addition of glucose may be beneficial to the initial growth of fungi and natural tannins and growth factors present in amla juice might have enhanced the tannase production.

Carbon sources	Tannase (U/ml)
Sucrose	0.47
Fructose	0.35
Starch	1.3
Glucose	1.88
Glucose with amla juice	2.51

Table 4: Effect of supplementary carbon sources on tannase production

Kar and Banerjee (2000) reported higher tannase production using *Caesalpinia digyna* seed cover powder than that obtained with only tannic acid. Sabu et al. (2005) stated that glucose and other readily metabolized carbon source reduce the lag period required for tannase synthesis and production. Banerjee and Pati (2007) also reported stimulatory effect of glucose at 0.1 gm% glucose on tannase production. Aguilar et al. (2001) reported the increased tannase production at 0.06 to 0.25 gm% glucose but but observed strong catabolite repression at 0.5 gm% using *Aspergillus niger* Aa-20 in submerged fermentation.

#### Effect Of Different Nitrogen Sources

The effect of different nitrogen sources was tested in the medium to increase tannase production. TWS-3 produced tannase with all the tested inorganic nitrogen sources (ammonium chloride, ammonium sulphate, ammonium nitrate) and organic nitrogen sources (yeast extract and peptone) as shown in Table 5. The highest tannase production of 2.18 U/ml was observed with ammonium chloride.

Nitrogen sources	Tannase (U/ml)
Ammonium chloride	2.18
Ammonium sulphate	1.38
Yeast extract	1.20
Ammonium nitrate	0.58
Peptone	0.63

Table 5: Effect of inorganic and organic nitrogen sources on tannase production

In compare to organic nitrogen sources, inorganic nitrogen sources proved better for TWS-3. The effect of inorganic nitrogen source like  $\text{NaNO}_3$  has been reported during the production of tannase by *Aspergillus japonicus* (Bradoo et al., 1997). Similarly, Paranthaman et al. (2009) reported tannase production by *Aspergillus flavus* in the medium containing  $\text{NaNO}_3$ . The *Aureobasidium pullulans* DBS66 showed maximum tannase production with  $(\text{NH}_4)_2\text{HPO}_4$  as nitrogen source (Banerjee and Pati, 2007).

In subsequent experiment tannase production was measured at different ammonium chloride concentrations (w/v %) like 0.1, 0.2, 0.3, 0.4, 0.5 and results are shown in Table 6. The ammonium chloride at 0.3 gm% concentration showed 3.45 U/ml tannase production indicated 222% increase.

Ammonium chloride (gm%)	Tannase (U/ml)
0.10	2.65
0.20	3.18
0.30	3.45
0.40	3.4
0.50	1.6

Table 6: The effect of ammonium chloride concentrations on tannase production

#### Ammonium Sulphate Precipitation

Crude tannase produced by TWS-3 fungal culture was concentrated and partially purified by ammonium sulphate precipitation. The tannase was partially purified in two fractions of 0-20% and 20-70% ammonium sulphate saturation. The result of specific activity and fold purification is shown in Table 7. The protein fraction of 20-70% ammonium sulphate saturation showed 43.53 U/mg of specific activity with 6.8 fold purification.

Procedure	Activity (U/ml)	Protein (mg/ml)	Specific activity (U/mg)	Purification fold	Yield (%)
Crude enzyme	5.97	2.83	2.10	1	100
Ammonium sulphate : 0-20%	5.6	0.73	7.67	4.1	22.19
Ammonium sulphate: 20-70%	7.41	0.17	43.53	6.8	

Table 7: The partial purification of tannase by ammonium sulphate precipitation

The partial purification of tannase from *Aspergillus ficuum* Gim 3.6 was carried out by aqueous two-phase extraction (ATPE) and 2.74 fold tannase was obtained (Ma et al. 2015). The tannase from *Penicillium notatum* NCIM 923 was purified by precipitation with ammonium sulphate at the saturation level of 75% and it was purified 5.96-fold with the specific activity was 6.74 U/mg (Gayen and Ghosh, 2013). The tannase from *Aspergillus niger* MTCC 2425 was purified to 1.4-fold with a yield of about 72.5% and the specific activity was 40.5 U/mg by

ammonium sulphate precipitation (Nandi and Chatterjee, 2016).

### References

- Aguilar CN, Augur C, Favela-Torres E, Viniegra-Gonzalez G (2001) Production of tannase by *Aspergillus niger* Aa-20 in submerged and solid state fermentation: influence of glucose and tannic acid. *J Ind Microbiol Biotechnol*, 26: 295–302
- Aguilar CN, Gutierrez-Sanchez G. (2001) Review: Sources, properties, applications and potential uses of tannin acyl hydrolase. *Food Science and Technology International*, 7(5):373-382
- Aguilar CN, Rodríguez R, Gutiérrez-Sánchez G. (2007) Microbial tannases: advances and perspectives. *Applied Microbiology and Biotechnology*, 76(1):47–59.
- Banerjee D, Pati BR. (2007) Optimization of tannase production by *Aureobasidium pullulans* DBS66. *J Microbiol Biotechnol*. 17:1049–1053.
- Belur PD, G Mugeraya. (2011) Microbial production of Tannase: State of art. *Res. J. Microbiol.*, 6(1): 25-40.
- Bradoo S, Gupta R, Saxena RK (1997) Parametric optimization and biochemical regulation of extracellular tannase from *Aspergillus japonicus*. *Process Biochem* 32:135–139
- Gayen S, Ghosh U. (2013) Purification and characterization of tannin acyl hydrolase produced by mixed solid state fermentation of wheat bran and marigold flower by *Penicillium notatum* NCIM 923 *BioMed Research International*, Volume 2013, Article ID 596380
- Kar B, Banerjee R, Bhattacharyya BC. (1999). Microbial production of gallic acid by modified solid state fermentation, *Journal of Industrial Microbiology and Biotechnology*, 23:173–177.
- Lekha PK, Lonsane BK (1994) Comparative titres, location and properties of tannin acyl hydrolase produced by *Aspergillus niger* PKL 104 in solid state, liquid surface and submerged fermentations. *Process Biochem*. 29:497–503
- Lowry OH, Rosenbrough NJ, Farr A, Randall RJ. (1951) Protein measurement with the Folin phenol reagent. *J Biol Chem*, 193:265-75.
- Ma WL, Zhao FF, Ye Q, Hu ZX, Yan D, Hou J, Yang Y. (2015) Production and partial purification of tannase from *Aspergillus ficuum* Gim 3.6. *Prep Biochem Biotechnol*. 45(8):754-68.
- Nandi S, Chatterjee A. (2016) Extraction, partial purification and application of tannase from *Aspergillus niger* MTCC 2425. *International Journal of Food Science and Nutrition*, 1(3):20-23
- Paranthaman R, Vidyalakshmi R, Muruges S, Singaravadi K. (2009) Optimization of various culture media for tannase production in submerged fermentation by *Aspergillus flavus*. *Advances in Biological Research* 3(1-2): 34-39
- Sabu A, Pandey A, Jaafar Daud M, Szakacs G. (2005) Tamarind seed powder and palm kernel cake: two novel agro residues for the production of tannase under solid state fermentation by *Aspergillus niger* ATCC 16620. *Bioresource Technology*, 96(11):1223–1228.

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Selwal MK, Selwal KK. (2012) High-level tannase production by *Penicillium atramentosum* KM using agro residues under submerged fermentation. *Annals of Microbiology*, 62(1):139–148

Sharma S, Agarwal L, Saxena RK. (2007) Statistical optimization for tannase production from *Aspergillus niger* under submerged fermentation. *Ind J Microbiol.* 47:132–138.

Sharma S, Bhat TK, Dawra RK. (2000) A spectrophotometric method for assay of tannase using rhodanine. *Analytical Biochemistry*, 279(1):85–89.



Original Paper

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## **Enhancement Of Actinobacterial Protease Production by Optimizing Fermentation Parameters**

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### **Abstract**

Actinomycetes were isolated from soil, compost pit and vermicompost samples. Protease producing actinomycetes were screened and out of twenty five cultures, ten were positive for protease production. Actinomycete isolate MG4 was selected for optimizing submerged fermentation technology. MG4 produced 264EU/ml of protease in submerged fermentation. The selected isolate grew on Bennett's medium with typical powdery texture and ivory aerial spore mass. MG4 exhibited straight chain spore arrangement pattern on morphological analysis by slide culture technique. Optimization of protease production process was done and the maximum production was observed at 30°C and pH 7 in 72 hours. Medium containing soybean residue promoted the protease production to maximum (316 EU/ml).

### **Introduction**

Actinobacteria are filamentous prokaryotes, rich in GC content. They are a peculiar group of bacteria predominantly present in soil. They are slow growers and play a very important role in mineralization. Actinobacteria can breakdown a wide variety of organic macromolecules which are difficult to degrade. The extensive range of enzymes produced by them allow these filamentous bacteria to survive in extreme climates also. Actinomycetes have been isolated from soil [Zhu et al. 2007, Atalan et al. 2000], water [Zaitlin et al. 2003], insects, salt lakes [Thumar and Singh 2007], hot springs [Song et al. 2009], marine environments etc [Tian et al. 2009]. Production of protease

[Subramaniet al. 2009], amylase, cellulase, glucose isomerase etc [Bhasin and Modi 2013, Bhasin and Modi 2012] have been reported by numerous researchers. They are also well known producers of antibiotics [Chater et al. 2006]. Majority of the antibiotics available in the market are produced by Actinomycetes, especially Streptomycetes. They have extraordinarily large genome size which accounts for their special capacity to produce a vast repertoire of metabolites and enzymes. Enormous capacity of extracellular enzyme production exhibited by Actinomycetes help in recycling of organic and inorganic matter in the ecosystem [Vonothini et al. 2008, Bascarn et al. 1990].

Present industrial global market for enzymes is more than \$ 2 billion which is expected to rise even further [Thumar et al. 2007]. Proteases find huge application in industrial market and accounts for 25% of total enzyme sales.

Majority of the proteases produced industrially is of microbial origin [Mehta et al. 2006]. Proteases are the degradative enzymes, besides catalyzing the hydrolysis of proteins they are also involved in specific modifications of proteins such as activation of zymogens [Rao et al. 1998]. Variety of proteases are produced using Actinomycetes for industrial applications. Submerged as well as solid state fermentation process are employed for the production of protease using Streptomycetes [Yang and Wang 1999, De Azeredo et al. 2006]. Mitra and Chakraborty (2005) have reported the presence of multiple kinds of proteases in the fermented broth of actinomycetes. Proteases find application in laundry, food, medicine, cosmetic, pharmaceutical industry and other biotechnological purposes [Ellaiah et al. 2002]. Numerous studies are associated with halophilic and alkalophilic proteases of bacterial origin [Thumar et al. 2007].

Plant and animal sources are also used for the production of proteases but microbial proteases are preferred because of low cost of production, wide pH and temperature range of enzyme activity and stability. They are also preferred for large scale production due to the ease of growth and production on economic grounds also. Microbial proteases are extracellular in majority of the cases making the production and recovery process convenient. Numerous bacteria such as *B. cereus*, *B. licheniformis*, *B. mojavensis*, *B. megaterium* and *B. subtilis*, *Streptomyces clavuliferus*, *Streptomyces nogalator*, *Streptomyces fungicidicus* [Subramani et al. 2009, Mitra and Chakraborty 2005, Bascarn et al. 1990] and fungi for example *Aspergillus flavus*, *Aspergillus melleus*, *Aspergillus niger*, *Chrysosporium keratinophilum*, *Fusarium graminearum*, *Penicillium griseofulvum*, *Scedosporium apiosermeum* are known to produce proteases [Nijland and Kuipers 2008, Rao et al. 1998]. Microbial protease production technology can be further improved by developing recombinant enzymes [Jisha et al. 2013]. The influence of climate on plants and quality of food and their scarcity in case of animals is a major hurdle for these sources of proteases. Fermentation process parameter optimization and use of economic agricultural residues make the microbial production technology highly acceptable.

Current investigation deals with isolation and screening of protease producing actinomycetes. Screening was done at qualitative as well as quantitative level. High yielding isolate was studied for optimization of submerged fermentation technology wherein medium combination, fermentation period, optimum pH and temperature were determined.

## Materials and Methods

### Isolation Of Actinomycetes

Soil samples were collected from garden area, open fields, compost pits and vermicompost. The samples were treated with calcium carbonate and sundried. Suspension of samples were inoculated on plates and incubated at 30°C for 7 days. Actinomycetes were isolated and preserved on Actinomycete isolation agar and Bennett's agar medium. Morphological analysis of the selected isolates was performed by slide culture technique.

### **Screening For Protease Producers**

Primary screening for qualitative protease producers was done on Bennett's agar medium containing milk (5%), casein(3%) and gelatin(1%) separately. All the isolates were spot inoculated on medium containing protein substrates and incubated at 30°C. Zone of hydrolysis was observed on milk Bennett's agar plates by the difference in transparency developed in the medium. Casein Bennett's agar was observed for visualization of hydrolysis by development of a clear area, a halo around the isolate's growth. Commassie brilliant blue was used for visualization of the zone of hydrolysis on gelatin Bennett's agar plates [Vermelho et al. 1996].

### **Submerged Fermentative Production For Secondary Screening**

Secondary screening for selected isolates spotted by primary screening was performed by submerged fermentation process. Comparison of protease production was done performing submerged fermentation process in Bennett's medium. The isolates were inoculated in 100ml conical flasks containing 20 ml of Bennett's medium. The flasks were incubated at 30°C and 100 RPM in orbital shaker [Remi 24CL] for 96 hours [Mehta et al. 2006].

### **Preparation Of Crude Protease Extract**

The fermentation process was terminated on fourth day of incubation and the fermented broth was harvested in sterile centrifuge tubes. Crude protease extract was prepared by centrifugation of fermented broth at 5000 RPM for 10 minutes.

### **Determination Of Protease Activity**

Protease production by different actinomycete isolates was determined by Nagase's method. Protease assay is a modification of two methods viz. Hagihara, 1953 and Anson, 1938. Casein was used as the substrate and protease activity was determined by estimating the soluble tyrosine released. Tyrosine was determined spectrophotometrically using Folin reagent. To 5ml of purified casein solution 1ml of crude enzyme extract (1:1 diluted with acetate buffer) was added. This was incubated for 10 minutes at 30°C. The reaction was terminated by adding 5ml of tri-chloro acetic acid. This was incubated at 30°C for 30 minutes for precipitating remaining total protein. The precipitates were separated by centrifugation. 2 ml of supernatant was mixed with 5 ml of sodium carbonate and 1ml of 1N Folin reagent. This was incubated for 30 minutes at 30°C. The absorbance for determination of tyrosine value was measured at 660 nm and expressed in Proteolytic Unit of Nagase (PUN). One PUN is defined as the amount enzyme which acts on casein for 10 minutes at 30°C and produces a quantity of Folin color-producing substances not precipitated by trichloroacetic acid that is equivalent to 1µg of tyrosine.

### **Optimization Of Protease Production**

Demand of microbial enzymes is increasing tremendously because of varied applications [Jisha et al.2013]. Continuous research is going on for establishing an effective production technology

which is economically viable. Production of protease was optimized by determining the optimum temperature and pH, fermentation period and medium ingredients required for maximum production.

#### **Determination Of Optimum Temperature For Protease Production**

All the microbes require specific temperature for the production of enzymes and metabolites. The actinomycete isolate MG4 was subjected to submerged fermentation process in Bennett's broth. Protease production was studied at 15°C, 20°C, 25°C, 30°C, 35°C, 45°C & 50°C. Protease produced at different incubation temperatures was estimated by Nagase's method

#### **Optimum pH For Protease Production**

Effect of pH on production of protease was studied by growing the isolate in Bennett's broth. Submerged fermentation was carried out for the actinomycete isolate MG4 with initial pH adjusted to 5, 6, 7, 8, 9, 10 and 11. Optimum pH was determined by estimating the enzyme produced using Nagase's method.

#### **Determination Of Optimum Fermentation Period For Protease Production**

Optimum fermentation period was determined by performing submerged fermentation process for the actinomycete isolate MG4 for different time intervals. Seven flasks containing Bennett's medium were inoculated with actinomycete isolate MG4 and incubated for protease production at 30°C and 100 RPM. Fermentation process was terminated in one conical flask after a fixed interval of 24 hours for continuously seven days. The extent of protease produced was determined by preparation of crude enzyme extract and determining the activity by Nagase's method.

#### **Selection Of Suitable Production Medium For Protease Production**

Production of enzymes significantly depends on the medium composition and different organisms are influenced by different medium components. The selected isolate was subjected to submerged fermentation in six different media to obtain maximum protease production. Media used by various researchers were inoculated with the selected actinomycete isolate such as Medium I consisting of Casein, 2%; Glucose, 0.1%;  $\text{KH}_2\text{PO}_4$ , 0.15%; proposed by Chahal et.al. (1976). Kathiresan (2007) reported the production of protease in a medium containing Casein, 5%; Glucose, 5%; Peptone, 5%, Yeast Extract 5%,  $\text{MgSO}_4$ , 0.1%,  $\text{K}_2\text{HPO}_4$ , 0.25%,  $\text{FeSO}_4$ , 0.1%, was used as Medium No. II. Media No. III was proposed by Shirato (1965) which contains

Glucose, 3.5gm%; Defatted soybean, 2.5%; Dried beer yeast, 0.3%; Ammonium sulphate, 0.2%; Calcium carbonate, 0.2%; Sodium chloride, 0.2%; Soybean oil, 0.24%.

Media No. IV contains Starch, 1.5%; Milk, 1.5%;  $\text{K}_2\text{HPO}_4$ , 0.3%; Yeast extract, 0.1%;  $\text{MgSO}_4$ , 0.05%;  $\text{NaHCO}_3$ , 1% and Medium No. V contains Gelatin, 1%; Peptone, 0.5%; Yeast extract, 0.5%, NaCl, 5%; proposed by Thumar et. al. (2007). Bennett's broth medium was also used for reference and named as Medium No. VI. The actinomycete isolate MG4 was inoculated in 20ml of above media in 100ml conical flasks and fermentation process was carried out for 96 hours at 30°C and 100 RPM. Crude enzyme extract was prepared by centrifuging the fermented broth at 5000 RPM for 10 minutes at 4°C. The comparison of protease production was done by determining enzyme activity by Nagase's method.

### **Results and Discussion**

#### **Microorganism**

Actinomycetes were isolated and screened for protease production. Culturally and morphologically diverse twenty five actinomycete cultures were isolated from compost and soil samples. The samples were rich in actinomycetal cultures. They grew on Bennett's agar and Actinomycete isolation agar medium with their typical earthy smell of geosmin. Geosmin is an organic compound which has the specific earthy flavor and is produced by actinobacteria and some other soil dwelling microorganisms [Juttner and Watson, 2007]. Actinobacteria possess tremendous adaptability to diverse environmental conditions. They have been isolated from extremely cold and hot environments [Cotarlet 2009, Song et. al. 2009]. Our collection of isolates consisted of 40% grey aerial spore mass bearing cultures and another 48% white, rest of them exhibited ivory and green aerial spore mass (fig.1). Pigmentation which is a common feature with actinomycetes was observed in 40% of our isolates. Slide culture technique revealed the spiral spore arrangement pattern of grey aerial spore mass bearing isolates. Straight chain spore patterns were observed with white and ivory colour spore mass bearing isolates. The isolate selected for this study exhibited ivory spore mass colour and straight chain spore pattern arrangement, according to Bergey's Manual of Systemic Bacteriology Volume 4 *Kitasatosporia* exhibits such features.

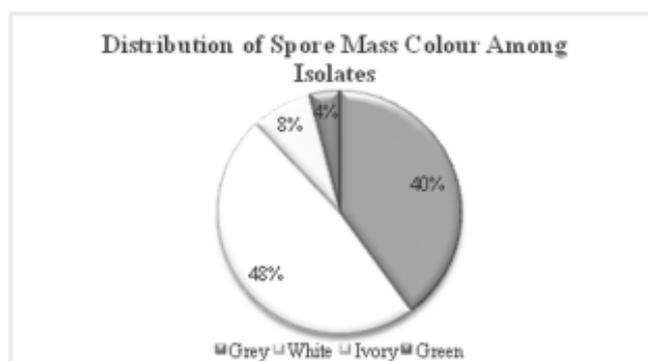


Fig 1. Distribution of Spore Mass Colour among Isolates

### Qualitative And Quantitative Screening For Protease Producing Actinomycete

Ten isolates were found to be positive for protease production out of which five were high yielding. The isolates were analyzed for degradation of casein and gelatin along with hydrolysis on milk agar plates. Large hydrolysis zones ranging between 24 to 44mm were produced by promising isolates (fig.2). Actinomycete isolate MG4 was selected for further studies as it exhibited highest productivity of 264 EU/ml of the fermented broth in submerged fermentation (Fig.3). Protease production strategy was optimized using the selected isolate MG4.

Protease production has been reported by numerous strains of actinomycetes [Subramani et al. 2009, Thumar 2007, Rifaat 2006] and Bacillus [Darani 2008]. They are also employed at industrial scale for large scale production. Actinomycetes produce large number of extracellular enzymes in order to survive in different type of environmental conditions with varying organic and inorganic content. They degrade the polymeric macromolecules for their nutritional purpose along with maintenance of ecological balance [Mitra and Chakraborty 2005, Bascarn et al. 1990].

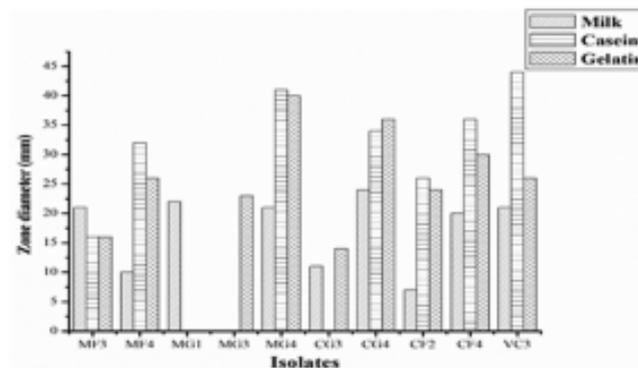


Fig 2. Zone of hydrolysis exhibited by isolates on milk agar, casein agar and gelatin agar plates

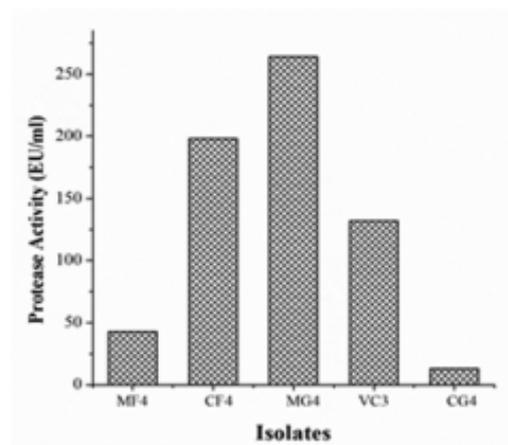


Fig 3. Submerged fermentative production of protease by selected isolates

### Optimization Of Submerged Fermentation Process For Protease Production By Actinomycete Isolate MG4

Influential parameters for protease production were studied in order to meet high yield demands for commercialization of production technology.

#### Influence Of Temperature On Protease Production

Growth and production of protease was maximum at mesophilic range of temperature. Highest protease production was observed at 30°C (Fig.4). Proteases working at mesophilic temperature find applications in degradation of environmental wastes as compared to thermophilic proteases for industrial applications [Sepahy and Jabalameli 2011, De Azeredo 2006]. Kathiresan and Manivannan 2007 also found high protease activity at 30°C. Numerous bacterial proteases produced from *Bacillus* species have mesophilic and others have thermophilic optimum temperature such as Sepahy (2011) reported 60°C as optimum.

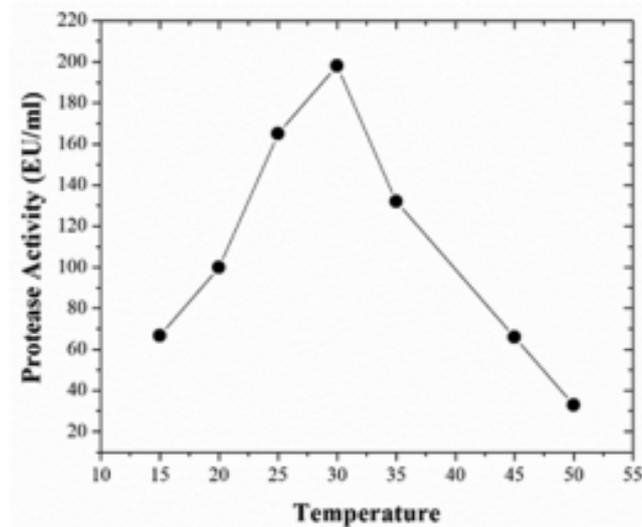


Fig 4. Effect of temperature on protease production

*Influence Of P<sup>H</sup> On Protease Production*

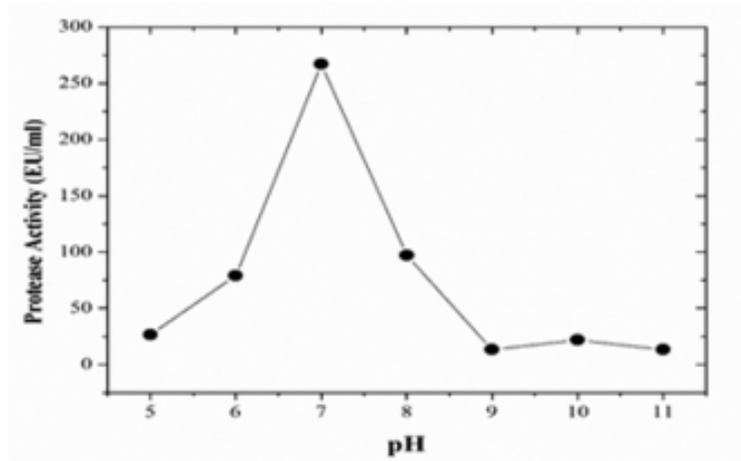


Fig 5. Effect of pH on protease production

Profound effect of pH on protease production and growth of the isolate was observed. The isolate MG4 exhibited very scanty growth and protease production at pH 5 and 6 (Fig.5). Growth and production was also less above pH 9. Highest protease production was observed at pH 7. Components of the medium also alters the pH which in turn influences the protease production. When ammonium salts are used as nitrogen source in the medium, the pH tends to become acidic on its degradation whereas organic nitrogen sources such as amino acids and peptides when utilized by microbes in the production medium leads to alkaline conditions [Ellaiah et al. 2002]. Majority of the reports focus on alkalophilic proteases because of industrial applications [Mehta et al.

2006]. Certain applications such as preparation of soluble flavoured protein hydrolysates at industrial level requires proteases with neutral optimum pH range [Rao et al. 1998]. Many proteases for example keratinases are required for degradation of feather wastes at neutral pH.

#### Determination Of Optimum Fermentation Period

Our study revealed that maximum protease production can be obtained after 72 hours of fermentation process (Fig.6). It is economically favorable that production reaches to its highest in 72 hours, which means that the fermentation process need not to be carried out long to get higher yields as in case of other actinomycete fermentation processes. In some cases *Streptomyces* are reported to produce protease in 144 hours [Subramani et al. 2009, Kathiresan and Manivannan 2007]. Fungal proteases also require longer incubation period such as seven days for high yield [Muthulakshmi et al. 2011]. Protease is required by the organism for growth starting from the initial stages where the proteinases digests the complex protein macromolecules into peptides. These peptides are further degraded by peptidases to release amino acids for vital activities of the cell. As the growth proceeds, proteases degrade majority of the proteins in the medium including other enzymes.

This leads to high titre of proteases and lesser amount of other enzymes and metabolites in the medium towards stationary phase in some cases. However addition of complex organic protein substrates induces protease production in early stages of growth also.

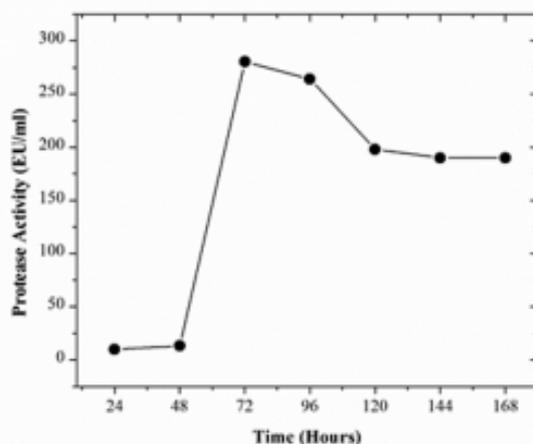


Fig 6. Determination of optimum fermentation period for protease production

#### Selection Of Suitable Production Medium

All the organisms vary in their growth pattern and production of metabolites, therefore there is no perfectly defined medium available so far which can be used for any organism in consideration [Jisha et al. 2013]. Production of extracellular protease is highly influenced by medium components [Mehta et al. 2006]. Protease is reported to be inducible in some cases, therefore a variety of medium combinations were studied for protease production. Extent of protease production by high yielding isolate MG4 was compared in presence of casein, gelatin as pure protein containing medium and defatted soybean and milk as crude protein source. A highly encouraging result was obtained, protease was produced in very high amount 316 EU/ml in the medium (Medium No. III) containing

crude protein source (defatted soybean) (Fig.7). Second highest productivity was observed in Bennett's broth (Medium No. VI). Medium containing casein along with yeast extract was next to Medium No. III and VI. Protease production seems to be enhanced in presence of yeast extract which is a common factor in all the three media showing high yield. Although specific organisms require specific nitrogen and carbon sources for optimum production, Ellaiah et al. (2002) reported a positive impact in most of the cases where complex organic nitrogen sources were used in the medium instead of simpler inorganic sources. However gelatin was not found to be suitable component for protease production in our study.

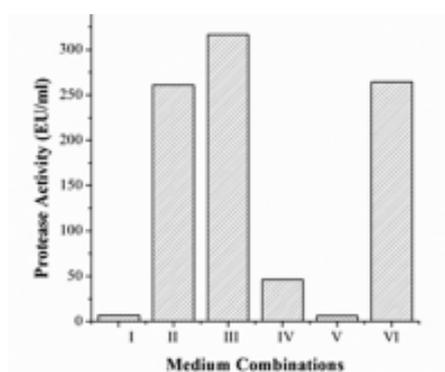


Fig 7. Determination of suitable fermentation medium for protease production

## Conclusion

Our study reveals the presence of diversity in actinomycetes present in soil and their extensive capacity to produce proteases. Actinomycetes are already explored for the production of numerous bioactive compounds but still there is tremendous scope available for searching industrially and environmentally useful cultures. The selected isolate exhibited ivory aerial spore mass colour with straight chains of spore pattern arrangement. The isolated culture demonstrated high protease production capacity in Bennett's broth. Growth and production of protease in case of our isolate exhibited synchronous trend, the suitable temperature and pH coincided for both. The optimum pH and temperature for production was found to be 7 and 30°C respectively. Requirement of moderate temperature and neutral pH for growth and production process are definitely advantageous results which opens a way for the application of the enzyme in food industry and environmental purposes. Early production of enzyme, i.e. 72 hours of optimum fermentation period also favors commercialization of the technology. Another encouraging result was the increased protease production in presence of crude nutritive sources. The productivity can further be increased by understanding and modulating the protease synthesis at genetic level.

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## References

Anson M. L. (1938) The estimation of pepsin, papain and cathepsin with haemoglobin, Journal of

general physiology, Vol.22: 79-89.

Atalan E., Manfio G.P., Ward A.C., Kroppenstedt R.M. and Goodfellow M. (2000) Biosystematic studies on novel Streptomyces from soil, Antonie van Leeuwenhoek, Vol. 77 (4): 337–353.

Bascarn V., Hardisson C. and Brafia A.F. (1990) Regulation of extracellular protease production in *Streptomyces clavuliferus*, Applied Microbiology and Biotechnology, Vol. 34 (2): 208-213.

Bhasin S., and Modi H.A. (2012) Optimization of Fermentation Medium for the Production of Glucose Isomerase using *Streptomyces* sp. SB – P1, Biotechnology Research International, Vol. 2012, doi:10.1155/2012/874152.

Bhasin S., and Modi H.A., (2013) Streptomyces: A Storehouse of Bioactive Compounds and Enzymes; A: Production of Glucose Isomerase, Research Journal of Recent Sciences, 2013, Vol. 2(1):330-339.

Chahal, D.S. and Nanda, S.K. (1976). A screening of some actinomycetes for protease production, Proceedings of the Indian Notational Science Academy Vol. 41(5) 427-434.

Chater K.F. (2006) Streptomyces Inside-Out: A new perspective on the bacteria that provide us with antibiotics, Philosophical Transactions of the Royal Society B Biological Sciences, Vol. 361 (1469): 761-768.

Cotarlet M., Negoita T., Bahrim G. and Stougaard P. (2009) Cold adapted amylase and protease from new Streptomyces antarctic strain, Innovative Romanian Food Biotechnology, Vol. 5: 23-30.

Darani K.K., Falahatpishe H.R. and Jalali M. (2008) Alkaline protease production on date waste by an alkalophilic Bacillus sp. 2-5 isolated from soil, African Journal of Biotechnology, Vol. 7 (10): 1536-1542.

De Azeredo L.A.I., De Lima M.B., Coelho R.R.R. and Freire D.M.G. (2006) Thermophilic protease production by Streptomyces sp. 594 in submerged and solid-state fermentations using feather meal, Journal of Applied Microbiology, Vol. 100 (4): 641–647.

Ellaiah P., Srinivasulu B. and Adinarayana K. (2002) A Review on Microbial Alkaline Proteases, Journal of Scientific & Industrial Research Vol. 61: 690-704.

Hagihara B. (1953) Standard Methods of Biochemical Experiments, Bunkodo, Tokyo, pp 207.

Jisha V.N., Smitha R.B., Pradeep S., Sreedevi S., Unni K.N., Sajith S., Priji P., Josh M.S. and Benjamin S. (2013) Versatility of microbial proteases. Advances in Enzyme Research Vol. 1 (3), 39-51 <http://Dx.Doi.Org/10.4236/Aer.2013.13005>.

Juttner F. and Watson S.B. (2007) Biochemical and ecological control of geosmin and 2-methylisoborneol in source waters, Applied and Environmental Microbiology, Vol. 73 (14): 4395-4406.

Kathiresan K. and Manivannan S. (2007) Production of alkaline protease by Streptomyces sp. isolated from coastal mangrove sediment, Research Journal of Environmental Sciences, Vol. 1 (4): 173-178.

Mehta V.J., Thumar J.T. and Singh S.P. (2006) Production of alkaline protease from an alkaliphilic actinomycete. Bioresource Technology Vol. 97: 1650–1654.

Mitra P. and Chakraborty P.K. (2005) An extracellular protease with depilation activity from

- Streptomyces nogalator*, Journal of Scientific and Industrial Research, Vol. 74: 978-983.
- Muthulakshmi C., Gomathi D., Kumar D. G., Ravikumar G., Kalaiselvi M. and Uma C. (2011) Production, Purification and Characterization of Protease by *Aspergillus flavus* under Solid State Fermentation Jordan Journal of Biological Sciences, Vol. 4(3): 137 - 148
- Nagase and Co., Ltd .Quantitative assay of protease activity. ItachiboriMinamidori 1 –chome, Osaka , Japan.
- Nijland R. and Kuipers O.P. (2008) Optimization of protein secretion by *Bacillus subtilis*, Recent Pat. Biotechnol. Vol. 2: 79–87.
- Rao M. B., Tanksale A. M., Ghatge M. S., and Deshpande V. V. (1998) Molecular and Biotechnological Aspects of Microbial Proteases, Microbiology And Molecular Biology Reviews, Vol. 62(3): 597–635.
- Rifaat H.M., El-Said O.H., Hassanein S.M. and Selim M.S.M. (2006) Protease activity of some mesophilic Streptomyces isolated from Egyptian habitats, Journal of Culture Collections, Vol. 5 (1): 16-24.
- Sepahy A. A. and Jabalameli L. (2011) Effect of Culture Conditions on the Production of an Extracellular Protease by *Bacillus* sp. isolated from Soil Sample of Lavizan Jungle Park, Enzyme Research Vol. 2011, Article ID 219628, doi:10.4061/2011/219628.
- Shirato S. and Nagatsu C. (1965) Carbohydrate sources for the production of protease and streptomycin. Applied Microbiology, Vol. 13:669-672.
- Song Z., Zhi X., Li W., Jiang H., Zhang C. and Dong H. (2009) Actinobacterial Diversity in Hot Springs in Tengchong (China), Kamchatka (Russia), and Nevada (USA), Geomicrobiology Journal, Volume 26(4): 256-263.
- Subramani R., Mahalingam R., Narayanasamy M. (2009) Characterization of a thermostable alkaline protease produced by marine *Streptomyces fungicidicus* MML1614, Bioprocess and Biosystems Engineering, Vol. 32(6): 791–800.
- Thumar J.T. and Singh S.P. (2007) Secretion of an alkaline protease from a salt-tolerant and alkaliphilic, *Streptomyces clavuligerus* strain MIT-1, Brazilian Journal of Microbiology, Vol. 38 (4):766-772.
- Tian X., Tang S., Dong J., Zhang Y., Xu L., Zhang S. and Li W. (2009) Marinactinosporathermotolerans gen. nov., a marine actinomycete isolated from a sediment in the northern South China Sea. International Journal of Systematic and Evolutionary Microbiology Vol. 59: 948–952 doi 10.1099/ijs.0.005231-0.
- Vermelho A. B., Meirelles M. N. L., Lopes A., Petinate S. D. G., Chaia A. A. and Branquinha M. H. (1996) Detection of extracellular proteases from microorganisms on agar plates, Memorias do Instituto Oswaldo Cruz, Rio de Janeiro, Vol. 91(6): 755-760.
- Vonothini G., Murugan M., Sivakumar K. and Sudha S. (2008) Optimization of protease production by an actinomycete strain, PS-18A isolated from an estuarine shrimp pond, African Journal of Biotechnology, Vol. 7 (18): 3225-3230.
- Yang S.S. and Wang J.Y. (1999) Protease and amylase production of *Streptomyces rimosus* in

submerged and solid state cultivations, Botanical Bulletin of Academia Sinica, Vol. 40 (4): 259-265.

Zaitlin B., Watson S.B., Ridal J., Satchwill T. and Parkinson D. (2003) Actinomycetes in lake Ontario: habitats and geosmin and MIB production, Journal American Water Works Association, Vol. 95 (2): 113-118.

Zhu H.H., Guo J., Yao Q., Yang S.Z., Deng M.R., Phuong L.T.B., Hanh V.T. and Ryan M.J. (2007) *Streptomyces vietnamensis* sp. nov., a streptomycete with violet–blue diffusible pigment isolated from soil in Vietnam, International Journal of Systematic and Evolutionary Microbiology, Vol.57 (8): 1770–1774.

Williams S.T., Sharpe M.E. and Holt J.G. (1984 - 1989) Bergey's Manual of Systemic Bacteriology, Ed: William R. Hensyl, Williams and Wilkins, Baltimore, ISBN 0-683-09061-5, Vol. 4.



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## Use Of Fourier Transform In The Theory Of Finance

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### **Abstract**

In Financial world, option is one of the definite types of contracts. Basically there are two types of option, Call and Put option. The important part is the valuation of this option and it is represented by a well-known Black-Scholes-Merton (BSM) Partial Differential Equation. It is of second order parabolic type Partial Differential Equation. The solution of this equation gives the theoretical value of an option (Call/Put). Here in the present paper we have solved BSM equation with the help of Fourier Transform. In fact we have solved BSM equation for two different Payoff functions: Standard Power option and Powered option as boundary conditions.

Keywords: Black-Scholes-Merton Model; Partial Differential Equation; Fourier Transform Method; Call/Put option.

### **Introduction**

The pricing of option is very important problem in financial market. In option pricing theory, the Black-Scholes-Merton equation is one of the most effective models for pricing options. If we consider the European call option, which gives the right to buy an asset on a specific future date, at a specific price, which depends on  $S$ -Spot price,  $X$ -Exercises Prices,  $t$ -Expiration date,  $r$ -risk free interest rate, and  $\sigma$ -Volatility. This model is very useful, since this requires five variables only in which four are easily available, those are and for the volatility we have to use historical data to estimate it. The formula developed by three economists- Fisher Black, Myron Scholes and Robert Merton. They were awarded the 1973 Nobel Prize in economics for their work [1].

### **Theoretical Analysis**

In Mathematical Finance, the Black-Scholes-Merton equation is a Partial Differential Equation

to evaluate the value of European Call/put option. Suppose  $C(S,t)$  is the call premium then the equation [3], [5], [7],

$$\frac{\partial C}{\partial t} + \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 C}{\partial S^2} + rS \frac{\partial C}{\partial S} - rC = 0$$

is a Black-Scholes-Merton Partial Differential Equation.

Where,

$$t \in [0, T] \text{ and } C(0, t) = 0 \text{ for all } t \text{ and } C(S, t) \rightarrow S \text{ as } S \rightarrow \infty$$

Consider the European call option whose final payoff at the expiry time  $T$  is given by a function  $f$  of the final spot price  $S$ .  $\lim_{t \rightarrow T^-} C(S, t) = f(S)$  which is a continuous function that need not be differentiable everywhere.

The common assumptions of the BSM are [7]:

- (1) The options are European type
- (2) No dividends are paid
- (3) Movement of the market cannot be predicted
- (4) No Commission and no transaction cost
- (5) Interest rates are risk free and it is constant
- (6) Volatility is constant
- (7) Returns are normally distributed.

To solve the above mathematical model various approaches and methods are proposed by researcher like the Method of Separation of Variable, Method of Laplace Transform [2]. Some of them having limitations and some having advantages over them. In this paper we have applied Fourier Transform Method to solve the problem. Our goal is to find the function  $C(S, t) : (0, \infty) \times [0, T] \rightarrow [0, \infty)$ , which satisfy the given Partial Differential Equation. This equation has many solutions corresponding to all the different functions that can be defined with as the underlying variable. The particular value that is obtained when the equation is solved depends on the Payoff functions. These specify the values of the call option at the boundaries of possible values of  $S$  and  $t$ . Here we will discuss two different Payoff functions: Standard Power option and Powered option. First, we will convert the Black-Scholes-Merton Partial Differential Equation to the heat equation by the following substitutions:

$$y = T - t,$$

$$x = \ln\left(\frac{S}{X}\right) + \left(r - \frac{\sigma^2}{2}\right)(T - t) \text{ and}$$

$$D(x, y) = e^{r(T-t)} C(S, t).$$

These substitutions also convert the above mentioned boundary condition,

$$\lim_{t \rightarrow T_-} C(S, t) = f(S)$$

into the initial condition,

$$\lim_{y \rightarrow 0^+} D(x, y) = f(Xe^x)$$

Thus the Black-Scholes-Merton equation gets converted into the following Heat Equation with the stated initial condition:

$$\frac{\partial D}{\partial y} = \frac{\sigma^2}{2} \frac{\partial^2 D}{\partial x^2} \quad \text{with} \quad \lim_{y \rightarrow 0^+} D(x, y) = f(Xe^x) \quad (1)$$

Applying Fourier transform on both the sides of the equation (1) we get,

$$\frac{\partial}{\partial y} F(D) + \frac{\lambda^2 \sigma^2}{2} F(D) = 0$$

$$\therefore F(D) = C_1 e^{\frac{-\sigma^2 \lambda^2}{2} y}$$

Now we get,

$$F(D(x, 0)) = G(\lambda) \quad \text{because} \quad D(x, 0) = f(Xe^x)$$

Here, is the Fourier transform of , so that is determined and we now have:

$$F(D) = G(\lambda) e^{\frac{-\sigma^2 \lambda^2}{2} y}$$

Taking inverse Fourier transform on both the sides we get,

$$D(x, y) = F^{-1} \left( G(\lambda) e^{\frac{-\sigma^2 \lambda^2}{2} y} \right)$$

Now, using convolution theorem and from the facts,

$$F^{-1}(G(\lambda)) = f(Xe^x) \quad \text{and} \quad F^{-1} \left( e^{\frac{-\sigma^2 \lambda^2}{2} y} \right) = \frac{1}{\sigma \sqrt{y}} e^{\frac{-x^2}{2\sigma^2 y}}$$

we get:

$$D(x, y) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(v) \frac{1}{\sigma\sqrt{y}} e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv$$

$$\therefore D(x, y) = \frac{1}{\sigma\sqrt{2\pi y}} \int_{-\infty}^{\infty} f(v) e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv$$

This is the required solution of the Heat equation [6].

**Solution Of The Problem Using Different Payoff Functions**

Many people have solved BSM equation for Standard Power Payoff function and Powered Payoff function using the Method of Separation of Variable [4].

**Standard Power Payoff Function**

Consider the Payoff function, which is known as Standard Power Payoff function:

$$f(S) = \max\{S^2 - X, 0\}$$

$$\therefore f(Xe^x) = \max\{X(Xe^{2x} - 1), 0\}$$

$$\therefore D(x, y) = \frac{1}{\sigma\sqrt{2\pi y}} \int_0^{\infty} X(Xe^{2v} - 1) e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv$$

$$= \frac{X^2}{\sigma\sqrt{2\pi y}} \int_0^{\infty} e^{2v} e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv - \frac{X}{\sigma\sqrt{2\pi y}} \int_0^{\infty} e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv$$

Taking,

$$Z = \frac{v-x}{\sigma\sqrt{y}}$$

We get,

$$\therefore D(x, y) = \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{-\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{(Z^2 - 4\sigma\sqrt{y}Z + 4\sigma^2 y)}{2}} dZ - \frac{X}{\sqrt{2\pi}} \int_{-\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{Z^2}{2}} dZ$$

$$= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{-\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{(Z-2\sigma\sqrt{y})^2}{2}} dZ - \frac{X}{\sqrt{2\pi}} \int_{-\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{Z^2}{2}} dZ$$

$$\begin{aligned}
 &= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{\frac{-x+2\sigma^2 y}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{t^2}{2}} dt - \frac{X}{\sqrt{2\pi}} \int_{\frac{-x}{\sigma\sqrt{y}}}^{\infty} e^{-\frac{Z^2}{2}} dZ \\
 &= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{-\infty}^{\frac{x+2\sigma^2 y}{\sigma\sqrt{y}}} e^{-\frac{t^2}{2}} dt - \frac{X}{\sqrt{2\pi}} \int_{-\infty}^{\frac{x}{\sigma\sqrt{y}}} e^{-\frac{t^2}{2}} dt \\
 &= X^2 e^{2(x+\sigma^2 y)} N(d_1) - XN(d_2)
 \end{aligned}$$

Where,

$$\begin{aligned}
 d_1 &= \frac{x + 2\sigma^2 y}{\sigma\sqrt{y}}, \quad d_2 = \frac{x}{\sigma\sqrt{y}} \quad \text{and} \quad N(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-\frac{t^2}{2}} dt \\
 \therefore C(S, t) &= S^2 e^{(r+\sigma^2)(T-t)} N(d_1) - X e^{-r(T-t)} N(d_2)
 \end{aligned}$$

Where,

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{3\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \quad \text{and} \quad d_2 = d_1 - 2\sigma\sqrt{T-t}$$

### Powered Payoff Function

Now, we consider the Payoff function, which is known as Powered Payoff function:

$$\begin{aligned}
 f(S) &= \max\{(S - X)^2, 0\} \\
 \Rightarrow f(Xe^x) &= \max\{X^2(e^x - 1)^2, 0\} \\
 \therefore D(x, y) &= \frac{1}{\sigma\sqrt{y}} \int_0^{\infty} X^2 (e^v - 1)^2 e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv \\
 &= \frac{X^2}{\sigma\sqrt{y}} \left[ \int_0^{\infty} e^{2v} e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv - 2 \int_0^{\infty} e^v e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv + \int_0^{\infty} e^{-\frac{(x-v)^2}{2\sigma^2 y}} dv \right]
 \end{aligned}$$

Taking,

$$Z = \frac{v-x}{\sigma\sqrt{y}}$$

We get,

$$\begin{aligned} D(x, y) &= X^2 e^{2(x+\sigma^2 y)} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-(Z^2-4\sigma\sqrt{y}Z+4\sigma^2 y)}{2}} dZ - 2X^2 e^{x+\frac{\sigma^2 y}{2}} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-(Z^2-2\sigma\sqrt{y}Z+\sigma^2 y)}{2}} dZ + X^2 \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-Z^2}{2}} dZ \\ &= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-(Z-2\sigma\sqrt{y})^2}{2}} dZ - \frac{2X^2}{\sqrt{2\pi}} e^{x+\frac{\sigma^2 y}{2}} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-(Z-\sigma\sqrt{y})^2}{2}} dZ + \frac{X^2}{\sqrt{2\pi}} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-Z^2}{2}} dZ \\ &= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{\frac{x+2\sigma^2 y}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-t^2}{2}} dt - 2\frac{X^2}{\sqrt{2\pi}} e^{x+\frac{\sigma^2 y}{2}} \int_{\frac{x+\sigma^2 y}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-t^2}{2}} dt + \frac{X^2}{\sqrt{2\pi}} \int_{\frac{x}{\sigma\sqrt{y}}}^{\infty} e^{\frac{-Z^2}{2}} dZ \\ &= \frac{X^2}{\sqrt{2\pi}} e^{2(x+\sigma^2 y)} \int_{-\infty}^{\frac{x+2\sigma^2 y}{\sigma\sqrt{y}}} e^{\frac{-t^2}{2}} dZ - \frac{2X^2}{\sqrt{2\pi}} e^{x+\frac{\sigma^2 y}{2}} \int_{-\infty}^{\frac{x+\sigma^2 y}{\sigma\sqrt{y}}} e^{\frac{-t^2}{2}} dt + \frac{X^2}{\sqrt{2\pi}} \int_{-\infty}^{\frac{x}{\sigma\sqrt{y}}} e^{\frac{-t^2}{2}} dt \\ &= X^2 e^{2(x+\sigma^2 y)} N(d_1) - 2X^2 e^{x+\frac{\sigma^2 y}{2}} N(d_2) + X^2 N(d_3) \end{aligned}$$

where,

$$d_1 = \frac{x+2\sigma^2 y}{\sigma\sqrt{y}}, \quad d_2 = \frac{x+\sigma^2 y}{\sigma\sqrt{y}}, \quad d_3 = \frac{x}{\sigma\sqrt{y}} \text{ and } N(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{\frac{-t^2}{2}} dt$$

where,

$$\therefore C(S, t) = S^2 e^{(r+\sigma^2)(T-t)} N(d_1) - 2SXN(d_2) + X^2 e^{-r(T-t)} N(d_3)$$

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + \left(r + \frac{3\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}}, \quad d_2 = d_1 - \sigma\sqrt{T-t}, \quad \text{and} \quad d_3 = d_1 - 2\sigma\sqrt{T-t}$$

**Conclusion**

The BSM equation is solved using Fourier Transform Method. This gives the value of an option

for the above mentioned two different Payoff functions. Using this solution the trader can find the theoretical value of options (call/put) on a variety of assets including securities, commodities, currencies etc. with stipulated Payoff functions. It is hoped that in certain situations solution found will be useful. Also the method used here has scope of wider adoption.

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### **References**

- Amber Habib, (2011) The calculus of finance, Universities Press. Black, F. & Scholes, M. (1973) The pricing of options and corporate liabilities, Journal of Political Economy 81, 637-656.
- E. G. Huges, (2007) The complete guide to option pricing formulas, McGraw-Hill, 2 edition.
- Erwin Kryszig, (2010) Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 8 Edition.
- Hyoseop Lee And Dongwoo Sheen, Laplace transform method for the Black-Scholes equation, International Journal of Numerical Analysis and Modeling, 6, 4, 642-65
- J. C. Hull, (2009) Options, Futures and other derivatives, Pearson Education, India, 8 Edition.
- Paul Wilmott, (2006) Paul Wilmott on Quantitative Finance, John Wiley & Sons Ltd., 2 edition.



## गुजरात के हिन्दी साहित्यकार

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सभाजनो, सबसे पहले तो मैं आप सभी का अभिवादन करती हूँ तथा राष्ट्रभाषा प्रचार समिति का हार्दिक आभार मानती हूँ कि मुझे आप सब के बीच अपनी बात रखने का अवसर दिया। मुझे गुजरात के हिन्दी साहित्यकारों पर बात करनी है। ग्लोबल विलेज(विश्वग्राम) तथा वसुधैव कुटुंबकम के दौर में ही हम हिन्दी रचनाशीलता की प्रांतीय अस्मिता की बात कर सकते हैं!

अन्य हिन्दीतर प्रदेशों की तुलना में गुजरात का हिन्दी के साथ एक अलग ही संबंध है। आँगन के साथ जैसे घर का। वह उसका हिस्सा भी है और उससे अलग भी। केवल अपभ्रंश के कारण यानी मूल की समानता के कारण ही नहीं, भाषा की एक साड़ी सांस्कृतिक विरासत भी होती है। गुजराती हिन्दी की यह सांस्कृतिक विरासत धर्म,आस्था तथा सामाजिक रहन सहन के रूप में समाज में भी यह उजागर हुई है और साहित्य के माध्यम से यह सब अभिव्यक्त भी होता रहा है। गुजरात के मध्यकाल में ब्रज तथा राजस्थानी में बहुत कुछ लिखा गया, अतः इसके संदर्भ में जितना कहा जाए कम ही है। डॉ. अम्बाशंकर नागर, डॉ. गोवर्द्धन शर्मा, डॉ.दयाशंकर शुक्ल, डॉ रामकुमार गुप्त,डॉ.महावीरसिंह चौहान, ओमानंद सारस्वत आदि ने इस क्षेत्र में बहुत महत्वपूर्ण काम किए हैं। इस संदर्भ में एक संकेत अवश्य करना चाहूँगी कि मध्यकाल में प्रचलित ब्रज,पुरानी गुजराती तथा राजस्थानी एवं संतों की सधुक्कड़ी कुछ इस तरह प्रवर्तमान थीं कि जैसे एक ही व्यंजन, विभिन्न सम्मिलित स्वाद से युक्त हो।

हम सीधे अपने विषय पर आते हैं। डॉ. अंबाशंकर नागर तथा डॉ महावीर सिंह चौहान ने गुजरात के हिन्दी रचनाकारों को मोटे तौर पर दो भागों में बाँटा है। एक वे, जिनकी मातृभाषा हिन्दी नहीं है और एक वे जिनकी मातृभाषा हिन्दी है और जो उत्तर प्रदेश बिहार, राजस्थान, मध्यप्रदेश आदि हिन्दी भाषा-भाषी राज्यों से हिन्दीतर प्रदेशों में आकर बसे हैं। इश्ट 'गुजरात की समकालीन हिन्दी कविता- युग संपृक्तिइष्ट' में डॉ. महावीर सिंह चौहान ने एक बहुत मार्मिक प्रश्न उठाया है कि क्या गुजरात की समकालीन हिन्दी काव्य परंपरा गुजरात की मध्यकालीन हिन्दी रचनाशीलता का ही सहज परिणाम है? इस प्रश्न में एक और नुक्ता जोड़ना अर्थपूर्ण होगा कि रचनात्मकता के स्तर पर आज लिखा जाने वाला हिन्दी साहित्य अपनी स्तरीयता में मध्यकाल में लिखे जाने वाले हिन्दी साहित्य के समकक्ष है। इस संदर्भ में डॉ शिवमंगल सिंह सुमन का यह कथनअर्थपूर्ण है - हिन्दी भाषी प्रांतों में रहने वाले हिन्दी के कवि और लेखक इस तथ्य का अनुमान भी नहीं कर सकते हैं कि हिन्दीतर प्रांतों में रहने वाले कवियों और लेखकों के क्या अभाव वसभाव हो सकते हैं। इसमें अड़चनें और सुविधाएं दोनों साथ-साथ होती हैं। अड़चन तो यह है कि दैनंदिन व्यवहार में न आने के कारण ऐसी रचनाओं में हिन्दी मुहावरों की पकड़ प्रयत्न साध्य हो जाती है और सुविधा यह है कि अन्य प्रांतीय भाषाओं का भाव सौकार्य और समृद्धि उसे अनायास ही प्राप्त हो जाती है जिससे हिन्दी का मानस प्रसार और अधिक व्यापक हो कर भारत की विभिन्न साधनाओं की समन्वय भूमि बनने का आधार प्राप्त करता है। (सुमन) सुमन जी जैसे रचनाकार हिन्दीतर भाषी प्रांतों की रचनाओं को हिन्दी के प्रसार में उपयोगी मानते हैं। ऐसे में नागरजी ने हिन्दी रचनाकारों का जो विभाजन किया है, उस पर भी एक दृष्टि डाली जा सकती है और उसे वर्तमान समय में थोड़ा इस तरह से विस्तृत किया जा सकता है।

लेखक की स्थानीयता की दृष्टि से अगर देखा जाए तो ; १-गुजरात में जन्मे हिन्दीतर भाषी रचनाकार, २-गुजरात में प्रवासी की हैसियत से आए हिन्दी भाषा-भाषी रचनाकार, ३-गुजरात में आकर स्थायी रूप से बस जाने वाले पर-प्रांतीय रचनाकार और ४- गुजरात में जन्में हिन्दी भाषी रचनाकार। व्यवसाय की दृष्टि से देखें तो ये रचनाकार अध्यापक, व्यवसायी, व्यापारी तथा मुक्त-लेखक (फ्री-लांसर ) हैं।

गुजरात में हिन्दी रचनाशीलता के विषय में तथा शोध के अन्तर्गत कई दस्तावेज़ी लेख एवं पुस्तकें हमें मिलती हैं। हिन्दी साहित्य परिषद के जो तीन महत्वपूर्ण प्रकाशन हैं- डॉ अंबाशंकर नागर अभिनंदन ग्रंथ, डॉ रामकुमार गुप्त अभिनंदन ग्रंथ तथा आचार्य रघुनाथ भट्ट अभिनंदन ग्रंथ थ उनमें गुजरात के हिन्दी रचनाकारों की जो सूची दी गयी है वह एक हज़ार की संख्या के करीब होगी। असल में गुजरात की हिन्दी रचनाशीलता के व्याप का अंदाजा लगाने के लिए ये तीन ग्रंथ तथा डॉ. रमण पाठकजी का 'गुजरात में लिखा हिन्दी साहित्य का इतिहास' बहुत ही महत्वपूर्ण स्रोत हैं। पाठकजी का लिखा इतिहास अब अप्राप्य है। इसका पुनर्प्रकाशन ज़रूरी है। इनमें हम डॉ. रघुवीर चौधरी के, 'गुजरात का स्वातंत्रयोत्तर हिन्दी साहित्य' को भी शामिल कर सकते हैं। २००३ तक के आँकड़े इन ग्रंथों में हमें मिलते हैं। उसके बाद हिन्दी रचनाकारों की सूची और भी बढ़ी है।

गुजरात में हिन्दी लेखन के आरंभिक रचनाकार चूँकि व्यवसाय से अध्यापक भी रहे हैं अतः हिन्दीतर प्रांतों में उनकी आवाजाही रही। डॉ. अम्बाशंकर नागर के साथ जिन रचनाकारों ने लिखना आरंभ किया था उनमें से अधिकांश रचनाकार हिन्दी भाषी प्रांतों से यहाँ आ कर बसे थे। अतः उनके लेखन में हिन्दी के वही प्रचलित स्वरूप और रचनाविधान था जो उनकी स्मृति में रचा बसा था। । कविताएं, खंड काव्य,

गज़लें और समीक्षा। फिर क्रमशः रचनात्मक गद्य लेखन भी सामने आया और कहानी उपन्यास तथा निबंध लेखन को गति मिली। नाटक लिखने वाले रचनाकार तुलना में कम आए।

गुजरात में लिखे जाने वाले हिन्दी साहित्यकारों का एक विभाजन हम इस प्रकार भी कर सकते हैं। भारतीय मध्यकाल में लिखने वाले दयानंद आदि को गुजरात की हिन्दी रचनात्मकता के भूमिका काल में सामहित कर सकते हैं। इसके बाद जो रचनात्मकता का पहला स्तर बनता है उसमें डॉ.अंबाशंकर नागर, रामदरश मिश्र, भगवत शरण अग्रवाल, किशोर काबरा, रामकुमार गुप्त, अविनाश श्रीवास्तव, सुधा श्रीवास्तव, भगवानदास जैन, चंद्रकांत मेहता, रघुनाथ भट्ट, शिवकुमार मिश्र, वसन्तकुमार परिहार, भगवतप्रसाद नियाज़ आदि को शामिल कर सकते हैं। इनमें अकादमिक कारणों से डॉ अंबाशंकर नागर की तथा रचनात्मक कारणों से किशोर काबरा एवं वसन्तकुमार परिहार की पहचान बनी। पर सबसे अधिक कोई नाम गुजरात के बाहर जाना गया तो वह अपने समय में डॉ. अंबाशंकर नागर तथा व्यापक रूप से शिवकुमार मिश्रजी का ही है।

दूसरे स्तर पर सुल्तान अहमद, श्रीराम त्रिपाठी, फूलचंद गुप्ता, अंजना संधीर, द्वारिका प्रसाद सांचीहर, शशी पंजाबी, सुभाष भदौरिया, सूर्यदीन यादव आदि को शामिल कर सकते हैं। यह कहना चाहिए कि सुल्तान अहमद, श्रीराम त्रिपाठी तथा अंजना संधीर जैसे रचनाकारों ने गुजरात के बाहर हिन्दी जगत में अपनी पहचान बनाई है।

तीसरे स्तर पर विमर्श आधारित साहित्य संगठनों से जुड़े रचनाकारों को शामिल किया जा सकता है जो एक तरह से एक उत्तर-आधुनिक गतिविधि है। उसमें 'अस्मिता'संगठन की रचनाकारों को तथा रचनाशीलता की उनकी विशेष भूमिका को शामिल किया जा सकता है। बड़ौदा तथा अहमदाबाद की महिला रचनाकारों का यह संगठन है जो केवल हिन्दी भाषा तक ही सीमित नहीं है। यह भारतीय भाषाओं में लिखने वाली महिलाओं का संगठन है। यह पिछले पच्चीस वर्षों से कार्यरत है। इसमें गृहणियों से ले कर अध्यापिकाओं तथा अन्य व्यवसाय से संबंधित महिला रचनाकार शामिल हैं।

यहाँ 'स्वर्णाभा गुजरात' जैसे महत्वपूर्ण प्रकाशन का भी उल्लेख करना आवश्यक है जिसका संपादन अंजना संधीर ने किया है। यह प्रकाशन इसलिए महत्वपूर्ण है क्योंकि इसमें गुजरात में लिखने वाली १०० से अधिक कवियत्रियों को सम्मिलित किया गया है। इनमें से बहुत सारी, बल्कि अधिकांश कवियत्रियां बहुत पहले की हैं, पर यह प्रकाशन-कर्म, यह पुस्तक उत्तर- आधुनिक गतिविधि का हिस्सा हो जाती है। महत्व इसी बात का है। लगभग इसी तरह का काम बिहार की श्रीमती मिथिलेशकुमारी ने अपने प्रदेश की महिला रचनाकारों को एक साथ प्रकाशित कर के किया है।

रामकिसन मेहता तथा प्रभा मजुमदार जैसे रचनाकारों का विशेष उल्लेख इसलिए करना चाहिए कि उन्होंने विमर्श केन्द्री तथा बौद्धिक संवेदना को अपनी रचनात्मकता में शामिल किया है। यहाँ उन गुजराती रचनाकारों को याद कर लेना चाहिए जिन्होंने गुजरात के बाहर अपनी पहचान बनाने के लिए हिन्दी में लिखा। सरूप ध्रुव तथा चीनू मोदी ऐसे दो रचनाकार हैं। एक ने विचारधारा के कारण तो एक ने यश प्राप्ति की कामना से हिन्दी माध्यम में अपनी रचनाएं लिखीं।

नारी विमर्श की तरह दलित विमर्श के संदर्भ में धीरज वणकर तथा धनंजय चौहाण जैसे रचनाकार भी शामिल किए जा सकते हैं जिन्होंने दलित संदर्भ को केन्द्र में रखा। अपनी बात दूर तक पहुँचाने के लिए गुजराती दलित कवि राजु सोलंकी ने भी कुछ रचनाएं हिन्दी में लिखी हैं। नारी विमर्श और दलित

विमर्श जैसी साहित्यिक प्रवृत्तियां भारतीय तथा वैश्विक संदर्भों की ओर संकेत तो करती हैं परन्तु यहाँ भी यह प्रश्न तो रहता ही है कि भारतीय अथवा राष्ट्रीय संदर्भ में पहचान किस रचनाकार की हो पाती है। इनमें भी हम प्रभा मजुमदार अथवा नीलम कुलश्रेष्ठ या फिर रानु मुखर्जी जैसे कुछ नाम ही गिना सकते हैं। यहाँ मेरे कहने का तात्पर्य यह नहीं है कि जिनकी पहचान राष्ट्रीय स्तर पर नहीं हो सकी है वे कमज़ोर रचनाकार हैं। पर जब रचनाशीलता का माध्यम हिंदी चुना है तो मूल्यांकन का एक आधार तो यह रहेगा ही।

मैंने यह जो विभाजन आपके सामने रखा उसमें स्तर से मेरा आशय गुणात्मक नहीं अपितु स्थित्यात्मक है। आप चाहें तो इसे पहली पीढ़ी, दूसरी पीढ़ी आदि नाम से भी बुला सकते हैं। साथ ही इसमें जिन रचनाकारों के नाम दिए हैं वह केवल संकेत मात्र है। सुल्तान अहमद तथा श्रीराम त्रिपाठी की पीढ़ी के बाद भी रचनाकारों की एक नयी पीढ़ी आ गयी है जिसमें करतार सिंह सिकरवार, ईश्वरसिंह चौहाण, पूर्वी शास्त्री आदि कुछ नाम गिनाए जा सकते हैं। आज गुजरात में बहुत बड़ी संख्या में हिन्दी के रचनाकार उपस्थित हैं और बहुत लिख रहे हैं। इन सभी के मूल्यांकन करते हुए दो-एक शोध प्रबंध भी लिखे जा चुके हैं।

अपने मतलब के लिए जो टूटा फूटा विभाजन मैंने आपके सामने रखा उसका आशय केवल इतना ही है कि गुजरात में लिखी जाने वाली हिन्दी रचनाशीलता के मोटे-मोटे बदलावों को रेखांकित किया जा सके। डॉ.अंबाशंकर नागरजी की रचनात्मक पीढ़ी ने जब लिखा तब उनका आशय गुजरात प्रदेश में अपनी एक पहचान को स्थापित करना था। फिर यह महात्मा गांधी की भूमि है। अतः हिन्दी के साथ का संबंध बहुत स्वाभाविक था। यहीं गुजरात विद्यापीठ भी था। उन्होंने अपने मूल वतन की भाषायी एवं साहित्यिक संस्कृति की स्मृति में हिन्दी को गुजरात में बसाया। इसकी तुलना हम उन प्रवासी/अप्रवासी या डायसपोरा के साथ कर सकते हैं जो भारत छोड़ कर विश्व के विभिन्न देशों में बसे थे। यहाँ मैं एक बात जोड़ देना चाहती हूँ कि गुजरात में लिखे हिन्दी साहित्य को प्रवासी दृष्टि से देख कर कोई शोध कार्य नहीं हुआ है। शोध के लिए यह एक अच्छा विषय हो सकता है। खैर ; इन रचनाकारों की रचनाओं में संवेदना के स्तर पर हिन्दी साहित्य की उनके अपने समय की रचनात्मकता ही रही। अंबाशंकर नागर और किशोर काबरा ने संभवतः इसीलिए प्रबंधात्मक रचनाएं भी लिखीं। इनके लिए गुजरात में रहते हुए अपनी मूल भाषा की रचनात्मकता को बचाए रखना महत्वपूर्ण था। इनकी व्यापक आइडेंटिटी या पहचान हिन्दी की थी; राजस्थानी, अवधी अथवा ब्रजी नहीं। गुजरात का अपना परिवेश हिन्दी भाषी परिवेश से भिन्न था; अपनी हिन्दी को परिशुद्ध रखने के लिए गुजराती के प्रभाव से बचाने का रचनात्मक प्रयास भी उनके लेखन में देखा जा सकता है। अतः इन रचनाओं में न ही गुजरात प्रदेश के जीवन्त रक्त का संचार हो सका न ही हिन्दी प्रदेश की हवाओं ने उन्हें छुआ ।

इसके बाद की पीढ़ी के रचनाकारों ने इस बात की ओर अधिक ध्यान दिया कि उनकी रचनाओं में हिन्दी प्रदेश की रचनात्मकता तो आए ही साथ ही गुजरात के परिवेश को भी नज़रंदाज़ न किया जाए। भाषा की शुद्धता के प्रति रवैया इतना कड़ा भी नहीं था। संभवतः यह जागरूकता विचारधारा के कारण आयी। प्रबंधात्मकता छूटी और लंबी कविताएं आयीं जिसकी शुरुआत परिहार जी से होती है। यूं वह दो पीढ़ियों के बीच के रचनाकार कहे जा सकते हैं।

विमर्शों का संबंध यों भी व्यक्ति से कम और संगठनों से अधिक है। यहाँ तक आते आते हिन्दीतर प्रांतों की रचनात्मकता को पहचान मिलना आरंभ हो गया था अतः वहाँ की हवाओं और गुजरात के परिवेश ने रचनाकारों की रचनाशीलता को प्रभावित किया। अतः महिला रचनाकारों का अस्मिता संगठन अस्तित्व में आता है। उसी तरह हिन्दी में दलित लेखन का गुजरात में प्रवेश होता है।

गुजरात की हिन्दी रचनाशीलता में केवल हिन्दी मातृभाषी ही कार्यरत नहीं है अपितु ,गुजरात में रहने वाले और हिन्दी पढ़ने-पढ़ाने वाले अथवा हिन्दी का उपयोग करने वाले सभी, जिनमें गृहणियों से लेकर व्यवसायी भी शामिल हैं। यह गुजरात की हिन्दी रचनाशीलता के लिए अच्छा संकेत है।

लेकिन मित्रो, गुजरात में लिखने वाले हिन्दी साहित्यकारों की बात जब हम करते हैं तो सवाल उठता है कि हम किस हिन्दी के साहित्यकारों की बात कर रहे हैं? क्योंकि अब हिन्दी की अस्मिता ही प्रश्नांकित हो रही है; वह भी सीधे तौर पर अंग्रेज़ी के कारण नहीं। सुधीश पचौरी का मानना है कि यह वास्तव में अंग्रेज़ीदाँ लोगों के 'बाल्कनीकरण' की छिपी प्रवृत्ति है। एक विशाल भाषा को बोलियों में विघटित करने की प्रवृत्ति। हमने जिस भाषा को आज तक 'हिन्दी' के रूप में पहचाना है वह तो कई समृद्ध बोलियों से सजी सँवरी हिन्दी है जिसमें तमाम बोलियों के रचनाकारों ने उत्तम कोटि का साहित्य रचा है। साथ ही तमाम हिन्दीतर भाषी प्रांतों में रहने वाले हिन्दी रचनाकारों ने भी रचा है और हिन्दी को समृद्ध किया है। हम जो हिन्दीतर हैं, जिन्हें अवधि, ब्रज, भोजपुरी, राजस्थानी चाहे कितनी भी दुरुह लगे हमारे सुधि समीक्षकों और संपादकों के सहारे मानक हिन्दी के द्वारा हम तुलसी जायसी, सूर-केशव के मर्म तक बड़ी सरलता से पहुँच ही जाते हैं।

सभाजनो, यह प्रश्न इसलिए भी कि आज आज़ादी के सत्तर वर्ष बाद भी हमारे देश में राजभाषा, राष्ट्र भाषा को लेकर एकमत नहीं बन पाया है। हम लोग जो यहाँ हिन्दीतर भाषी राज्यों से संबंधित हैं उनके लिए यह प्रश्न और भी जटिल होता जा रहा है। इधर भोजपुरी-हिन्दी पर जो घमासान मचा है वह कई सारे प्रश्न हमारे सामने खड़े करता है। भोजपुरी हिन्दी का झगड़ा हिन्दी प्रदेश का अन्दरूनी झगड़ा है यह कह कर हम उससे किनारा कर सकते हैं। लेकिन इस झगड़े के परिणाम तो हिन्दीतर प्रदेशों को भी भुगतने तो पड़ेंगे ही। हम लोग, जो हिन्दी में इतने रचे - बसे हैं कि कई बार यह भी भूल जाते हैं कि हिन्दी हमारी मातृभाषा नहीं है; लेकिन प्यार हम हिन्दी से उतना ही करते हैं जितना हिन्दी मातृभाषी अपनी भाषा से करते हैं। हमारे सामने बहुत जल्द ही यह निर्णयात्मक स्थिति आ जाने वाली है कि हम अब अपने पाठ्यक्रमों में किस हिन्दी को पढ़ें-पढ़ाएं ? आज अगर भोजपुरी, हिन्दी से अलग अपनी अस्मिता के लिए लड़ेगी तो कल क्या ब्रज, राजस्थानी, खड़ीबोली आदि अलग नहीं होंगी? मित्रो यह न भूलें कि भाषा बोलने वालों की संख्या के आधार पर राजभाषा तय होती है। बोलियाँ जब अपनी अस्मिता की पहचान के लिए अलग होंगी और आठवीं सूची में स्थान पाएंगी तो राजभाषा के रूप में हिन्दी का स्थान प्रश्नांकित हो जाएगा। जब यों भी भाषाएं तथा समाज-शास्त्रों के विभिन्न विषय संकट के दौर से गुज़र रहे हैं ऐसे में भाषा की यह अलगाववादी मानसिकता हिन्दी के मामले में खतरे की घंटी ही समझनी चाहिए। आठवीं सूची में स्थानापन्न होने के विवाद का भविष्य इतना कुरूप है कि अन्य भाषाओं की बोलियाँ भी इसके लिए लड़ सकती हैं। झारखंड, छत्तीसगढ़ और तेलंगाना के बाद कतार में कौन- कौन होगा? यह भौगोलिक 'बाल्कनीकरण' है, जो भाषाओं के बाल्कनीकरण की ओर ले जाता है।।

ऐसे में हमारे सामने एक ही विकल्प रहेगा- केवल अपने ही प्रदेश में लिखे जाने वाले हिन्दी साहित्य को अपने पाठ्यक्रम में पढ़ना। यानी हम अपने पाठ्यक्रम में केवल गुजरात में लिखा जाने वाला हिन्दी साहित्य ही पढ़ेंगे! अधिक से अधिक हम हिन्दीतर प्रदेशों का एक समूह बनाकर अपने हिन्दी- पाठ्यक्रम को कुछ इस तरह गढ़ेंगे कि 'हिन्दीतर भाषा प्रदेशों का हिन्दी साहित्य'। इसमें अलग अलग हिन्दीतर भाषी प्रदेशों में लिखे जाने वाले हिन्दी साहित्य का 'अध्ययन एवं अनुशीलन' होगा! तो सवाल यह है कि क्या हम इस प्रकार का पाठ्यक्रम पढ़ना चाहेंगे? आज जब ज्ञान के सभी विषय अर्थ के तराजू से तोले जा रहे हैं और ये जो हिन्दी है, वही अपने अस्तित्व के लिए संघर्ष कर रही है ऐसे में ये नयी परिस्थितियाँ कैसे संभलेंगी? वर्तमान पाठ्यक्रम में एक कोर्स के रूप में इसे पढ़ना अलग बात है, पर पूरा पाठ्यक्रम? फिर जब यह बोलियाँ अलग हो जाएंगी तब हमारे पाठ्यक्रम में न सूरदास होंगे न तुलसी न मीराँ न ही कबीर। फिर अन्य मध्यकालीन कवियों को पढ़ने का प्रश्न ही नहीं रहेगा। ऐसे में मुझे कहना चाहिए कि आज की संगोष्ठी का यह विषय हमें उस अकल्पनीय और अनिच्छनीय संकट के लिए मानसिक रूप से तैयार करेगा।

इस बात पर ध्यान देना ज़रूरी है कि गुजरात के कई महापुरुषों ने हिन्दी के माध्यम से राष्ट्रीय एवं भारतीय हितों को सिद्ध किया। मध्यकाल में मीराबाई एक ऐसा नाम है जो हिन्दी तथा गुजराती दोनों ही साहित्यों के इतिहास में गौरवपूर्ण स्थान को प्राप्त कर प्रतिष्ठित हैं। प्रणामी संप्रदाय के जामनगर निवासी, स्वामी प्राणनाथ ने हिन्दी को राष्ट्रभाषा के रूप में पहली बार पहचाना था। वे भी गुजराती थे। हिन्दी गद्य के उन्नायकों में से एक लल्लूलाल, गुजराती थे। स्वामी दयानंद सरस्वती, महात्मा गांधी- ये सभी गुजराती थे, हिन्दी की राष्ट्रीय अस्मिता तथा विकास के लिए प्रतिबद्ध थे। आज गुजरात में रहने वाले और हिन्दी में लिखने वाले, हिन्दी के लिए काम करने वाले लोगों की राष्ट्रीय पहचान क्या है मीरा की पहचान कृष्ण भक्ति थी, भाषा माध्यम थी, प्राणनाथ की पहचान उनकी अपनी धार्मिक क सांस्कृतिक भूमि थी, भाषा माध्यम थी। फोर्ट विलियम कॉलेज ने लल्लूलाल को पहचान दी, राजनीति ने गांधीजी को पहचान दी तथा स्वामी दयानंद सरस्वती को राष्ट्रीय नवजागरण ने पहचान दी।

अब सवाल यह है कि गुजरात की आधुनिक तथा समकालीन हिन्दी रचनाशीलता देश अथवा प्रदेश की किस व्यापक अस्मिता के लिए रचनाशील है? आज गुजरात में लिखे जाने वाले समकालीन हिन्दी साहित्य के पास ऐसी क्या आधार भूमि है, जो उसे राष्ट्रीय मंच पर पहचान दे सकती है आज राष्ट्रीय स्तर पर लिखे जाने वाले मुख्यधारा के हिन्दी साहित्य में गुजरात का प्रतिनिधित्व क्या है गुजरात में लिखी जाने वाली कविताएं, कहानियाँ तथा उपन्यास, समीक्षा आदि क्या हिन्दी प्रदेशों में लिखे जाने वाले साहित्य की मुख्यधारा का एक हिस्सा बन सके हैं नागरी प्रचारिणी के एक अंक में रजनीकांत जोशी जी ने यह प्रश्न उठाया था कि क्यों गुजरात के हिन्दी साहित्य को मुख्य धारा में पहचान नहीं मिलती। स्वतंत्रता के पूर्व गुजरात में जो कुछ भी हिन्दी संबंधित हुआ वह मुख्यधारा के समानांतर था। आजादी के बाद भारत में विभिन्न प्रदेश बने अतः एक विभाजन तो अपने आप हो ही गया। विश्वविद्यालयों में हिन्दी अध्यापन का आरंभ हुआ अतः हिन्दी-सेवी की संख्या में वृद्धि हो गयी। हिन्दी में पढ़ना लाभदायी है- तो हिन्दी में और हिन्दी का अध्ययन किया गया। स्वतंत्रता मिल गई अतः राष्ट्रभक्ति मसला नहीं रहा, आधुनिकता के कारण भक्ति मसला नहीं रहा। फिर हिन्दीतर प्रदेशों में विभिन्न प्रकार के अनुदान एवं हिन्दीतर होने की सत्ता ने हिन्दी के विकास में बाधा पहुँचायी। इसमें कोई संदेह नहीं कि आज हिन्दी के साथ किसी-न-किसी रूप से संबंधित लोगों

का संख्या पहले की अपेक्षा बहुत अधिक है, परन्तु इन सभी में हिन्दी भाषा की अस्मिता के लिए समर्पित लोगों की संख्या कितनी? हमारे पास एक अवसर आया था जब हम हिन्दी के प्रति अपनी प्रतिबद्धता अभिव्यक्त कर सकते थे। मेरा संकेत है राज्य की उस शिक्षा नीति की ओर जहाँ हिन्दी को वैकल्पिक भाषा बनाया गया। लेकिन हम में से लगभग सभी यह अवसर चूक गए। पूरी ज़िन्दगी हिन्दी का लाभ और हिन्दी से रोटी कमाने वाले हिन्दी के लोग अपनी मातृ-भाषा संवर्द्धन में लगे रहे, अवसर मिलने पर अंग्रेज़ी के समर्थक भी हो गए। जो हिन्दी सेवी के रूप में अपनी पहचान बनाए हुए थे वे न जाने किन संभवित राजनीतिक लाभों के लिए चुप रहे। पर इन सब में हिन्दी की स्थिति तो रघुवीर सहाय के शब्दों में 'दुहाजू की बीबी' ही बनी रही है।

अगर आपने नयी शिक्षा नीति का मसौदा पढ़ा हो तो आपने देखा होगा कि उसमें हिन्दी के लिए कोई जगह नहीं है। अंग्रेज़ी, संस्कृत तथा क्षेत्रीय भाषाएं, विशेषकर दक्षिण की, उसमें परिलक्षित होती हैं, हिन्दी नहीं। क्या इसलिए कि हिन्दी किसी प्रदेश विशेष की भाषा नहीं है? वैश्विक हिन्दी सम्मेलन इसके लिए आंदोलन के स्तर पर काम कर रहा है। गुजरात में रहने वाले हिन्दी लेखकों तथा हिन्दी का प्रयोग करने वाले अन्य लोगों के पास अभी भी यह एक अवसर है कि वह हिन्दी रचनाशीलता के माध्यम से हिन्दी की रक्षा करें।

जय हिन्दी!! जय भारत!!



## નિસર્ગોપચાર

ડૉ. વી. કે. ચાવડા

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### પ્રસ્તાવના :

નિસર્ગોપચાર એક જીવનપ્રણાલી છે. સાથે સાથે ઉત્તમ ચિકિત્સાપદ્ધતિ છે. અને વ્યક્તિને સ્વમાનશીલ અને નિર્ભય બનાવે છે. નિસર્ગના સિદ્ધાંતો અને નિયમો સરળ પણ ચોક્કસ છે. નિસર્ગમાં સમસ્ત જીવન લયબદ્ધ રહે છે અને જીવનની લયબદ્ધતા જ પરમ શાંતિ અર્પે છે. આ લયબદ્ધ જીવન નૈસર્ગિક જીવનની ઝાંખી આપણને રોજ થાય છે. સૂર્યનારાયણ નિયમિત ઊગે છે. વાયુ પોતાનું કાર્ય નિરંતર કરે છે. આ બધું કાર્ય પંચમહાભૂત તત્વોના આધારે ચાલે છે. પશુ, પંખીનું જગત નૈસર્ગિક જીવન પ્રણાલીનો ઉત્તમ દાખલો છે. કેટલા આનંદમાં રહે છે ? કેટલું મસ્તીભર્યું જીવન જીવે છે? કિલ્લોલ કરતી એમની સવાર પડે છે. આપણે જાગીએ છીએ અને સૂર્યનારાયણના દર્શન કરીએ તે પહેલાં તો તેઓ તેમના કલરવથી સારાચે વાતાવરણને આનંદિત કરી મૂકે છે. વહેલી સવારમાં મોર અને કોયલને ટહુકતા સાંભળ્યા હોય, બુલબુલ અને કાળા કોશીનું મીઠું મધુરું સંગીત આપણા કાને પડ્યું હોય લક્કડખોદનો હુંકાર સાંભળ્યો હોય તો આપણે પણ આનંદ-વિભોર બની જઈએ છીએ.

પક્ષીઓના મધુર અવાજો, ગાય ભેંસનું ભાંભરવું, ઘોડાની હણહણાટી, હાથીની કિકિયારી અને સિંહ, વાઘની ગર્જનાઓ એમના નૈસર્ગિક જીવન પ્રણાલીથી પ્રાપ્ત કરેલા સ્વાસ્થ્યની જ નીપજ છે.

નિસર્ગોપચારનાં સિદ્ધાંતો અને નિયમો સરળ અને સાદા છે. અને વ્યક્તિ જો અનુસરે તો આરોગ્યનો આનંદ માણી શકે અને તો રોગને નોંતરવાનો પ્રશ્ન ઉપસ્થિત થતો નથી. રોગો અનેક સ્વરૂપે આવે છે. પણ તેનું કારણ એક જ છે શરીરમાં વિજાતીય દ્રવ્યો અગર ઝેરનો ભરાવો.

આ વિજ્ઞાતીય દ્રવ્યો ખોરાક તથા દવા દારૂની વિચિત્ર પદ્ધતિને લીધે વિકૃત બનેલા લોહીના બંધારણથી શરીરમાં અકુદરતી નકામા પદાર્થોની, ખોરાક સ્વરૂપે તેમજ દવા સ્વરૂપે જમાવટ થાય છે.

**વિષયવસ્તુ :**

**નિસર્ગોપચાર એક ઉત્તમ ચિકિત્સાપદ્ધતિ :**

શરીરના અમુક અવયવોની અકુદરતી સ્થિતિને લીધે લોહીના ભ્રમણમાં વિધ્ન પેદા થાય છે તથા જ્ઞાનતંત્રની કાર્યવાહીમાં વિક્ષેપ પડે છે. વિઘાતક વિચારો આવે છે. લાગણીઓનું ખેંચાણ થાય છે અને તેથી મન ઉપર પણ ખોટાં દબાણ વધી જાય છે. આ કારણોસર શરીરમાં જે મળ અને વિષનો ભરાવો થાય છે તેનો નિકાલ મૂત્રાશય, ગુદા, ફેફસાં અને ત્વચા દ્વારા શરીર કરે છે. એ અવયવો એકત્ર થયેલા મળનો નિકાલ કરવામાં અશક્તિમાન બને છે ત્યારે શરીરમાં રહેલી વૈષ્ણવી શક્તિ તાવ, ઝાડા, ગડગૂમડાં અને ઊલટી દ્વારા તેનો નિકાલ કરે છે અને આ તાવ, ઝાડા વગેરેને આપણે રોગ માની લઈએ છીએ અને તે દબાવવા દવા દારૂનો ઉપયોગ કરીએ છીએ. દવા દારૂના ઉપયોગથી વૈષ્ણવી શક્તિના કાર્યમાં અવરોધ ઊભો થાય છે.

શરીરમાં રહેલી વૈષ્ણવી શક્તિ શરીરનું નૈસર્ગિક સમતોલપણું ટકાવી રાખવા જે પગલાં ભરે છે તેને સરળતા કરી આપવાના માર્ગો નિસર્ગોપચારે નક્કી કરેલાં છે. જેમાં...

- ઉપવાસ (ભૂખમરો નહિ)
- પદ્ધતિસરનો વનપક આહાર
- શુદ્ધ જળ તથા જળના પ્રયોગો
- સમયસરનો સૂર્યપ્રકાશ
- શુદ્ધ હવા
- સૂર્યકિરણોથી તમ થયેલી માટી
- આસન પ્રાણાયામ અને હળવો વ્યાયામ
- યમનિયમ
- આરામ અને ઊંઘ એ મુખ્ય ગણાવી શકાય.

નિસર્ગોપચારના સિદ્ધાંતો અને તેને ઉપકારક થતા માર્ગોનો આગળ વિચાર કરીએ તે પહેલાં નિસર્ગોપચારની દૃષ્ટિએ શરીરમાં બેક્ટેરીયા શો ભાગ ભજવે છે તે પણ જાણી લઈએ.

બેક્ટેરિયા-સૂક્ષ્મ જંતુઓ રોગને લઈ આવે છે અને આપણા તે દુશ્મનો છે એવી માન્યતા પ્રચલિત છે. પરંતુ નિસર્ગોપચાર એમ માનતું નથી. તે માને છે કે આપણું શરીર સદાયે સૂક્ષ્મ જંતુઓથી ભરેલું રહે છે અને આ બધા શરીરતંત્રમાં એકત્ર થયેલા મળને તથા વિષને દૂર કરવાનું કાર્ય કરે છે. શરીરમાં એકત્રિત થયેલો મળ જ્યારે આ જંતુઓ દૂર કરશે ત્યારે આપોઆપ જંતુઓ પણ અલોપ થઈ જશે. જે વ્યક્તિનું શરીર અંદરથી શુદ્ધ છે તેના ઉપર જંતુઓ કદી માટી અસર ઉત્પન્ન કરી શકતાં નથી. જેઓ એક યા બીજા કારણોસર અશક્ત છે તથા જેમના શરીરના ઉત્સર્ગ માટેના અવયવો અનેક પ્રકારના મળથી ભરાઈ ગયા છે, તેવી પ્રત્યેક વ્યક્તિએ તંદુરસ્તી ગુમાવેલી હોય છે અને તેથી જ ત્યાં જંતુઓ પેદા થાય છે અને શરીરનું સાફસૂફીનું કામ કરવા માંડે છે, જેને આપણે રોગ તરીકે ઓળખીએ છીએ.

જંતુઓ રોગનું મુખ્ય કારણ હોય એમ પુરવાર કરવા માટે એકપણ નક્કર ઉદાહરણ નથી. એમ ડૉ.બેડાએ સને ૧૯૨૨માં એન્ટીવેક્સીનેશન લીગની વાર્ષિક સભામાં જણાવ્યું હતું. આ પુરવાર કરવા એક જ દષ્ટાંત પૂરતું થઈ પડશે.

પ્રો.પેટનકોફરે એક પ્રયોગ કરતાં કોલેરાના જંતુઓથી ભરેલી એક ટેસ્ટ ટ્યૂબ પોતાના ગળામાં વહેતી મૂકી છતાં એમને કશું થયું નહિ. આ ટેસ્ટ ટ્યૂબમાં રહેલા કોલેરાના જંતુઓની શક્તિ આખી સૈનિકોની પલટણોનો નાશ કરી શકે એટલી હતી. પ્રો.પેટનકોફરના શરીરની નૈસર્ગિક શક્તિને લઈને જ કોલેરાના જંતુઓ તેમને માઠી અસર કરી શક્યા નહિ.

નૈસર્ગિક શક્તિ અગર વૈષ્ણવી શક્તિની એક મર્યાદા પણ સમજી લઈએ. આગળ આપણે જણાવ્યું છે કે વૈષ્ણવી શક્તિ આપણા શરીરમાં એકત્ર થયેલા મળને બહાર ફેંકી દેવાનો પુરુષાર્થ કર્યા જ કરે છે. જો શરીરના અવયવો એ મળને બહાર ફેંકી દેવા અસમર્થ હોય તો વૈષ્ણવી શક્તિ એક્યુટ રોગો દ્વારા પણ બહાર ફેંકે છે. કેટલીકવાર એવી સ્થિતિ ઉભી થાય છે કે આ વૈષ્ણવી શક્તિ પોતાના ગજા ઉપરાંતનું કાર્ય કરીને બિનઅસરકારક બને છે. આવી વ્યક્તિએ શું કરવું? અસાધ્ય એવી સ્થિતિને તેમાંથી ઊભા થયેલ રોગ ઉપવાસ, ખોરાકરૂપી ઔષધ દ્વારા વશ કરવામાં અસરકારક બનાવવા પ્રયત્ન કરવો જોઈએ જો વૈષ્ણવી શક્તિ ફરીથી અસરકારક ન જ થાય તો નૈસર્ગિક સારવાર કે અન્ય સારવાર પદ્ધતિ તે રોગને નાબૂદ કરી શકશે નહિ.

આપણે સારી રીતે જાણીએ છીએ કે “Healing comes from within not from without” શરીરમાં કોઈપણ પ્રકારે થયેલા જખ્મો કે બગાડ દવાદારૂથી સારા થતા નથી. પણ શરીરની આંતરિક શક્તિ જ તેને રૂઝવે છે, સુધારે છે. આંતરિક શક્તિ જ્યારે સાવ નિષ્ફળ જાય છે ત્યારે તે દર્દીને ગમે તેટલા દવા દારૂ આપે તો પણ સારું થતું નથી. જો દવાદારૂ આપવાથી રોગ દૂર થઈ જતાં હોય તો પછી કોઈ પૈસાદાર વ્યક્તિને મરવાનો વખત જ ન આવે. એટલે જ નેચરોપથી શરીરમાં રહેલી પ્રતિકારાત્મક શક્તિને મદદરૂપ થવાથી તથા એના કાર્યમાં સરળતા કરી આપવાની સલાહ આપે છે.

આ સરળતા કરી આપવાના ઉપાયોમાં ઉપવાસ શરીર શુદ્ધિનું સૌથી ઉત્તમ સાધન છે. અને પાચનતંત્રમાં વપરાતું લોહી શરીરના શુદ્ધીકરણમાં વપરાય છે. એ રીતે શરીરમાં એકત્ર થયેલો મળ ફેંકવા માંડે છે. દર્દીની ઉંમર, એની શારીરિક શક્તિ, રોગ વગેરે ધ્યાનમાં રાખી ઉપવાસના દિવસો નક્કી થાય છે. ૧, ૩, ૫ થી માંડી ૩૦ કે ૪૦ દિવસો સુધી ઉપવાસમાં પણ શરીરના ટીસ્યૂઝને જરૂરી પોષણ મળી રહેવું જોઈએ તે ધ્યાન બહાર જાય તો ઉપવાસને બદલે તે ભૂખમરો બની જાય તેથી જ ઉપવાસ એ કોઈ અનુભવી નેચરોપેથના માર્ગદર્શન નીચે કરવા તે હિતાવહ છે. ઉપવાસ પાણી ઉપર થઈ શકે. શાકભાજી અને ફળોના રસ ઉપર પણ કરી શકાય. ઉપવાસમાં જીભ ઉપર છારી બાઝે છે અને ધીરે ધીરે તે ઓછી થવા માંડે છે. જ્યારે જીભ સ્વચ્છ થાય ત્યારે ઉપવાસ બંધ કરવો જોઈએ. ઉપવાસ છોડતી વખતે ફળોના રસથી શરૂઆત કરવી અને પછી ફળ અને વનપક વસ્તુઓનો ઉપયોગ કરવો અને છેલ્લે કાચા ઉગાડેલાં અનાજ, ફળફળાદિ કાચાં શાકભાજી અને નટ્સ લેવા જેથી ફરીથી શરીરમાં મળનો ભરાવો થાય નહિ. ત્યારબાદ ધીરે ધીરે રોજિંદા આહારનો ઉપયોગ વિવેકપૂર્વક કરવો.

શરીરને કાર્ય કરતું રાખવા માટે પોષણની જરૂર છે. આ પોષણ ખોરાકમાંથી મળે છે. આજનો આપણો ખોરાક અકુદરતી અને સત્વહીન છે. તેમાંથી આપણને પોષણ કરતાં મળ અને વિષ વધુ મળે છે. આપણો ખોરાક અને એનું પ્રમાણ એવું હોવું જોઈએ કે શરીરને જરૂરી એવા બધાં તત્ત્વો મળી રહે. છતાં ઓછામાં ઓછો મળ ઉત્પન્ન થાય. જો આમ બને તો શરીરના અવયવો કોઈપણ પ્રકારના દબાણ વગર તેનો નિકાલ કરી શકે. આવા ખોરાકમાં વનપક ફળો, નટ્સ, કાચા શાકભાજી, ઉગાડેલા ફળાગાવેલાં કઠોળ, અનાજનો સમાવેશ કરી શકાય જ્યારે દૂધ,

દહીં માટે બે મત છે. એક માન્યતા એવી છે કે દૂધ અને દૂધની બનાવટો શરીર માટે જરૂરી છે અને બીજો મત છે કે ફણગાવેલું અનાજ સુપાચ્ય અને શક્તિદાયક છે. અને શરીરમાં ઓછામાં ઓછો મળ ઉત્પન્ન કરે છે. નિસર્ગોપચારની દૃષ્ટિએ ખાદ્ય વસ્તુઓ એના કુદરતી સ્વરૂપમાં લેવામાં આવે તે વધુ ઈચ્છનીય છે. જે પણ ખાદ્ય વસ્તુઓ આપણે લઈએ તે ખૂબ જ ચાવી ચાવીને લેવી જરૂરી છે. વધુ પડતા મસાલાવાળા, તળેલા, ખાંડની બનાવટવાળા અને અથાવેલા અથાણાઓથી દૂર રહેવું. પ્રત્યેક વ્યક્તિ માટે તે હિતકારક છે. ખોરાક વધુને ઓછો ન લેવો. બિનજરૂરી ઉપવાસ ન કરવા ભૂખ લાગે ત્યારે જ ખાવું. તરસ લાગે ત્યારે જ પાણી પીવું. આ સૂચનોનો અમલ કરવામાં આવે તો શરીર તંદુરસ્ત જરૂર રહેશે.

### હવે જળ અને જળોપચાર કેવી રીતે ઉપયોગી છે તે જોઈએ

રોગને મુક્ત કરવાની શક્તિ જળમાં રહેલી છે. શરીરના વજનમાં ૪/૫ વજન પાણીનું હોય છે. એટલે શરીરને જ્યારે પણ પાણીની જરૂર પડે છે ત્યારે તરસ લાગે છે. અને તરસ લાગે એટલે તરત જ શાંતિથી પાણી પી લેવું જોઈએ. શરીરને જળનો સંપર્ક થતાં જ શરીરમાં રહેલો મળ ત્વચા દ્વારા બહાર આવવા માંડે છે. ઠંડા પાણીની અસર શરીર પર ચમત્કારિક છે. આથી જ આર્યોએ નદી, સરોવરમાં સ્નાન કરવાની સૂચના આપી છે. અને પાણીમાં ઊભા રહી સૂર્ય ઉપાસના કરવાનો આદેશ આપ્યો છે. ઠંડા પાણીથી જેમ સ્નાનની જરૂર છે એમ અંદરની સફાઈ માટે પણ પાણીની જરૂર છે.

સૂર્યપ્રકાશ આપણા જીવનમાં મહત્વનું સ્થાન ધરાવે છે. આ સૃષ્ટિ સૂર્યપ્રકાશ વગર જીવંત રહી ન શકે. પ્રત્યેક વ્યક્તિએ રોજ વહેલી સવારે ખુલ્લા શરીર પર સૂર્યપ્રકાશ લેવો જરૂરી છે. લીલાં શાકભાજી, ફળફળાદિ વગેરેમાંથી પણ સૂર્યપ્રકાશ મેળવી શકાય છે.

સ્વચ્છ હવા વગર આપણે જીવી જ ન શકીએ. દૂષિત હવાથી આપણે જરૂર રોગિષ્ટ બનવાના. સ્વચ્છ હવા જ આપણા લોહીનું ભ્રમણ તંદુરસ્ત રાખે છે. અને શરીરને જરૂરી પ્રાણવાયુ પુરો પાડે છે. ત્વચા અને લોહીને જો તંદુરસ્ત રાખવા હોય તો આપણે સ્વચ્છ હવા લેવી જ જોઈએ.

માટીમાં રહેલા તમામ તત્વો આપણા શરીરને ઉપયોગી છે. માટીને પેક્સ, ગારો વગેરે રોગ નિવારણમાં ઘણા ઉપયોગી છે. ધરતીમાંથી પેદા થતાં શાકભાજી, ફળફળાદિ અનાજ વગેરે શરીરને નિભાવવામાં અગત્યનો ભાગ ભજવે છે. એ જ રીતે આકાશ તત્વ પણ શરીરની સુખાકારીમાં ઉપયોગી છે.

### તારણ :

યમ નિયમમાં સત્ય, અહિંસા, અપરિગ્રહ, અસ્તેય, બ્રહ્મચર્ય, શૌચ, સંતોષ, તપ, સ્વાધ્યાય અને ઈશ્વર પ્રણિધાનનો સમાવેશ થાય છે. આ દશ યમ નિયમને સંપૂર્ણપણે ભાગ્યે જ કોઈ વ્યક્તિ પાળી શકે. પરંતુ એનો એક હજારમો ભાગ પણ જો અનુસરવામાં આવે તો વ્યક્તિના મન ઉપર તેની ઈચ્છાઓ અને લાગણીઓ પર ઘણો કાબૂ આવી જાય. જેથી એનું આરોગ્ય સંપૂર્ણપણે સચવાઈ રહે. આપણે સખત પરિશ્રમ કર્યા બાદ જો થોડીવારને માટે પણ શવાસન કરીએ અને શરીરને સંપૂર્ણપણે રીલેક્સ કરી શકીએ તો ટૂંક સમયમાં કરેલા શ્રમથી લાગેલો થાક દૂર થઈ જશે. નીચે ધરતી, ઉપર આકાશ અને ચારે દિશા ખુલ્લી હોય એવી જગ્યાએ જો સૂઈએ તો આપણે અચૂક નવી શક્તિ પ્રાપ્ત કરી શકીએ.

આગળ આપણે પશુપંખીના સ્વાસ્થ્ય વિશે અને એમના નૈસર્ગિક જીવન વિશે ઉલ્લેખ કર્યો છે. એમના એ જીવનનો અભ્યાસ આપણા પૂર્વજોએ કરેલો છે. શ્રી રામચંદ્રજીના બંને પુત્રો લવ અને કુશ આશ્રમના વાતાવરણમાં ઉછર્યા અને નૈસર્ગિક જીવન જીવ્યા. અને તેના પ્રતાપે એમણે નાની ઉંમરમાં જ અશ્વમેઘ યજ્ઞના અશ્વને પોતાના આંગણે બાંધી

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શક્યા અને યુદ્ધ નોતરી શક્યા. બાળપણમાં શ્રીકૃષ્ણ ગોકુળમાં ગોપ-ગોપીઓ સાથ નૈસર્ગિક જીવન જીવ્યા. જેને પરિણામે એમને પ્રેમ અને શૌર્યની સરિતા વહેવડાવી. સર્વદમન એના નૈસર્ગિક જીવન વ્યવહારને લીધે જ નિર્ભયતાથી સિંહનું મોં ફાડીને તેના દાંત ગણી શક્યો. અનેક સાધુસંતો નિસર્ગના સતત સંપર્કમાં રહી તનમનથી સ્વસ્થ બની અધ્યાત્મમાં સારી એવી પ્રગતિ કરી શકે છે. નૈસર્ગિક જીવન જ વ્યક્તિને ભયથી મુક્ત કરે છે અને એનું આધુનિક દૃષ્ટાંત મહાત્મા ગાંધી છે.

**સંદર્ભો :**

યુક્તાહાર, ૧૯૬૫, ડૉ. જયંતિ ઠાકોર ચન્દ્રિકા પ્રિન્ટરી, અમદાવાદ.

નિસર્ગોપચારનો ઈતિહાસ, ૧૯૯૨, ડૉ. મહાદેવ પ્રસાદ, મહેશ મુદ્રણાલય, અમદાવાદ.

નિસર્ગોપચાર, ૧૯૯૪, ડૉ. જયંતિ ઠાકોર અને શ્રી બાલુભાઈ રાણા, મહેશ મુદ્રણાલય, અમદાવાદ.



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## **Positive Goal Setting**

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### **Abstract**

Many people begin their career in management with high hopes of making an impression on their bosses by developing the business or by implementing new and better ways of doing things. Unfortunately, most of them find that they are so busy handling day-to-day issues that there never seems to be time for anything else.

Furthermore, comparatively few people have tangible goals; most have the awareness that things could be improved but only vague ideas about how to achieve these improvements.

All tasks are either reactive or proactive. Reactive tasks are when you react to situations that occur, and are driven by events and the actions of other people. Conversely, proactive tasks are when you seek opportunities to make a positive impact in the workplace and are driven by you.

This Article will throw some light on management students / employees to be proactive in positive Goal Setting. Behaving proactively revolves around anticipating events and using initiative to predict the likely outcome, whilst being in a position to respond and take the appropriate action when needed.

Those who gain recognition and promotion in organizations are usually those who are proactive;

they are those who use their initiative to make things happen. In order to truly be proactive, however, there are two things that need to be addressed.

The first is that a certain amount of time needs to be freed up from handling routine tasks, resolving crises, and handling interruptions.

The second thing that you need to do is to be able to set positive goals that will inspire you and your team to make things happen. Setting goals that motivate people is not easy and requires effort and good judgment.

This article will also provide new direction for other research to the scholars.

Keywords : Goal, Goal Setting, Positive Goal Setting, Motivation.

### **Introduction**

**Goal:** A goal is a desired result a person or a system envisions plans and commits to achieve a personal or organizational desired end-point in some sort of assumed development. Many people endeavor to reach goals within a finite time by setting deadlines.

**Goal Setting:** Goal-setting ideally involves establishing specific, measurable, attainable, realistic and time-bounded (S.M.A.R.T.) objectives. On a personal level, the process of setting goals allows people to specify and then work towards their own objectives most commonly, financial or career-based goals. Goal-setting comprises a major component of personal development.

### **The Positive Psychology of Goal Setting**

Having goals can help you live the life you want. It can give you a focus and some direction. This article outlines why setting goals can be beneficial for your wellbeing. It also discusses how your character strengths can be used to assist you in setting and achieving goals.

### **The benefits of goal setting:**

Hope and optimism

Goals give you a focus and something to look forward to. They give your life a purpose and increase your feelings of hope and optimism. Whether your goals are long term or short term, you are giving yourself a reason to get up in the morning. The link between hope and goal setting goes both ways. Thinking about and planning your goals can increase a feeling of hope and optimism. This optimism can then boost your ability to achieve your goals. It will also assist you in planning more goals in the future. A person with hope is able to define their goals, know how they are going to get there and are motivated to achieve them. Furthermore, hope will help a person work through any complications and so not give up when things get difficult.

### **Taking control**

If you set and achieve daily goals, these will add up to some major goal accomplishments at the end of the year. And it's all your own work. Happy people take control of their lives, rather than just drifting or let others make the decisions. Recognize the feeling of control and empowerment as you establish and then accomplish your goals. Imagine you have a deadline at work (something you cannot control). However, how would it be if you made the decision to meet that deadline ahead of time? Or if you are the sort of person that tends to go over deadlines, making excuses

all the way, turn this around and work hard to meet that deadline.

Recognize how much you can do. Even a shift in attitude can give a feeling of mastery. Being able to overcome hurdles and developing a more constructive attitude to the things you cannot control is a great confidence booster.

### **Flow experience**

By setting yourself regular, meaningful goals you position yourself to encounter more flow experiences .A flow experience is one where your whole consciousness is absorbed with a particular activity. Thoughts of time and other needs (such as hunger) are forgotten. Positive psychologists generally agree that the more flow experiences a person has, the happier they are. Goals give us something we can actively get involved with, which is an essential ingredient to a flow experience.

To achieve this state it is important to have a clear purpose. So clearly defining your goals is a good start. Also, you will want to choose a goal that is challenging for you, but is not out of your depth. If it is not challenging enough, you will almost certainly become bored. It is worth reviewing your goals on a regular basis to help keep you motivated. Furthermore, try to obtain regular feedback so you are aware of how you are doing. Support from others can be a good idea, else make sure you track your progress in some way.

Goals and the flow experience have a good relationship. By setting goals we enhance our chances of experiencing flow. By experiencing flow, we are more likely to achieve our goals.

### **General wellbeing**

Having goals in our life is good for our wellbeing. It provides us with an opportunity to go on a journey which we can learn from and enjoy. It helps a person appreciate their capabilities, gives life a purpose and increases optimism. As such, it can reduce stress and help reduce the chances of developing depression.

Carrying out goal-related tasks gives a person focus and increases happiness.

#### **Goal setting and your strengths**

When setting and working on your goals, consider how you might use your personal strengths to help you achieve your objectives. It is worth knowing what your top strengths are as these are the ones that are most effortless to use and so drawing on them should be a great motivator.

### **Consider how the following strengths may assist you when setting up your goals:**

Curiosity, creativity and love of learning may assist you in your brainstorming. This may be useful when you are considering which goals to set, how you are going to achieve them and ways to overcome potential difficulties. Bravery can help you reach for those huge goals you've never quite got off the ground. This strength will enable you to act, in spite of your misgivings. If persistence is your strength, then you are sure to achieve the goals you set yourself. Having humor as your strength will enable you to laugh if things go wrong, as you see the lighter side of life. Prudence can help you set the right goals as you are able to consider whether the goal you think you want now is one you will want in the future. Being authentic means you will remain true to yourself when setting your goals. It ensures you are doing them for yourself and not other people.

Another way you can make use of personal strengths when setting goals, is to actually set

a goal dedicated to developing a particular strength. For instance, you might want to work on being kinder, so decide to volunteer at an organization that helps other people.

Alternatively, you could use goal setting as an opportunity to nurture a particular strength, although the strength is not a goal in itself. For instance your goal is to write a novel. However, along the way you decide to exercise your gratitude strength and so make a conscious effort to acknowledge those people who assisted you in working towards your goal.

Whatever goals you set yourself, enjoy the process and reflect on how they are benefiting you along the way.

### **Observation**

Did you know that most people who try to attain their personal goals fail? This is especially true of behavior changing goals such as weight loss, smoking cessation, alcohol and drug abuse programs.

For example, the majority of people who start a weight control program and achieve their weight loss goal (so we exclude those who attempt, go part way, and then fail) will be at or in excess of their previous weight level one year later. There are similar failure rates for other programs designed to control smoking, drugs and alcohol.

As looked further into this, what was puzzling that most of these programs are technically correct. For example, if you follow what most weight control programs suggest you will lose weight. The addiction control programs methods are sound. So why do these goals setting programs fail so broadly? Certainly it is not due to lack of desire on the part of those Who try these programs to achieve their personal goals? If a person is involved in weight control, he / she will say "I want to lose weight". If smoking is a problem, he will say " I want to quit smoking ". If drinking is problem, he will say "I want to stop drinking". What are "lose," "quit," and "stop"? All negative goals. And that's the problem.

We naturally move towards positive goals and intuitively away from negative goals. We are pleasure-seeking organisms who seek pleasure and avoid pain. Lose, quit, and stop are all negative goals. (The first three letters of a diet are "die.")

So why do we ever get involved in these negative goal programs in the first place? Typically, it is a negative emotion such as fear or anger. We fear what is happening to our health or are angry with ourselves for what we have done and, based on that emotion, we now submit ourselves to do these negative things such as lose, quit, and stop, much like we would punish a child.

Then one of two things occurs. We fail and nothing more really matters. Or we succeed. As we succeed, we start to get confident and somewhat cocky." He haven't had a cigarette in three days!" As we gain that confidence, the negative emotions that brought us into the negative control program in the first place start to weaken. And when those negative emotions, the anger and the fear disappear, we go right back to our previous behavior.

### **Conclusion**

To increase our chances for achieving any goal, we need to frame it as a positive goal with a positive outcome. Don't tell yourself you are going to "lose" weight. Say, "I am going to get into a size 8 dress by next summer." Instead of "quitting" smoking, how about, "I am going to

get fresh, pink new lungs and more money in my pocket.” Rather than “stop” drinking, instead see yourself waking up with a clear head, without a frequent hangover. We will move more naturally and comfortably toward the achievement of a POSITIVE goal.

The mind will more readily accept a positive goal and not automatically try to find ways and rationalizations to sabotage us as with a negative goal.

### **References**

Edwin A Lockey , Gary P Latham, “New development in Goal Setting and Task Performance”, published by Routledge part of Taylor and franchise group, 2013.

Edwin A Lockey, Gary P Latham. Goal Setting : A motivational technique that works, Prentice-Hall, 1984

Larrie A Rouillard "Goal and Goal Setting” Crisp Publication, 2003

New Directions in Goal-Setting Theory Current Directions in Psychological Science October 1, 2006 15:5265-268

Sheldon, K.M., & Elliot, A.J. (1999). Goal striving, need satisfaction and longitudinal well-being: The Self-Concordance Model. *Journal of Personality and Social Psychology*, 76, 482–497.

The Effect of Employee Learning Goals and Goal Commitment on Departmental Performance *Journal of Leadership and Organizational Studies* February 1, 201320:1 62-68

### **Web References**

[www.wikipedia.org](http://www.wikipedia.org) [www.managementthinker.com](http://www.managementthinker.com) <http://makethechange.com.au> <http://www.beyond.com/articles> <http://www.mindtools.com>

<http://thewirelessincome.com/wp-content/uploads/2013/01/goal-setting.jpg> <http://www.free-management-ebooks.com/templates.htm> <http://topachievement.com/articles.htm>

