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Oil Spill

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Abstract

Crude oil and refined petroleum products are mixtures of a large numbers of components, each with its own chemical and physical properties.

Once oil is spilled, it immediately begins to undergo many natural physical, chemical and biological changes .

Oil and oily wastes can sometimes be broken down using biological process. Biodegradation of oil by microorganisms can only take at oil–water interface, so that on land the oil must be mixed with a moist substrate.

The rate of degradation depends upon temperature and availability of oxygen and appropriate nutrients containing nitrogen phosphorous.

There are a number of products on the market which contain oil degrading bacteria and other micro- organisms. And addition of oil soluble nutrients to accelerate the process of natural degradation these nutrients are more likely remain at the oil water interface rather than become dissolved in the sea .

Although degradation rates can often be increased by regular aeration of the soil and by the addition of fertilizers , such as urea and ammonium phosphate. The method is only likely to be applicable to relatively small spills because of the amount of land required.

The contaminated material should not contain more than 20% oil, the oily debris is the spread over the surface to a depth of no more than 0.2 meters , the maximum application rate being about 400 tones of oil per hectare of land the oil should be left to weather until it is no longer sticky before being thoroughly mixed in with the soil using a plough or rotavator mixing should repeated at intervals of 4–6 weeks for the first six months but less frequently thereafter the biodegradation is suitable to applicable on artificial island at Belayim.

Introduction

Water and sediments through the world contain microorganisms (bacteria, yeasts, and fungi) which utilize and degrade petroleum components.

A very large number of species of micro- organisms, which can degrade petroleum, have been identified in open and coastal areas. Biodegradation is the most important of the processes in determining the ultimate fate of oil in the marine environment, although it does not immediately decrease the volume of oil or its impact on the environment after it is spilled.

Biodegradation is promoted by dispersion of oil slicks into small particles of high surface area. This applies whether dispersion occurs naturally or is induced by application of dispersants.

It is interesting to note that biodegradation enhances the rate of natural dispersion of oil. For biodegradation to proceed at reasonable rates, nutrines such as nitrogen and phosphorus must be present.

Thus, biodegradation proceeds more rapidly in costal waters (which contain many of these nutrients) than in the open sea.

Microorganism can degrade most components of crude oil, but the lighter, lower molecular weight components are degrated faster than the heavier ones.

Higher temperatures accelerate biodegradation, but this process still
proceeds at significant rates even in arctic regions .

Asphaltenes a class of compounds which is usually a small component of crude oils, are degrated at rates which are so slow as to be insignificant.

Fortunately, however it is widely accepted that asphaltenes are virtually non- toxic .

Lighter components are degraded
faster than high molecular weight ones , the most favourable temperatures for the microbial growth are above 25^{o} C. Below 5^{o} C virtually any growth ceases.

Solubility of oxygen in sea water is low (6 to 8 mg per liter) compared to quantities required for complete oxidation of hydrocarbons:

3 to 4 mg of o2 per mg of hydrocarbon for conversion into CO2 and H2O.

Finally bioconversion of one mg of hydrocarbon require approximately 0.1 mg of nitrogen and 0.015 mg of phosphorus, whilst quantities existing in the Mediterranean waters are relatively low, less than 500 mg / m3 and less than 70 mg / m3 respectively.
Under optimum conditions in the Mediterranean region, bacteria can oxidize up to 1 gram of oil per square metre per day.

Factors Influencing Impact & Recovery

Oil Type:
Both crude oils and products differ widely in toxicity, Experiments on plants and animals have shown that severe toxic effects are associated with compounds with low boiling points. The greatest toxic damage has been caused by spills of lighter oil.
Oil Toxicity is reduced as the oil weathers, thus a crude oil spill that reaches a shore quickly will be more toxic to the shore life than if the slick has been weathering at sea for sevearl days before stranding.

Oil Loading:
If oil loading is high, penetration into sediments may be enhanced, and there is a greater likelihood of oil masses incorporating stones and gravel and hardening to form relatively persistent asphalt pavements. These are commonly 5- 10 cm. thick and 1 - 30 m wide.

Greorephical factors:
In the open sea there is scope for oil slicks to disperse. Close to shore, damage is likely to be more pronounced in sheltered shallow water bays and inlets, where oil in the water may reach higher concentration than in the open sea . This is also likely to be true of inland lakes and some riverine systems .

Climat, Weathear, And Season
High temperatures and wind speeds increase evaporation , which leads to a decrease in toxicity of oil remaining on the water. Temperatures affect the viscosity of the oil and also the ease with which it can be dispersed, and with which it can penetrate into sediments. .
According to seanson, vulnerable groups of birds or mammals may be congregated at breeding colonies , and fish may be spawning in shallow nearshore waters .

Biological Factors
Different species have different sensitivities. For example, many algae (seaweeds) are quite tolerant, possibly because of their mucilage coatings and the frequency of tidal washings.
In contrast, mangrove trees are very sensitive, the main groups of plants and animals are Mammals, Birds, Fish, Invertebrates, Plank tonic organisms, larger algae, Marsh plants and Mangroves.

Materials and methods
Sand cores from a clean desert area located into holes lined with plastic sheets, and kept permanently under open field conditions.
Some of the cores were artificially polluted by mixing the sand with 20% (w/w) of weathered crude oil, others were left untreated as control.
Cores were irrigated once weekly, soil samples were collected weekly for microbiological and chemical analysis.

Microbiological Analysis
Microbiological capable of utilizing crude oil were counted using the standard plate method. We used a solid inorganic medium supplemented with 1% (w/v) weathered crude oil as a sole source of carbon and energy.
Cultures were incubated at 30o C . After counting the total and individual organisms , representative strains were isolated on the same medium , purified and identified by consulting pertinent keys and comparing them with already identified strains of our collection .
Bacteria growing in liquid culture were also counted directly under the light microscopicusing a hemocytometer.

Results And Discussion
After 28 weeks, the total extractable hydrocarbons determined gravimetrically decreased to reach 63.5% of the original value. The total extractable alkanes determined decreased to reach 20% of the starting values (figure 1).
These results indicate that clean desert samples do contain oil–degrading microorganisms, which start their activity immediately after the spill.
Such organisms degrade most quickly octadecane (C18) and shorter alkanes, alkanes longer than C18 more resistant to biodegradation. .
The microbiological analysis revealed that the clean desert sample contained $1.8x10^4$ total oil-degrading bacteria per g.
Two Arthrobacter strains, one with white colonies (there after named white strain) and the other with orange colonies (organo strains) in addition to one Pseudomonas, one Rhodococcus and one streptomyces strains were identified and occurred in almost equal proportions.
The total numbers of oil–degrading bacteria in the clean samples remained rather constant at that level during the 28 week-period, whereas in the oil–polluted samples, the numbers steadily increased reaching $1.2x\ 10^5$ after 18 weeks and $2.5\ x10^6$ after 28 weeks.
However, this increase did not involve the five oil-degrading strains in the clean soil evenly
The increase was almost exclusively due to the white strain of Arthrobacter. Other oil degrading bacteria including the orange Arthrobacter strain either remained almost constant or even disappeared
(Figure 2).
This result is quite interesting because it demonstrates that even the indigenous oil-degrading microorganisms seem to be of different survival potential in the presence of oil pollutants.

Some, here the white Arthrobacter strain, are strong competitors and predominate over the others.
It may be expected that non-indigenous microorganisms in the cocktails would also be weak competitors.
In order to shed light on the varying competition potential of indigenous oil degraders, we studied the growth behavior of selected bacterial isolates in the presence of various carbon sources.
To obtain comparable results we selected the two Arthrobacter strains for this study, the strong competitor (white strain) and the weak one
(Orange strain).
The results in figure 3 show that the strong and weak competitor strains
of Arthrobacter show a similar growth behavior in nutrient broth. Apparently both strains have similar competition potential for conventional carbon sources. However, when grown in an inorganic medium containing 1%
(W/v) crude oil as a sole source of carbon, both strains behaved differently (figure 4).
The white strain, the strong competitor, grew better than the orange strain. A similar result was obtained when instead of crude oil either n-octadecane (figure 5) or the aromatic hydrocarbon phenanthrenes (figure 6) were used. It ithus obvious that one indigenous Arthrobacter strain , this makes that strain particularly valuable for self–cleaning and bioremediation purposes
The results indicate further that the foreign cocktails of oil–degrading microorganisms would probably not be very beneficial because such bacteria may interfere with the absolute predominance of this strong indigenous competitor, which established itself naturally.

Conclusions

We investigated the dependency of microbial oil degradation on various factors. We identified a mathematical model to predict the maximum oxygen uptake rate as a function of the concentrations of nitrogen, phosphorus, crude oil and dissolved oxygen and the temperature.
However, since the model is based upon the data obtained by liquid culture systems , other factors such soild phase must be taken into as diffusion terms on the surface of account in order to describe the degradation of attached oil on an actual shore.
Diffusion of dissolved oxygen , nitrogen and /or phosphorus from liquid phase to soild phase through the laminar film could be the rate limiting process in the overall degradation process.
In the experiments by the beach simulator units tidal movements in actual ocean environment and were able to demonstrate biologically, chemically and visually the effect of application of fertilizers and possibly of seeding with oil–degrading bacteria. It is our wish to accomplish quantitative understanding of the phenomena actually taking place on an oil–contaminated shore, and to establish a mathematical model which is capable of predicting the effects of bioremediation.

Refrences

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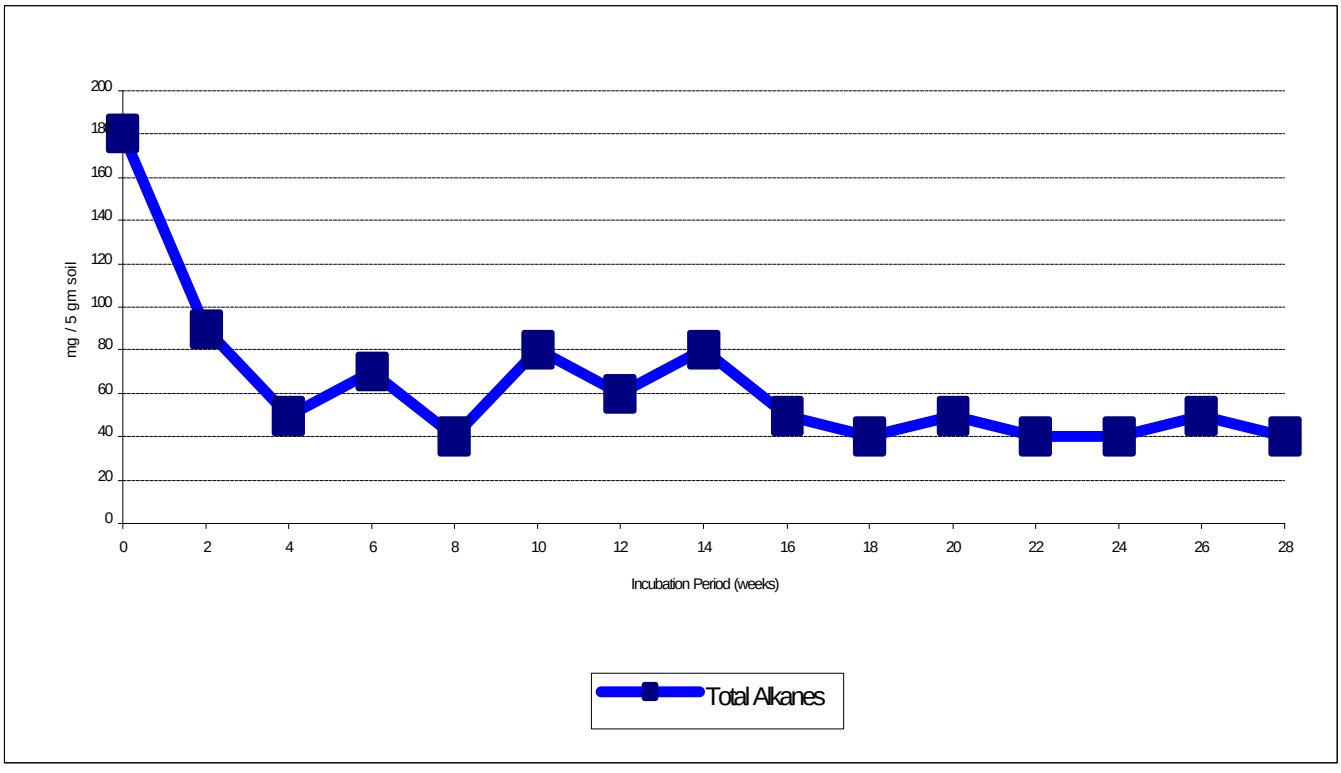

Fig-1 Changes of the concentration of total extactable alkanes in oil polluted sand with time.

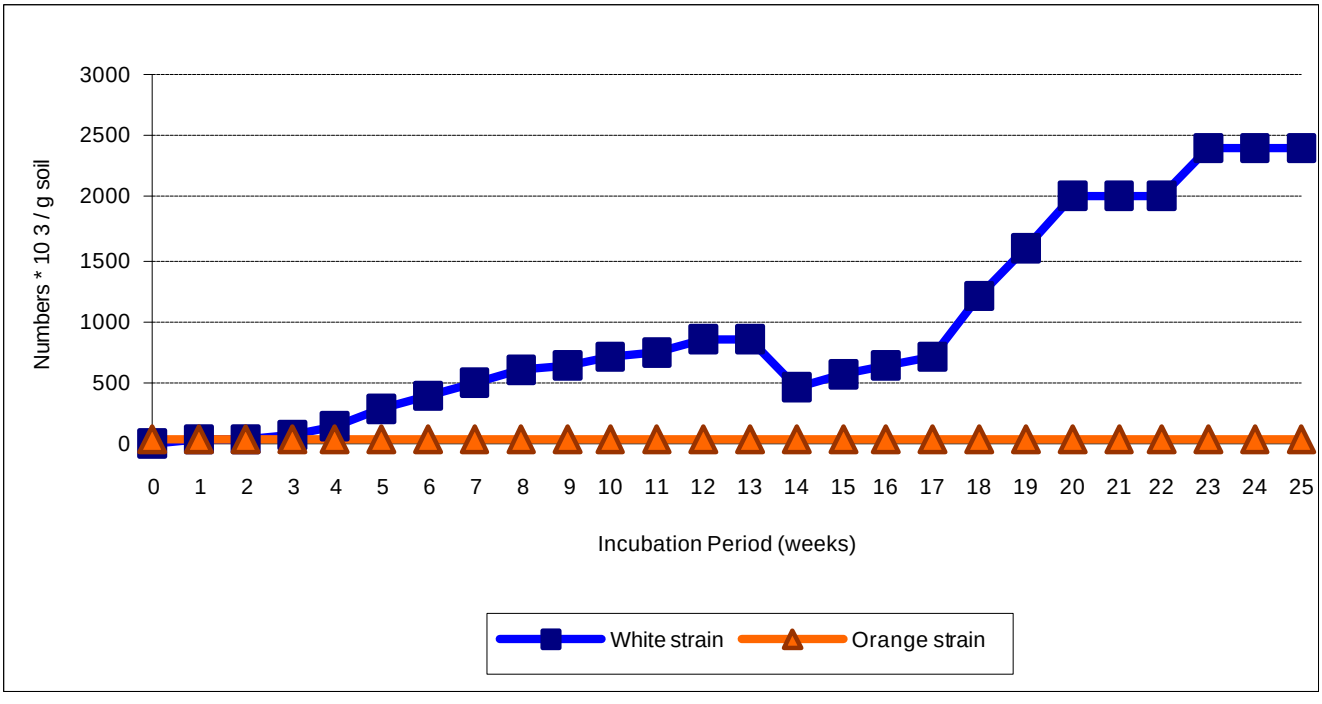

Fig. 2 The changes of numbers of two indigenous oil-utilizing strains of Athrobacter in oil-polluted sand with time.

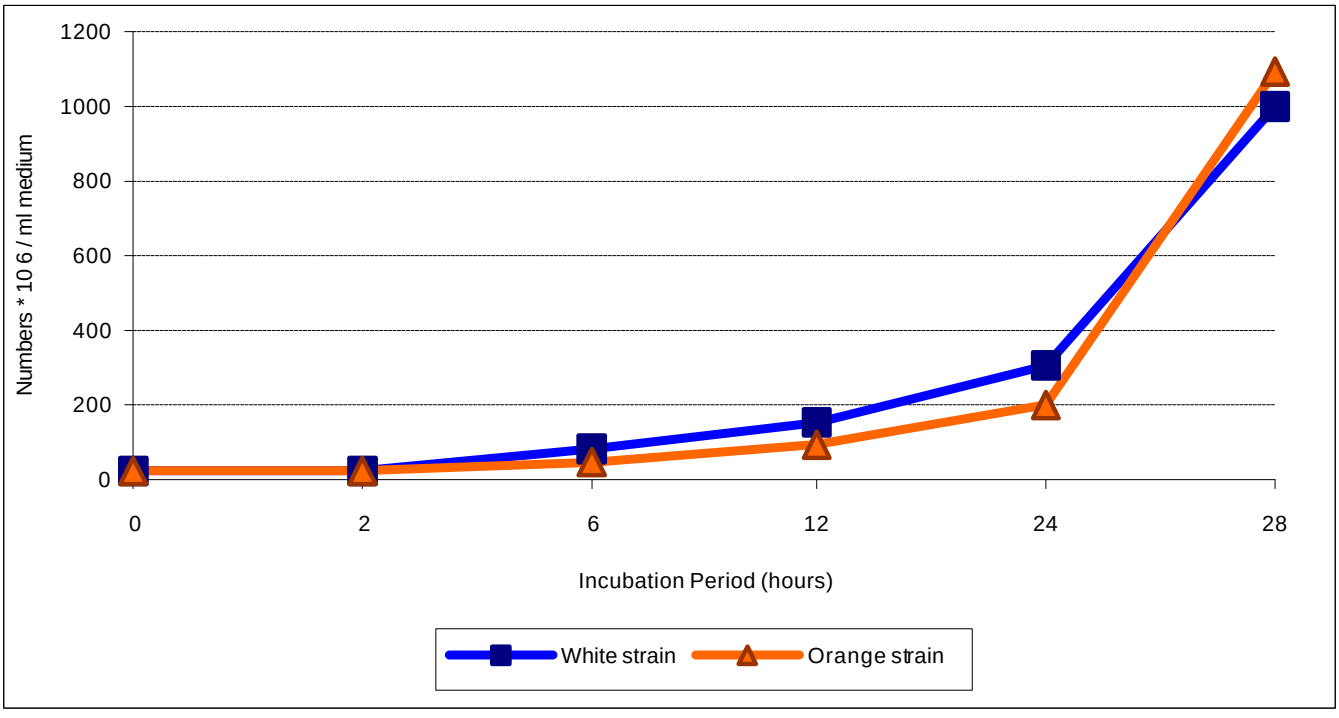

Fig-3 Growth of two indigeneus Arthrobacter strain in conventional nutrient broth.

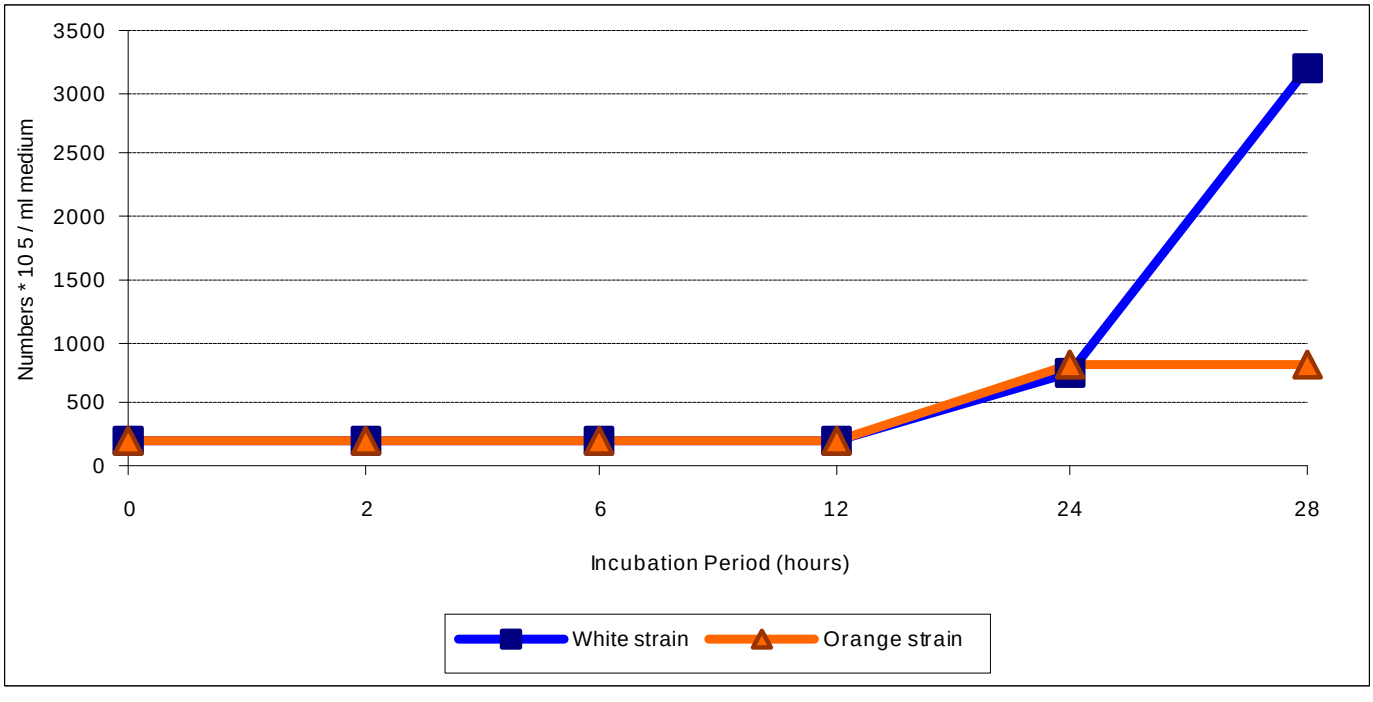

Fig-4 Growth kinetics of two indigenous Arthrobacher strains on crude oil as a sole carban source

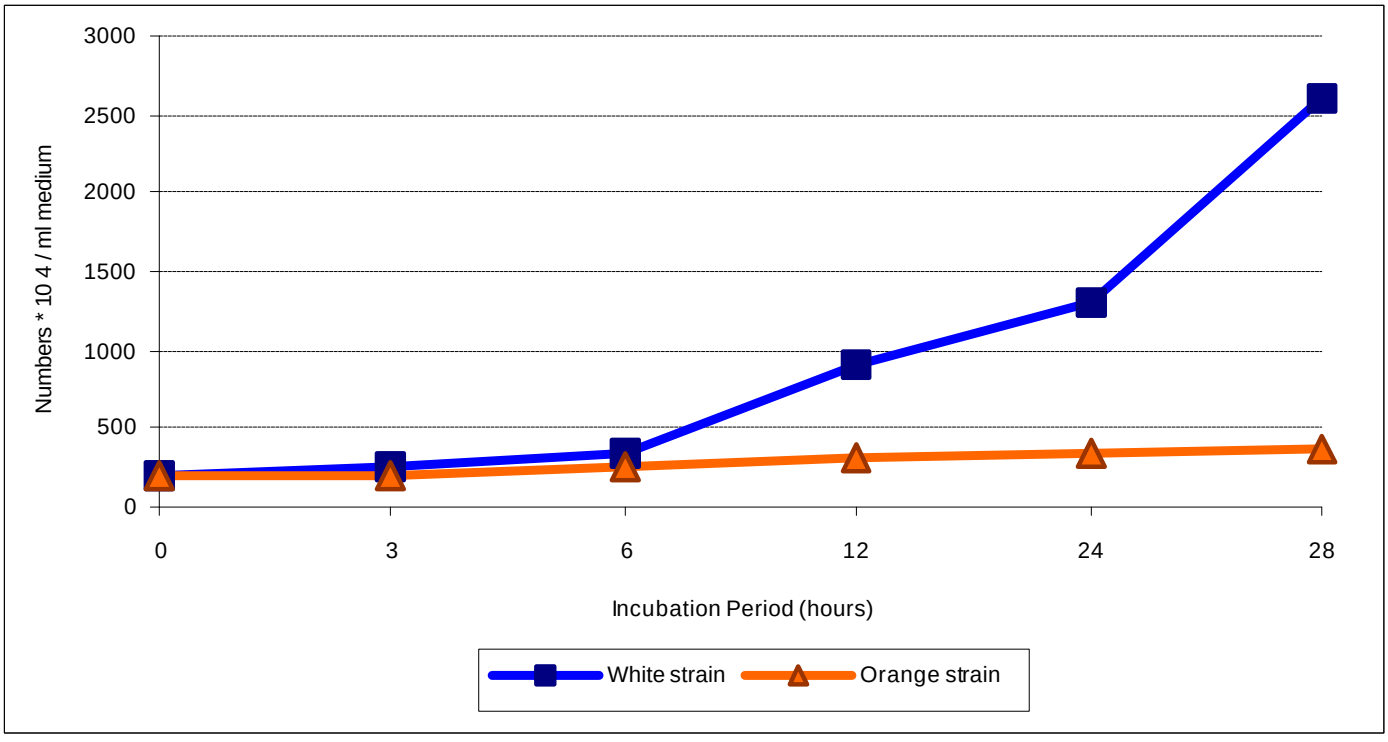

Fig-5 Growth kinetics of two indigenous Arthbacter strains on n-octadecane as a sole carbon source.

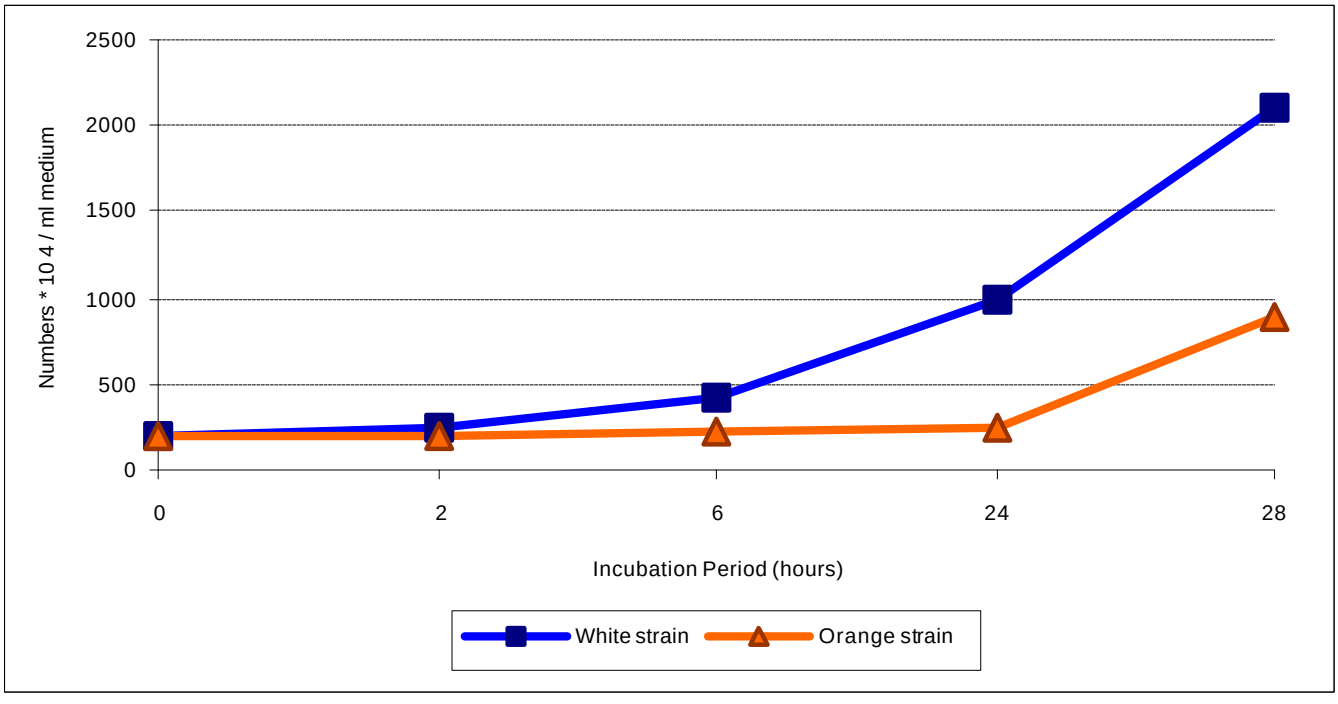

Fig-6 Growth kinetics of two indigenous Arthrobacter strains on phenanthrene as a sole carbon source.