VETIVER SYSTEM TECHNOLOGY FOR PHYTOREMEDIATION OF PALM OIL MILL EFFLUENT (POME)

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Introduction:

- Water is the source of life, and is the basic condition of human survival. Insufficient water supply is one of the serious problems around the globe.
- Fast industrialization and intensive agricultural practices causes the production and release of considerable amounts of wastes into the water sources.

Palm Oil Mill Effluent (POME)

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- **Palm oil is one of the most rapidly expanding vegetable oils in Fats market after soybean oil.**
- **Malaysia is one of the world's largest palm oil producer with a total crude oil production of 17.56 million tonnes per year.**
- **POME is generated from the production of palm oil. It is a colloidal suspension of 96% water, 0.7% oil and 5% total solids including 2–4% suspended solid.**
- **The palm oil mill industry in Malaysia has been identified as the largest contributor to the pollution load in rivers throughout the country.**

Conventional Treatment Methods & Disadvantage

The cheapest way of discharging of POME is to release it into the river;

POME contains high concentrations of :

- **organic matter**
- **suspended solids (SS)**
- **oil and grease**
- **plant nutrients**

So it can cause significant environmental effects like oxygen depletion if it is discharged without efficient treatment.

The traditional disposal methods such as open dumping or land application of POME is become impractical as it is :

Expensive, cause clogging the soil, kills the vegetation on contact and, limitation on open space.

Conventional Treatment Methods & Disadvantage

➢ ***Anaerobic treatment:***

Long retention time, large area required.

➢ ***Aerobic:***

High energy requirement.

➢ ***Membrane:***

Short membrane life, membrane fouling, expensive.

➢ ***Evaporation***

High energy consumption.

Phytoremediation

Phytoremediation is a new, cost effective, aesthetically pleasing, and low cost technology that directly uses green plants to degrade, or render harmless various environmental contaminants including organic compounds or heavy metals from the environment in their tissues.

Characteristic of suitable plant species used for phytoremediation

- **high uptake of both organic and inorganic pollutants**
- **grow well in polluted water**
- **accumulate, degrade or volatilize the contaminants**
- **grow quickly**
- **easy harvesting**

Vetiver Grass

1. Plant species	
Common name	**Vetiver grass**
Scientific name (genus / species)	*Chrysopogon zizanioides L.Roberty ex Vetiveria zizanioides*
Family	**Poaceae (Gramineae)**
2. Availability in climate zone	
Climatic range	**Subtropical to tropical**
Geographic range	**Native to India, Sri Lanka, Burma and Southeast Asia ,South China and Thailand and subtropical Northern Australia (Queensland).**
3. Growth characteristic and reproduction	
Life cycle and growth form	**Perennial and persistent, year-round growth in tropical climates.**
Growth height	**Up to 1.5 - 2 m**
Growth rate and period	**Rapid and High Biomass up to 130 t/ha.**
Root and rhizome growth and development	**Extensive, strong and dense root system that penetrates vertically deep into the soil (up to 3 m under ideal conditions).**

Unique Characteristics

• **The Vetiver System (VS) was first developed by the World Bank for soil and water conservation and now being used in over 100 countries.**

• **Not invasive, it flowers but set no seeds hence no weed potential.**

• **Erect and stiff stems**

• **Deep, extensive and penetrating root system**

•**Prefer full sun**

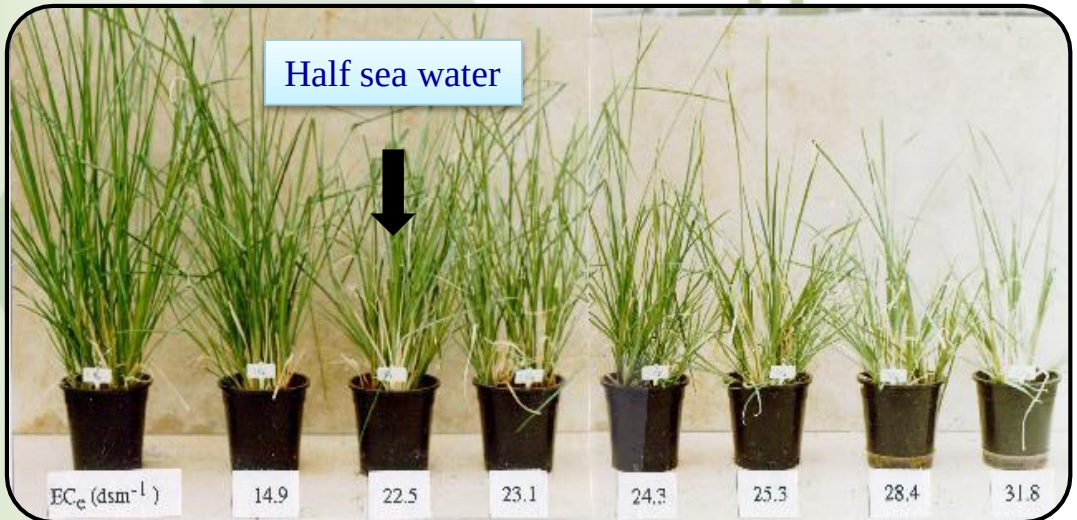
Tolerant to:

•**Drought and flood**

•**Acidity(pH 3- 10.5), alkalinity, salinity(47.5 dsm^{-1}), Aluminium and Manganese toxicities**

•**Heavy metals**

•**Various soil types**



Removal efficiencies

General aspects

Researches in North Australia, South China and Thailand have proved the effectiveness of Vetiver in constructed wetland systems for the treatment of domestic (municipal), industrial and agricultural wastewaters, and also landfill leachate. This plant was very successfully used in Australia for the treatment of domestic primary effluents from septic tanks.

Nitrogen and phosphorus compounds

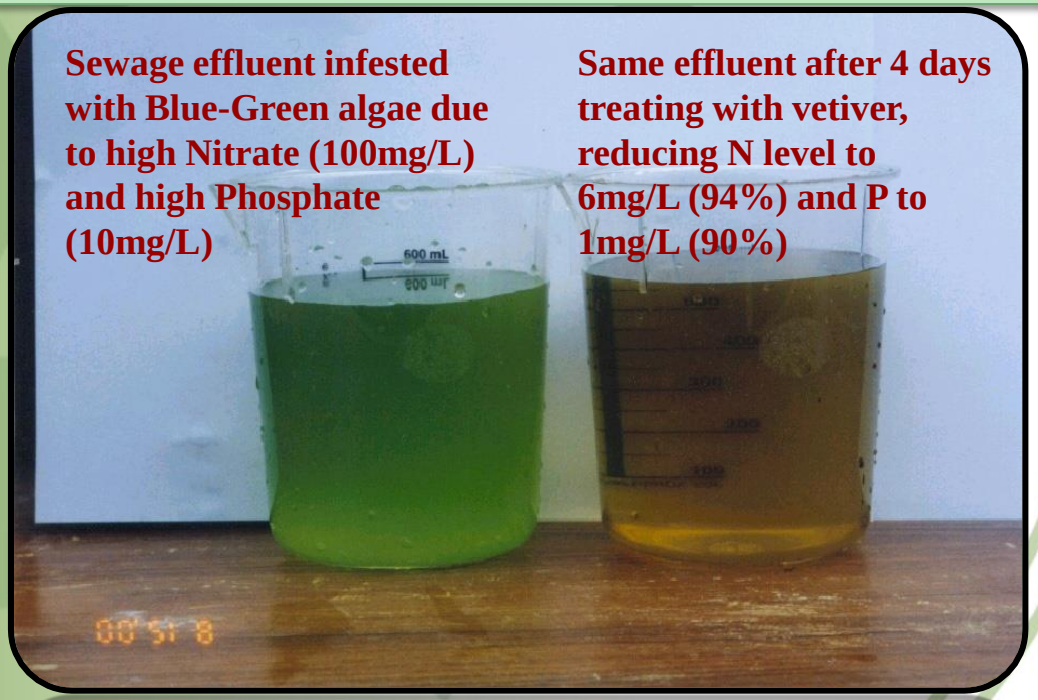
Generally, vetiver grass proved to be tolerant to eutrophic conditions and was able to grow at high strength NH3-N concentrations of about 390 mg/L.

In the study conducted by Klomjek (2005) in Thailand, Vetiver showed a good NH3-N treatment performance for medium strength municipal wastewater. Mean reduction 76.5 % (mean influent conc.: 19.5 mg/L).

Removal percentage from polluted river water

Parameters	Removal rates (%)
Total Phosphorus	98% after 4 weeks
Total Nitrogen	74% after 5 weeks

Vetiver clean up blue green algae in 4 days, with high capacity of removing N and P in polluted water.



Organic constituents (BOD and COD) :evaluation of existing case studies

Removing COD, BOD from piggery effluent

Parameters	Concentrations (mg/L)	Removal rates after 4 days (%)
COD	825	64
BOD	500	68

Removal percentage from Textile wastewater

Parameters	COD	BOD
Vetiver grass	46 %	67 %
Phragmites mauritianus	37 %	61%

Australia
Wastewater pond on a fertilizer factory in Brisbane, Vetiver growth after 3 months

Australia
Sewage effluent pond

Vietnam
one month old vetiver growing under nutrient rich piggery effluent

Case Study

Palm Oil Mill Effluent, Malaysia

MATERIALS AND METHODS

Experimental design

Three POME concentrations in aerobic and anaerobic set up.

- **100% POME (Pure POME)**
- **50% POME + 50% distilled water (Half POME)**
- **25% POME + 75% distilled water (Quarter POME)**
- **Control (without plant)**

Plants Preparation

Vetiver Root After One months Growing in Solution

First Day of Experiment

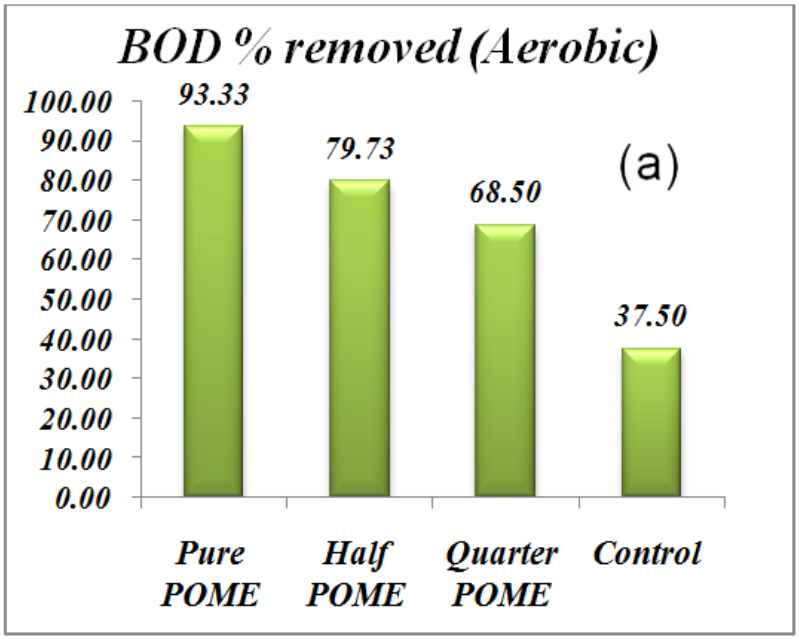
After 28 Days, Growing in POME

POME Characteristics

Parameter	Unit	Measurement Method	Value
pH	_	pH Meter	7
COD	mg/l	Spectrophotometry	1414
BOD	mg/l	Manometric/respirometric	300
Total Nitrogen	mg/l	Macro kjeldahl	210
Total Phosphorus	mg/l	Ascorbic acid	11

RESULTS AND DISCUSSIONS

Effect of Aeration & Various Concentrations in Reduction of BOD



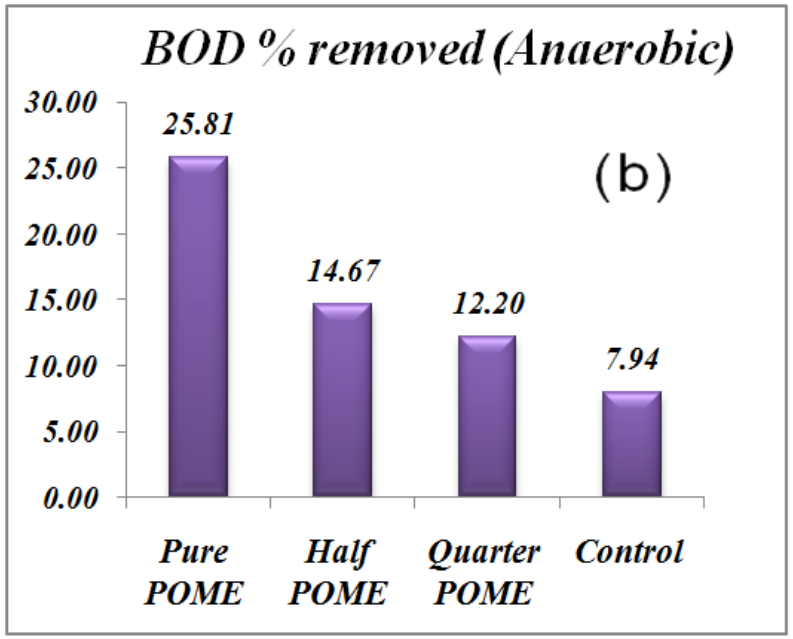
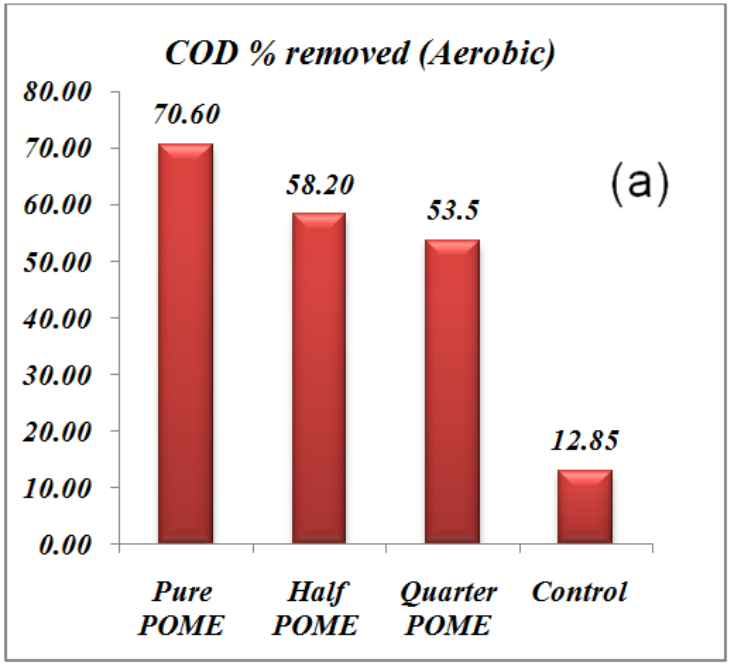


Figure 1: (a) Reduction of BOD in Aerobic set up (b) Reduction of BOD in Anaerobic condition.

Effect of Aeration & Various Concentrations in Reduction of COD



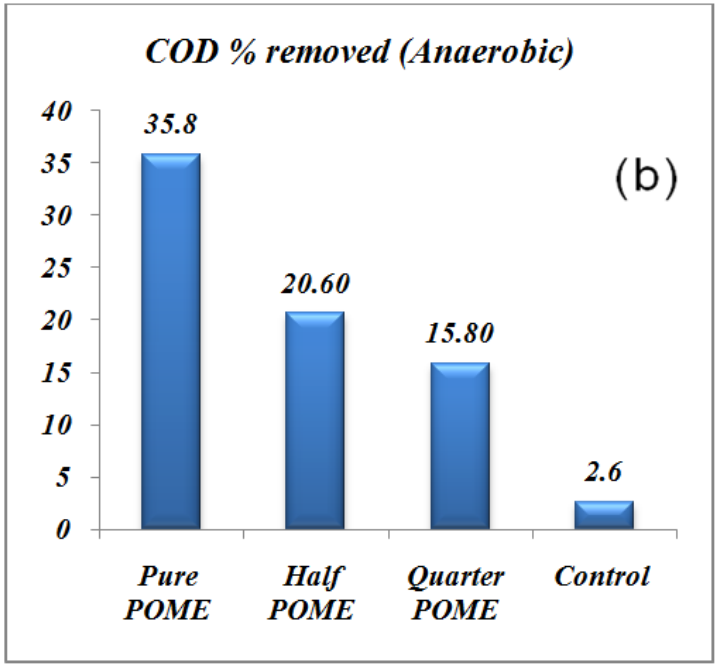
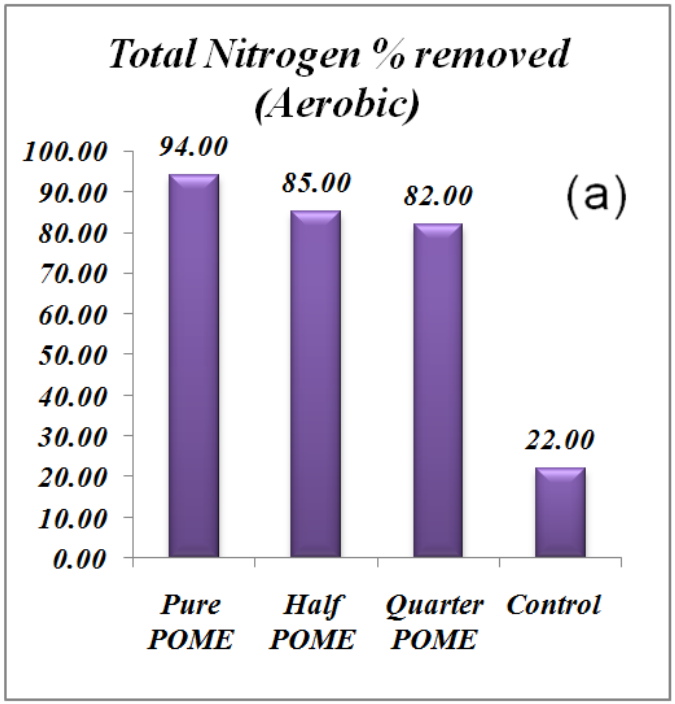


Figure 2: (a) Reduction of COD in Aerobic set up (b) Reduction of COD in Anaerobic condition.

Effect of Aeration & Various Concentrations in Reduction Nitrogen



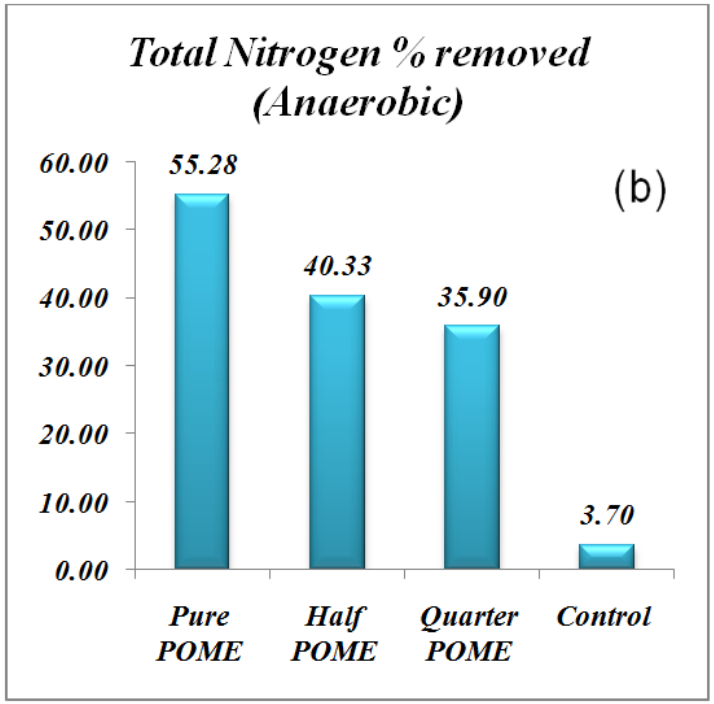
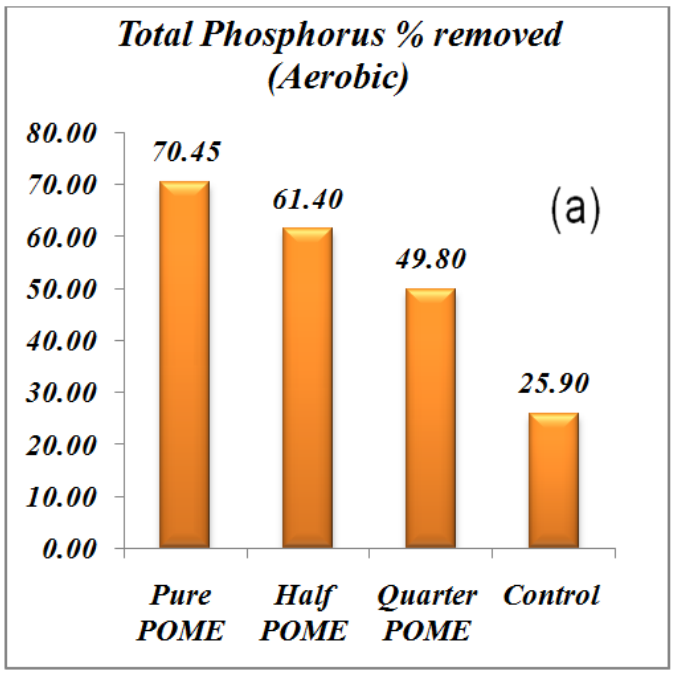


Figure 3: (a) Reduction of Total Nitrogen in Aerobic set up (b) Reduction of Total Nitrogen in Anaerobic condition.

Effect of Aeration & Various Concentrations in Reduction Phosphorus



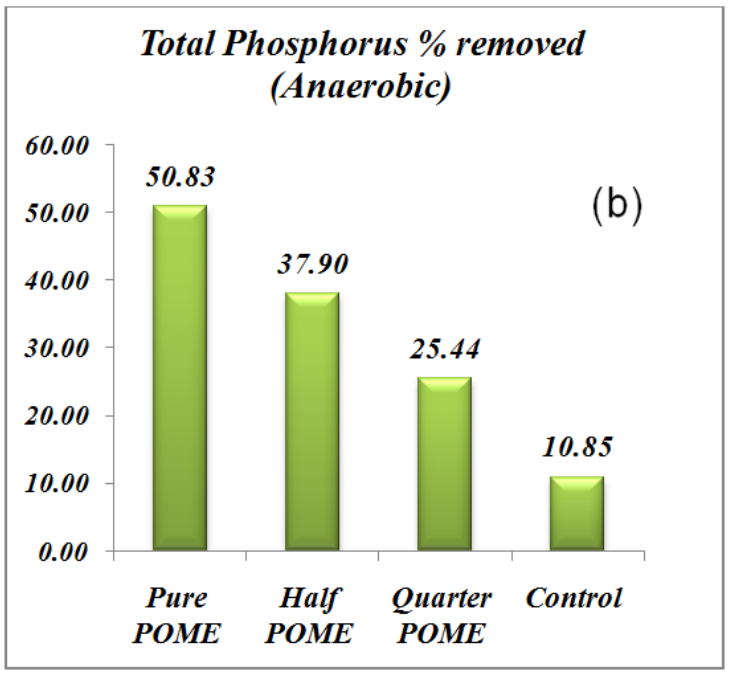


Figure 4: (a) Reduction of Total Phosphorus in Aerobic set up (b) Reduction of Total Phosphorus in Anaerobic condition.

CONCLUSION

These results showed that Vetiver System Technology (VST) is effective in reducing BOD, COD and nutrient levels in POME. Although the aerobic treatment is superior to the anaerobic one, but the former will incur higher operating and maintenance cost.

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Thank you