Moringa oleifera PREPARED VIA SUPERCRITICAL FLUID EXTRACTION AS AN ALTERNATIVE COAGULANT FOR WATER TREATMENT

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ABSTRACT

The removal of turbidity is vital in water treatment plant operation, and is usually carried out by chemical coagulants e.g. aluminium sulphate (alum). In this study, supercritical fluid extraction (SFE) was used to prepare *Moringa oleifera* (*M. oleifera*) powder as a coagulant or bioflocculant for water treatment was studied. Relative to chemical coagulants, this bioflocculant will not cause adverse side effects towards human health and the environment. By using SFE, it can also eliminate hazardous chemicals that are used as solvents in the conventional extraction method. From 1 kg of raw *M. oleifera*, it produced 42% of pure *M. oleifera* powder, 30% of extracted oil and 28% of discarded husks. It was found that 0.01 g of *M. oleifera* coagulant was able to reduce more than 95% of turbidity and also reduced up to 60% in bacterial population in 1 litre of river water. In this study, we found that SFE could be used to produce coagulant from *M. oleifera*. The coagulant performed well and has the potential to replace alum as a main coagulant in water treatment plants. Sludge produced from these plants will be hazardous free and also will not fall in the category of scheduled waste.

ABSTRAK

Penyingkiran kekeruhan adalah penting dalam operasi harian loji rawatan air dengan menggunakan bahan penggumpal berasaskan kimia seperti aluminium sulfat atau alum (Tawas). Dalam kajian ini pengekstrakan menggunakan teknik "*Supercritical Fluid Extraction"* atau SFE telah digunakan bagi menyediakan serbuk *Moringa oleifera* sebagai bahan penggumpal atau dikenali sebagai "*Bioflocculant"* dalam aplikasi rawatan air. Berbanding dengan bahan penggumpal kimia, *Bioflocculant* tidak mengakibatkan kesan sampingan terhadap kesihatan manusia serta alam sekitar. Dengan menggunakan SFE ini, ianya juga dapat sekaligus mengelakkan penggunaan bahan kimia sebagai pelarut yang secara lazimnya digunakan semasa proses pengektrakan sebelum ini. Dari jumlah 1 kg bahan *Moringa oleifera* mentah, 42% daripadanya boleh menghasilkan serbuk tulen *Bioflocculant*, 30% daripadanya pula adalah minyak yang telah diekstrak keluar manakala baki 28% merupakan bahan sekam yang terbuang. Didapati seberat 0.01 g *Bioflocculant* dapat mengurangkan kekeruhan lebih daripada 95% dan 60% populasi bakteria semasa proses rawatan 1 liter air sungai. Dalam kajian ini, SFE boleh digunakan dalam penghasilan bahan penggumpal berasaskan *Moringa oleifera* dan *Bioflocculant* tersebut berpotensi menggantikan alum sebagai bahan penggumpal utama di loji rawatan air. Enapcemar yang terhasil daripada proses rawatan air diatas juga tidak berbahaya serta tidak dikategorikan sebagai bahan buangan berjadual.

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LIST OF SYMBOLS AND ABBREVIATIONS

ALUM	:	Aluminium sulphate
AMPs	:	Alignment of Multiple Protein Sequences
ANOVA	:	Analysis of Variance
APHA	:	American Public Health Association
BLAST	:	Basic Local Alignment Search Tool
CGYA	:	Casitone Glycerol Yeast Autolysate Agar
CO_2	:	Carbon Dioxide
DNA	:	Deoxyribo Nucleic Acid
dNTP	:	Deoxy Nucleoside Tri Phosphate
HDPE	:	High Density Poly-ethylene
KASSB	:	Kumpulan Air Selangor Sendirian Berhad
$MgCl_2$	:	Magnesium chloride
MLD	:	Million Litre per Day
MT	:	Metric Tonne
NCBI	:	National Centre for Biotechnology Information
NTU	:	Nephelometric Turbidity Unit
PAC	:	Poly-aluminium chloride
PASS	:	Poly-aluminium silico sulphate
PCR	:	Polymerase Chain Reaction
R2A	:	Reasoner's 2 Agar
rRNA	:	Ribosomal Ribonucleic Acid
SD	:	Standard Deviation
SFE	:	Supercritical Fluid Extraction
TBE	:	Tris borate ethylenediaminetetraacetic acid
TGYA	:	Tryptone Glucose Yeast Agar
TSS	:	Total Suspended Solids
WTP	:	Water Treatment Plant

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Water pollution in Malaysia

Availability of clean water is one of problems faced by developing countries such as Malaysia where increasing population and economic activities lead to an increase in requirement of clean water. Water as a renewable yet finite plus vulnerable resource is vital for a sustainable future but this problem of contaminated water is exacerbated by climate change and local water demand conflicts. River water provides 97% of main water source for domestic, industrial and agricultural demand in Malaysia. Department of Environment (DOE), Malaysia stated in the Environmental Quality Report (2014) that out of the 473 rivers monitored, 52% of it were found to be clean, 39% semi contaminated and the rest (9%) were contaminated or polluted. The causes of contamination were identified mainly due to flood, construction activities, earth works, and land clearing which contribute to high turbidity caused by silt, clay and other impurities (Linsley *et al.,* 1992). Others such as leachate, surface runoff, commercial waste, factory effluent and agricultural activities also contribute to contaminated river water. The problem of turbidity was often faced with the urban community because the appearance of coloured turbid water was non-appealing and rejected by the general public. The turbidity issue was supported by the Malaysian Water Association (1994) finding that Malaysian river waters are highly turbid due to content of silt and 47% of them shows value of more than 50 mg/L suspended solids. Appendix A shows the parameters to measure in order to follow the criteria of good water quality for healthy environment and Appendix B shows

the acceptable requirement for human consumption, pathogenically free, non-toxic and radiologically safe.

1.2 Water treatment

Before distributing river water for public usage, any impurities inside it will be removed at the water treatment plant (WTP) and must follow the requirements of the National Standard for Drinking Water Quality 2004 (Appendix B). Access to safe drinking water and adequate sanitation services is vital to human health, but also has other important benefits ranging from the easily identifiable and quantifiable (costs avoided, time saved) to the more intangible (convenience, well-being, dignity, privacy and safety) quoted from WHO/UNICEF (2010). The water treatment technology is generally divided into three parts such as using physical actions with filtration and sedimentation, chemical actions such as coagulation and disinfection, and also biological action, such as sludge degradation, and now the latest are membrane aerated biofilm reactor (Kunetz *et al.,* 2016). Coagulation or flocculation is tasked of qualitatively removing turbidity and quantitatively reducing suspended solids. Flocculation is the mechanism of attaching between fine particulates in water column and clumping them together into flocs, forming large agglomerates. Flocculation happens when segments of the polymer chain adsorb on different particles and help particles to aggregate. In the first scenario, pollutant particles that are suspended in water are called colloids and have a negative charge, which causes them to repel each other. This allows the particles to maintain their weight light, making it hard for it to sediment to the bottom of the water column. With time the particles attached to each other and become heavier and thus are forced down due to an increase in their mass. The dosage of flocculants is important in order to avoid problems in settling in the clarification step where it is crucial to have flocs that are either floating or are

settled to the bottom which can be easily filtered out from the plant (Davis & Cornwell, 1998).

Many flocculants are multivalent cations such as aluminium, iron, calcium or magnesium. These are the main chemicals used by a majority of water treatment operators for water treatment plant daily operation. Of which, aluminium sulphate or alum was the popular choice used in WTP due to its availability and affordability. Alum is derived from natural bauxite which is abundant and dissolved with sulfuric acid. During water treatment process, alum's action of forming Al^{3+} ions will bind with negatively charged impurities creating a body of flocs. Currently in Malaysia, the flocculation step is carried out by alum's variants such as Poly-aluminium chloride (PAC) or Poly-aluminium silico sulphate (PASS) (Bratby, 1980; Jolicoeur & Haase, 1989). However, studies have shown that there are negative implications of using alum such as Alzheimer disease (Suarez-Fernandez *et al.,* 1999) and also due to the limited availability and relative expense of these chemicals for the developing world, there is a demanding need to find alternative water purification solutions (Pritchard *et al.,* 2010). Residual aluminium in drinking water enters the human body and is classified as highly reactive and is more dissolved in the stomach where the pH is very low and the alum's toxicity may be a risk via adsorption (Sieliechi *et al.,* 2010). In Malaysia alone, as much as 22,000 MT of alum's waste are disposed from WTP annually and sent to sanitary landfill as scheduled waste (EQR, 2015).

1.3 Potential use of bioflocculant

There is ongoing research worldwide to find an alternative coagulant to alum. For example, a drinking water producer in Saskatoon, Canada has changed from alum to ferric sulphate to offer a higher degree of satisfaction to the consumer despite its higher

operating cost (Eaglebrook, 2002). Ideally, the alternative should be cost effective, socially acceptable and environmentally friendly (Niquette *et al.,* 2004). In this context, natural coagulants present a viable alternative (Kawamura, 1991). Other alternative such as inorganic coagulants such as Lanthanide salts which has been considered as a replacement to alum, and also polymers such as chitosan and *M. oleifera* which have been suggested as the major organic coagulants (Niquette *et al.,* 2004). Organic coagulants or bioflocculant are basically a bio-based organic particle apart from bacteria or algae that promotes clumping action of suspended pollutant waste. Polymers are first used as flocculation agents with its' ionic charge and are derived from plants seeds, leaves and roots (Kawamura, 1991). However, polymers mainly served as coagulation aids. Tannin biopolymers were first used and are less harmful than synthetic polymers (Özacar & Sengil, 2003). Since synthetic polymers is cheaper and can be used at below 1 mgL^{-1} in order to follow WHO worldwide regulations, the idea of using biopolymers died down. Later, chitosan was also considered as one of the more promising material (Bratby, 2007). However, its availability and uncertain costing, health impacts and other modification problems eventually double the production cost of drinking water (Najm & Trussell, 1999).

The source of the bioflocculant in this study was *M. oleifera* which belongs to *Moringaceae* family which is a kind of shrub tree originating from sub-Himalayan continent of India, and found to flourish on Malaysian soil. Brought by Indian merchants to be cultivated as a food source, it has been found to possess water treatment capabilities. The active component derived from both crushed (powdered) and defatted (oil extracted) seeds of *M. oleifera* is a soluble protein (Flo-polypeptide) which contains a natural cationic polyelectrolyte that causes coagulation or flocculation (Barth *et al.,* 1982). Its hydrophobic structure of proline which is a type of amino acids buried inside the *M.*

oleifera protein core has the ability to form hydrogen bonds providing the sternness to the protein structure. During water treatment, the polypeptides will attach itself to the impurities causing electrostatic flocculation which is accelerated by stirring. It also contains antimicrobial peptides (AMP) which have bactericidal, fungicidal and tumoricidal properties (Suarez *et al.*, 2005).

The conventional method to prepare bioflocculant from *M. oleifera* seeds involves solvent extraction (SE) using n-hexane in order to remove oil (Ali *et al.,* 2010). Solvent extraction involves Soxhlet extractor setup which includes a percolator or a heater element for reflux process where the liquid solvent is evaporated to facilitate the circulation inside the apparatus, and a thimble to retain the solids or this case the *M. oleifera* seed. Finally, the siphon mechanism systematically transfers the solvent's vapour inside and out from the thimble and subsequently removes the oil out from the seed. There are many types of solvents that is used, ranging from ethanol to hexane or other petroleum base solvents.

Ruttarattanamongkol *et al.* (2014) recently proposed using supercritical fluid extraction (SFE) to extract oil from *M. oleifera*. However, the potential use of *M. oleifera* as coagulant (bioflocculant) after utilising SFE has not been assessed. SFE is basically a process of separating extract in liquid state from its original matrix material which is in solid state using a more stable and non-toxic higher pressure CO_2 as solvent. The solvent can push through the matrix diffusing the extracts or in this study the oils. Extraction using SFE leaves no solvent residue in the extracts which unlike SE has a major setback of solvent residue in the extracts. Moreover, the extract via SFE is more stable. SFE has been utilised to extract a wide range of organic compound from natural materials. In this study, we harness the ability of SFE to extract and discard as much oil as possible from the crushed seeds and we assessed the potential of *M. oleifera* powder as a coagulant in

water treatment after SFE. We also reported the optimal water treatment conditions by *M. oleifera* as a bioflocculant in terms of water turbidity and bacterial population.

1.4 Objectives: -

(a) To compare the yield and physical characteristics of *M. oleifera* powder prepared using SFE and SE method.

(b) To determine the capability of SFE prepared *M. oleifera* powder and alum to reduce the turbidity, total suspended solids and bacteria in raw water.

(c) To conduct cost-beneficial analysis of application of SFE prepared *M. oleifera* powder as an alternative for alum in water treatment

CHAPTER 2: LITERATURE REVIEW

2.1 Global need for water treatment

In 2014, World Health Organization reported only 89% or more of global population gained access to treated drinking water from the sources of piped water or other improve source, while the rest 11% still rely on unimproved system and surface water (rural areas) (WHO/UNICEF, 2014). Thus the quantity of water supplied is much more in demand than the quality of water supplied (Smith & Reed, 1991). The impact of poor water treatment management to the population is the widespread of water-related diseases. Water-related diseases such as waterborne diseases, water-washed diseases and water-based diseases are the most apparently linked to inadequacy of improved domestic water supply system (Gleick, 2002). However, the major reason for the spread of water-related diseases was found to be poor hygiene practices than contaminated water source (Young & Harvey, 2004).

2.2 Conventional steps in water treatment

Several water quality parameters were need by conventional WTPs to monitor finished water after applying coagulants to reduce turbidity and to remove suspended natural organic matter. WTPs are expected to give and supply safe and aesthetically acceptable water to their communities at a reasonable cost (Zhang *et al.,* 2012). Following the regulatory requirements by local water monitored agencies, WTPs operator have to ensure a balance between the velocity gradient of coagulants and the variability of source water quality. The steps that are regularly followed by all the WTP operators may be

arranged in a "treatment train" (a series of processes applied in sequence) such as coagulation or flocculation, sedimentation, filtration, and disinfection of raw water (surface water) (Angreni, 2009). Worm *et al.* (2009) reported that although WTPs have been operating since the beginning of human civilization, the treatment work has recently become more complex because of strict rules and to maintain better quality of drinking water.

In the coagulation step, coagulating agents such as alum and synthetic polymers will interact with raw water and combine small pollutant particles into larger aggregate clumps or floc. Breese (2006) suggested that choosing the right dosage for coagulation should have many considerations such as the dosage patterns, flash mixing, colloid stability, and type of coagulants selected.

Water (water, flocs, coagulants and solids) from coagulation step will flow into a settling area in order for mud and sand to be taken out (by the actions of scrapers of water overflow), and the desirable level of turbidity should be less than 2 NTU and this varies with the size of holding area, clarifier performance, temperature and sudden change in raw water conditions (Breese, 2006).

Clearer water will pass through sand and anthracite (filtration media) which discards any remaining pollutant solids and thus enhances the effectiveness of disinfection (Angreni, 2009). James (2005) reported that backwashing occurred after increased passage of particles and microorganism containing raw water through granular media filter, and this is a common problem known as "ripening" which decreases the performance of the filters.

After filtration step, there is disinfection by chlorine with the function of killing or inactivating the pathogenic bacteria that remain in the water column. However, this step

will indirectly produce chlorination by-products (Nikolaou *et al.,* 2005). This by-product has health effects. In order to overcome the by-products, Huseyin *et al.* (2005) proposed using intermediate oxidation (ozonation) to degrade micro pollutants, eliminate remaining microorganisms and to remove chlorinated by-products that emerged.

2.3 Use of alum as a coagulant

The transmission of water-related diseases is due to the lack of sufficient personal and domestic hygiene where the importance of a water supply that is free of pathogens and aesthetically pleasing is neglected (Dorea, 2010). The abundance of bauxite material in natural water supply makes the aluminium based coagulant or alum the prime selection of WTP operators for coagulant (Niquette *et al.,* 2004). Coagulation with aluminium sulphate has been and is likely to continue to be a key player in successful water treatment and supply operations, with the advantages of local availability, easy and fast application even by unskilled operators (Dorea, 2010).

In North America, it is recommended to optimize coagulation, flocculation and sedimentation towards treating raw surface water by removing organic matter, reduce turbidity, kill harmful bacteria and control chlorination by-product (U.S.E.P.A., 1998). Alum seems to be the most suited to undertake the above task thus it is at present the most highly in demand chemical coagulant and the most popular reference in water treatment (Niquette *et al.,* 2004).

2.4 Other coagulant and bioflocculant

Other than alum and its variant, WTP operators also use coagulants such as ferric salts variant i.e. ferric chloride. Ferric chloride has more practical usage at a wider pH

range of 5.0 – 9.0 compared to alum which is restricted to pH of 6.0 – 7.5. Ferric chloride also dissolves easily (Noortgate & Goessens, 2003). The downside of its usage is the yellowish appearance in the water column after treatment and which lacks aesthetic value. Furthermore, it is an iron-based coagulant and an iron element is a high value commodity thus making its usage for water treatment costlier than alum (Dorea, 2010). When using other coagulants such as calcium chloride, the precipitates are very fine and difficult to settle (Omar *et al.*, 2013). It is estimated that chemical coagulants have disadvantages when using in larger dosage and prolonged usage have impacts on the environment and human health (Chou *et al.,* 2009). For this reason, plant starch or protein has become of interest as a natural coagulant to treat polluted/raw water (Omar *et al.,* 2013).

Starch or polysaccharides with repeating units of xylo-glucan from tamarind seed kernel can be used as an adsorbent for hexavalent chromium from wastewater (Agarwal *et al.,* 1994). But tamarind flocculant can only perform well on clay slurries and its performance was similar to alum only in the constant falling rate periods, meaning that the water is evaporated from the surface of the mixture (coagulant and raw water) and the temperature of it remains constant (Chakrabarti *et al.,* 2008).

The coagulation property of chitosan is from a linear copolymer of D-glucosamine and N-acetyl-D-glucosamine that is produced from deacetylation of chitin (Kurita, 2006). The further potential of chitosan has been intensively explored by researchers as it's possesses intrinsic properties such as non-toxicity and is bio-degradable (Renault *et al.,* 2009).

Bioflocculation by flocculant-producing bacteria such as trypsin-sensitive floc forming *Bacillus* sp. is also a promising path towards sustainable water treatment field (Salehizadeh *et al.,* 1999). However, the strain was found to be heat unstable and

decreased its coagulation performance at 100°C, but new heat stable strains/species such as *Rhodococcus erythropolis* were found and further study is needed (Takeda *et al.,* 1991).

2.5 *Moringa oleifera* historical development

The negative effects of using alum have drawn a lot of attention (Muyibi & Evison, 1995; Ndabigengesere & Narasiah, 1998). Therefore, substituting alum with an alternative coagulant which is cost effective, socially acceptable and environmentally friendly must be considered (Niquette *et al.,* 2004). In this context, natural coagulants present viable alternatives (Kawamura, 1991). There is increased interest in the use of organic based coagulants which originated from plants, such as *M. oleifera* seed (Jahn, 1988; Muyibi & Evison, 1995).

As reported by National Research Council (2006), *M. oleifera* has been used in the past in rural areas of Sudan as an ingredient for water treatment. Other places have been documented using *M. oleifera* to treat water (Gopalan *et al.,* 1971; Palada, 1996; Sampson, 2005; and Fahey, 2005).

Since 1970's *M. oleifera* has caught the attention of researchers in various fields of study (Muyibi & Evison, 1995). The authors pointed out that eventhough *M. oleifera is* not as good as alum in efficiently treating contaminated water, it did fulfill most of the criteria of treated water and is cost effective. *M. oleifera* is therefore recommended for developing countries especially in low tech rural area. *M. oleifera* is a highly potential coagulant for water treatment either in forms of shelled or non-shelled seeds (Ndabigengesere *et al*., 1995).

2.6 *Moringa oleifera* mechanism of action

The first stage in the application of *M. oleifera* seeds extract in water treatment is to transform the extract into powder form (Bichi, 2013) and then mix it in water and filter through Mosley cloth (Muyibi & Evison, 1995), filter through Whattman filter paper (Muyibi *at al.,* 2003), and extraction by aqueous, salt and oil procedure (Ali *et al.*, 2010). Bichi *et al.* (2012) later confirmed that aqueous and oil extraction gave better result for *M. oleifera* to perform in water treatment.

Case studies have been undertaking to study the effect of *M. oleifera* after water treatment process and Al-Anizi *et al*. (2014) found that by pretreating *M. oleifera* crushed seeds with heat will deactivated some of its enzyme but further investigation is needed to clarify the methodology. Study on the sedimentation effect of *M. oleifera* seed's polypeptide shows that it helps too in bacterial disinfection (Suarez *et al*., 2005). The study also looked into the molecular structure of *M. oleifera* determinants of Flo-polypeptide and AMPs by analyzing the structure to function connection.

2.7 Supercritical fluid extraction to replace solvent extraction

Over the past three decades, supercritical CO_2 or SFE has been used for the extraction and isolation of valuable compounds from natural products (Hartono *et al*., 2001). SFE has proven effective in the separation of essential oils and its derivatives for use in the food, cosmetics, pharmaceutical and other related industries, producing high-quality essential oils with commercially satisfactory composition (lower monoterpenes) than possible with conventional hydro-distillation (Ehlers *et al*., 2001). SFE uses high pressure CO_2 as an oil extracting agent, and has proven an excellent alternative to chemical solvents (Hartono *et al*., 2001).

The use of SFE in extraction also eliminates organic solvents and the expensive post processing step of solvent removal (Piras *et al*., 2009). The only drawback of SFE process is the initial high investment cost as compared to traditional methods (Herrero *et al*., 2006). For *M. oleifera*, its soft seed can be easily pressed mechanically in order to collect the oil but it is still inefficient, yielding less oil with the researcher utilizing solvent extraction with n-hexane to harness more oil (Lalas & Tsaknis, 2002). However, problem arises due to solvent residue present inside the oil after extraction (Herrero *et al*., 2006). Nevertheless, researcher have the opportunity to explore novel technology to extract the oil from *M. olefeira* efficiently, thus the discovery of SFE as new approach to demonstrate the feasibility of extraction without solvent residue (Ruttarattanamongkol *et al*., 2014).

CHAPTER 3: MATERIALS AND METHODS

3.1 Preparation of *Moringa oleifera* seeds as bioflocculant

M. oleifera was obtained from mid-size tree e.g. Fig. 3.1 (a), planted in the state of Sabah, Malaysia. The first batch of 10 kg sun-dried seeds was ordered and the seeds were in good condition and the requirement was to be only from dry pods (Fig. 3.1 (b)) were used. The seeds (Fig. 3.1 (c)) were removed from its shells and the kernels (Fig. 3.1 (d)) were crushed and grinded into medium fine size particle with measurement of average less than 1mm using a domestic grinder, and the grinded *M. oleifera* was then oven dried at 50ºC overnight (Memmert, Germany) to decrease its moisture content (Fig. 3.2). Next, it was used for further preparation in oil extraction steps which are supercritical fluid extraction and solvent extraction.

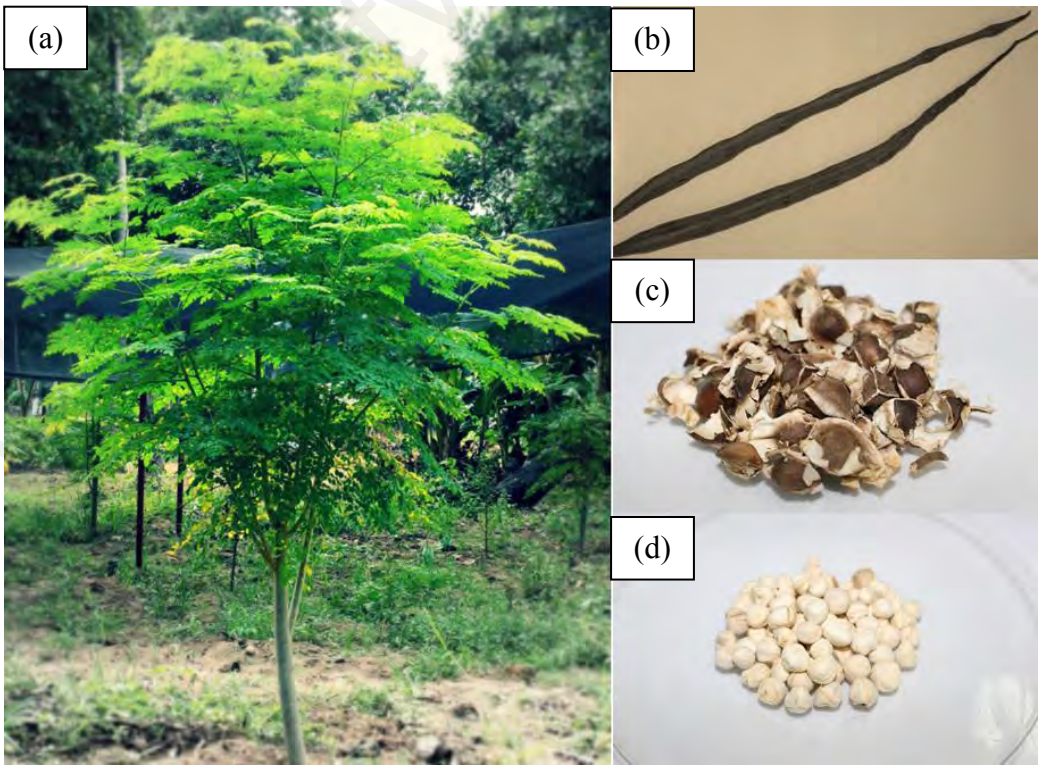

Figure 3-1: (a) *Moringa oleifera* tree, (b) dried seed pods, (c) dried seeds, (d) kernels.

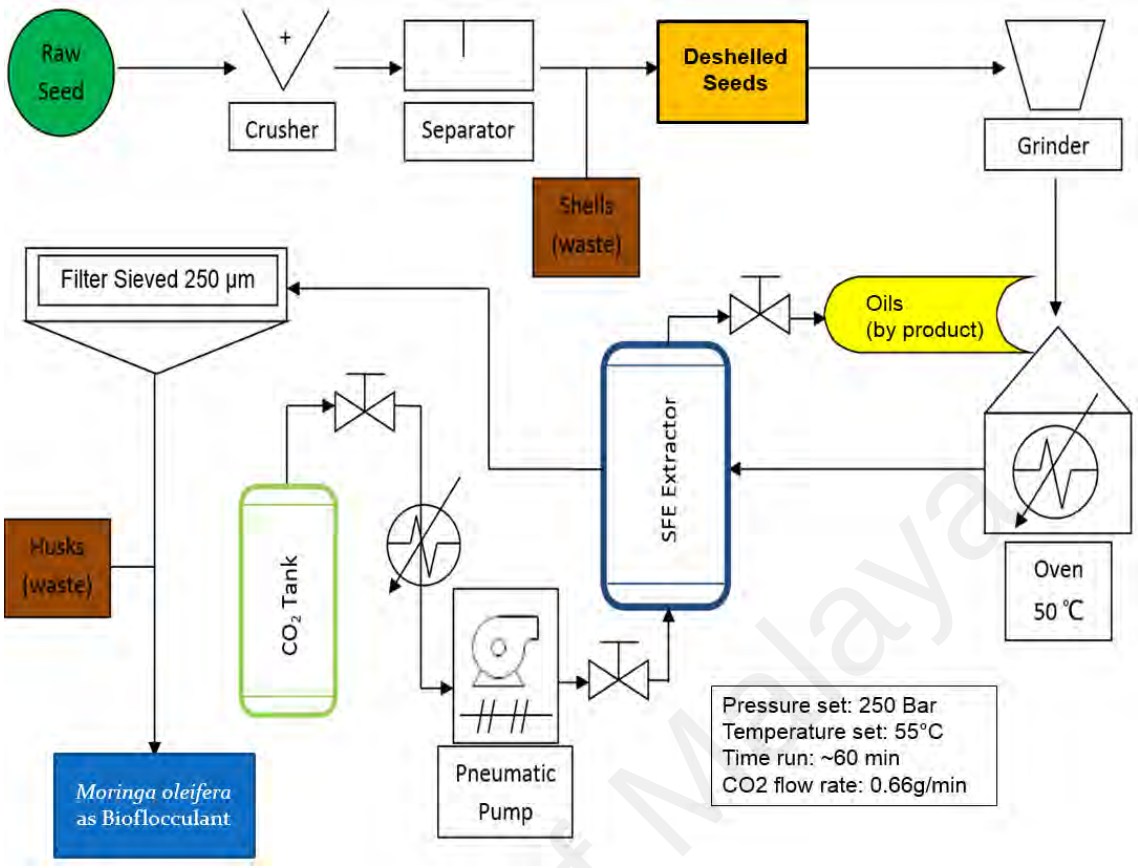

Figure 3-2: Steps in preparation of *M. oleifera* bioflocculant

3.2 Supercritical fluid extraction

Oil inside the *M. oleifera* powder was extracted via the SFE method (Uribe *et al*., 2011) using the TST (Taiwan) Oven Extraction system model OV-SCF-1000 (Fig. 3.3). The instrument parameter was monitored and controlled using Digital Pressure Control Module (Fig. 3.4) where the extraction was carried out at 250 Bar and 50–60ºC with 10 min of static extraction and 30 min of dynamic extraction with an industrial grade CO_2 flow rate of 0.66 g min^{-1}. With the ratio of 1 kg of grinded *M. oleifera* was place inside extraction chamber and about 68.29 L of CO_2 was pumped inside the chamber under its high controlled pressure which will be pressing and extraction oil out form the grinded

M. oleifera. The final product was sieved through a 250 µm mesh to remove any remaining husk and the percentage of oil (% w/w) was determined according to Pearson (1976) by previous average of 45% w/w of oil initially and at the end the remained percentage in the stock powder of *M. oleifera* was at average of 35% w/w. The stocks *M. oleifera* powder obtained were kept inside a dry cabinet at 27°C and humidity of less than 25%.

Figure 3-3: Oven Extraction Furnace

Figure 3-4: Digital Pressure Control Module

3.3 Solvent extraction

Hanon (China) model SOX406 Fat Analyzer (Fig. 3.5) based on Soxhlet apparatus was utilized. It is basically an electrical heat induced instrument to extract oil from *M. oleifera* using n-Hexane as extraction agent. The setup for the extraction was carried out in multi cycle runs which comprised of ratio 1 kg of grinded *M. oleifera* immersion in 6 L of n-Hexane solvent and extraction at 90°C for 15 minutes, then washing of *M. oleifera* powder again in solvent for 30 minutes and finally recovery of *M. oleifera* powder by discarding any remaining solvent and placing it in drying oven at 60°C overnight. The weight of oil extracted was determined for each 30 minutes internal. At the end of extraction, the resulting mixture containing the oil was heated to recover the solvent from the oil, before it was sieved through a 250 µm mesh and kept inside a dry cabinet with a stable temperature of 27°C and humidity of less than 25%. At the end the solvent was distilled and the percentage of oil extracted was determined (Pearson, 1976) with final oil percentage remained in *M. oleifera* was also at average of 35% w/w.

Figure 3-5: Fat Analyzer

3.4 Sampling of river water

Batang Labu river water was collected using a sterile 50-liter high density poly-ethylene (HDPE) plastic container at the Salak Tinggi's WTP, Salak Tinggi (2°N 47'21'', 101°E 44'15'') (Fig. 3-6), and kept cold (at 4°C) until analysis. In this study, Salak Tinggi's WTP designated 'IL26' was chosen as it is classified as one of the *River Water Supply Scheme for Selangor* (EQR, 2014) and also due to the proximity of the WTP's to the city centre. It supplies around 70 MLD for Kuala Lumpur International Airport and Bandar Enstek, Negeri Sembilan. Water intake station was located adjacent to Batang Labu river where the raw river water routinely pumps into a pre-settling reservoir named Labu Dam. After the Batang Labu river water passing through different type of landscapes e.g. agricultural, plantation and residential, the stream flow is most of the time at a medium-fast velocity and full of silt before reaching the intake point with average

water quality value of 72 (Class III) and average total suspended solids value of 81 (Class II) according to EQR (2015) annual report.

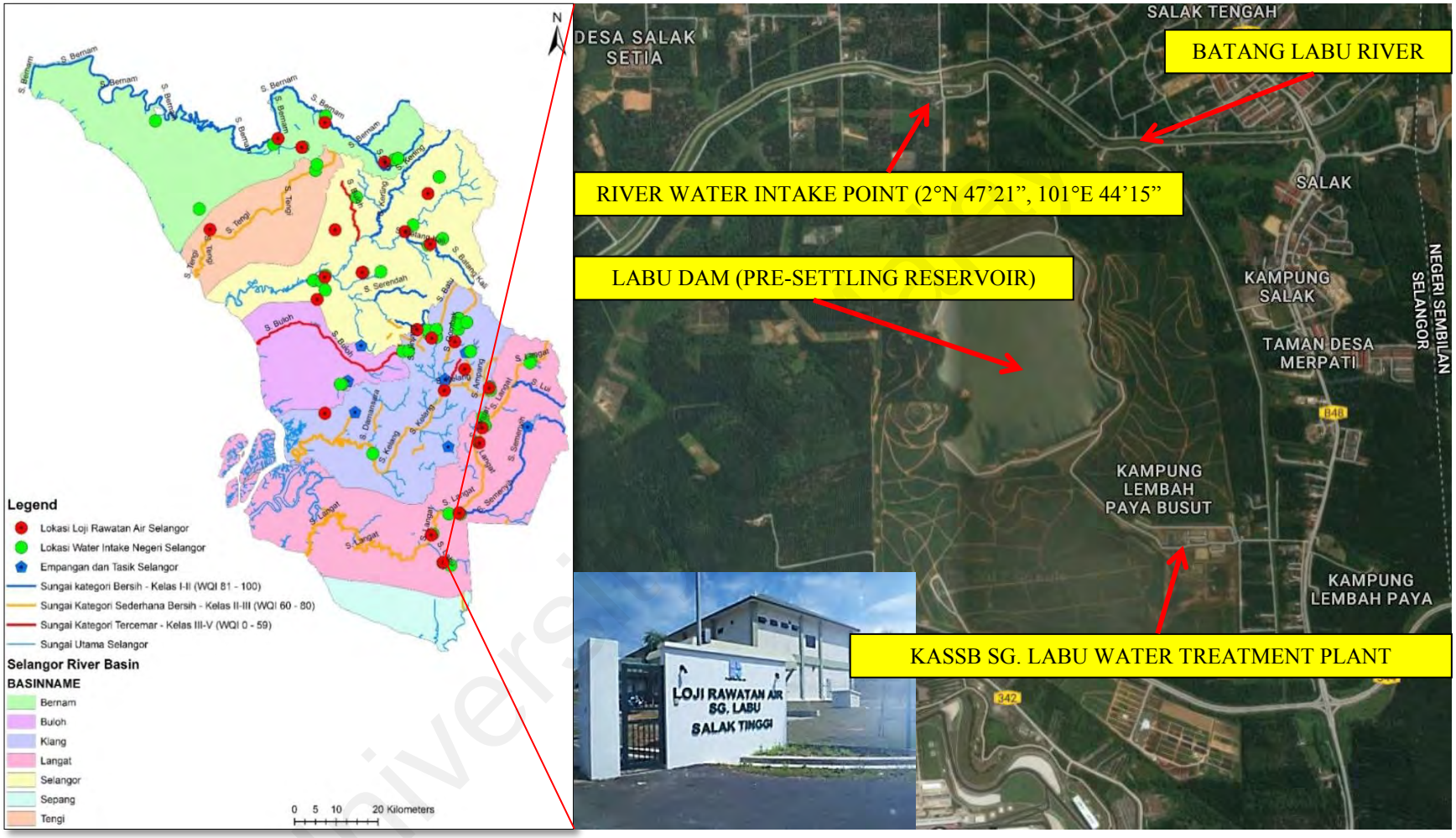

Figure 3-6: Location of sampling point at Sungai Labu WTP, adjacent to Batang Labu River, Salak Tinggi, Selangor.

3.5 Jar test

Jar testing is a method of mimicking a comprehensive water treatment process in a small-scale test. In real life operation, it will give WTP operators the right dosage of treatment chemicals to be applied and thus will give the best output of treated water. The main process of this analysis was to have the raw water filled a number of beakers in an equal amount of water with the average of 1 L. Each of the beakers will be given different dose of chemicals mainly the coagulant before mixing step, and finally the end result of main parameter mainly the turbidity and total suspended solids will be compared. Jar testing was carried out using a jar tester (Lovibond Flocculator, Germany) (Fig. 3.7) according to standard sedimentation jar test analysis (Griffith & Williams, 1972) where for each test run mixing was at 200 rpm for 5 min and sedimentation was for 15 min. The different treatment dosages of *M. oleifera* were carried out together with alum as reference in each beaker containing 1000 ml raw river water samples and one sample was left untreated as a control. Selected parameters (turbidity, TSS and culturable bacteria) before and after each jar testing analysis were recorded.

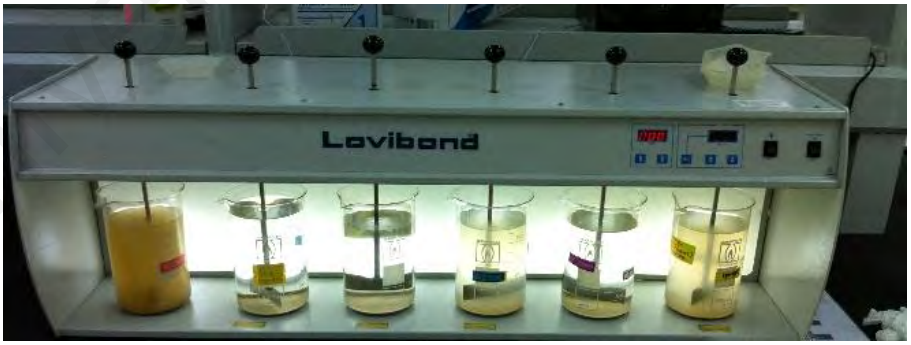

Figure 3-7: Jar Tester

3.6 Turbidity

Turbidity is one of the main variables measured in the collected water sample before coagulation assay. O'Dell (1993) defined the method as based upon the comparison of the light intensity emitted and scattered through water sample column with formazin polymer as a standard reference suspension. According to Standard Methods 2130B (Eaton *et al*., 2005) analysis consists of a nephelometer with light source emitting through the sample and detected by photo-electric detectors to indicate the intensity of light scattered within the sample. The measurements are made in unit of NTU's or Nephelometer Turbidity Unit (Thermo, USA). Water sample (C) in ml was diluted with turbid-free water (B) in ml until the turbidity falls between 30 and 40 NTU. If the initial measurement was below 30 NTU, the measurement could be read directly without any dilution. The final turbidity of diluted sample (A) is computed as follow:-

$$NTU = [A \times (B + C)]/C$$

3.7 Total suspended solids

TSS is a one of the factors in water quality analysis, which targets suspended load carried by a body of water. The measurement was carried out by filtering a known volume of well-mixed water sample through pre-combusted glass fibre filter (GFF) before drying in an oven (Memmert, Germany) (Fig. 3.8) at 103°C to 105°C for an hour, and to measure the differences between post and pre-weight. According to Standard Methods 2540D (Eaton *et al*., 2005), we first pre-weigh (B) pre-combusted GFFs (47 mm diameter, Whatman) on an analytical balance before filtering through 500 ml water sample (C). The filtrates were discarded and the filter paper of was dried at 103°C to 105°C for at least an

hour or overnight in a drying oven, cooled in a desiccator before it was weighed again on analytical balance or post-weight (A). The calculation for TSS is as follow:-

$$TSS\ (mg\ L^{-1}) = (A - B) / C$$

Figure 3-8: Drying Oven

3.8 Enumeration and identification of culturable bacteria

In this study, we also assessed the types of culturable bacteria found on *M. oleifera* seeds and extraction powder. The microflora composition in river water samples before and after the coagulation assay were also assessed. For the isolation and enumeration of the culturable microflora, we used the spread plate method on three different types of general microbiological media; Reasoner's 2 Agar (R2A) (Reasoner & Geldreich, 1979), Tryptone Glucose Yeast Agar (TGYA) (Yale, 1938), Casitone Glycerol Yeast Autolysate Agar (CGYA) (Prakasam & Dondero, 1967). We also used the selective MacConkey Agar for enumeration and cultivation of Gram negative enteric bacilli such as coliform and *Escherichia coli* (MacConkey, 1905). For solid samples such as seeds and powder,

sterile saline solution (0.9%) was added and samples were homogenized via blending before spread plating. All plates were incubated aerobically at 35°C overnight before enumeration and identification. The calculation for percentage bacterial count reduction with treatment of coagulant before and after 15 minutes is as follow:-

$$\text{Percent Reduction} = [\ (A - B)\ x\ 100\ ] / 100$$

For the identification of isolated bacteria, colony forming units of different morphology and pigmentation were selected for further purification before they were picked up for DNA extraction and Polymerase Chain Reaction (PCR). PCR was performed by suspending each purified bacterial colony in 100 µl sterile distilled water and incubating at 94°C for 10 min before spinning down the mixture and keeping it on ice. Amplification of the 16S rRNA gene was carried out in 20 µl reaction mixtures containing: 0.1 µl Taq polymerase, 2 µl $MgCl_2$ buffer, 0.4 µl dNTP, and 0.8 µl bacterial universal primer 27F and 1525R each, and 1 to 2 µl of DNA template. The thermal cycling profile was as follows: initial denaturation at 94°C for 2 min, 35 cycles of 94°C for 30 sec denaturation, 60°C for 40 sec annealing, 72°C for 90 sec extensions, 72°C for 7 min final extension and then cooled down at 4°C. PCR was carried out in a thermal cycler Applied Biosystems model 2720 (Thermo Fisher Scientific Inc., USA). Amplicons were then resolved by electrophoresis in a 1% Agarose gel in Tris-Borate-EDTA (TBE) buffer, and viewed after staining with ethidium bromide via a gel imaging system. After successful amplification, DNA sequencing of the amplicon was outsourced to the Industrial Biotechnology Research Centre, SIRIM Berhad (Malaysia). In order to determine the phylogenetic affiliation of each isolate, similarity search against the National Centre for Biotechnology Information (NCBI) GenBank database was conducted using the BLAST program (Altschul *et al*., 1997). The isolate was assumed to

belong to a given species if the similarity between the query sequence and the database is higher than 97% (Stackebrandt & Goebel, 1994).

3.9 Statistical analysis

All values were reported as mean ± standard deviation (S.D.) unless otherwise stated. Count data were log-transformed to meet parametric assumptions of equality of variance and normal distribution before statistical analyses. Statistical significance was evaluated at $p < 0.05$ whereas percentage reduction of turbidity and TSS were tested for its significance using one-way Analysis of Variance (ANOVA) and the Tukey's test with PAST (Hammer *et al*., 2001).

3.10 Cost-benefit measurements

Cost-benefit analysis of operating water treatment plant consists of economics and non-economics related aspects i.e. health and environment. Economic related benefits mainly focused on the estimation of running daily water treatment costs, and this information was obtained with permission from local WTP operators i.e. Kumpulan Air Selangor Sdn. Bhd. (KASSB).

CHAPTER 4: RESULTS

4.1 Preparation of *Moringa oleifera* as bioflocculant

In this study, the yield of bioflocculant from *M. oleifera* seed powder extracted via SFE technique was 42.1 ± 0.1% of the initial weight (Table 4.1). The yield from SFE was higher than the conventional SE method using hexane as a solvent (38.4 ± 0.3%) ($t = 9.79$, $p < 0.001$). The amount of oil extracted using the SFE method (29.6 ± 0.1%) was also higher than that using the SE method (28.4 ± 0.5%) ($t = 4.56$, $p < 0.05$). Concurrently, less husk was produced from the SFE method i.e. about 28.3 ± 0.2% of initial weight as compared to that of 33.0 ± 0.3% from the SE method ($t = 10.58$, $p < 0.001$). Using the SFE method, about 420 g of pure *M. oleifera* bioflocculant, 300 g of extracted oil and 280 g husk waste were obtained from 1 kg of grinded *M. oleifera.*

Figs. 4.1 and 4.2 show the photomicrographs of the particles achieved after SFE and SE extraction, respectively. The diameter of particles obtained by SFE method ranged from 10 to 35 μm (18 ± 5 μm, n=110) and were smaller compared to those obtained by the SE method which from 11 μm to 39 μm (23 ± 8 μm, n=110) ($t = 5.185$, $p = 1\times 10^{-6}$).

Table 4-1: Yield of *Moringa oleifera* extraction powder (bioflocculant) by SFE and SE methods, and p-values for t-test.

Method of Extraction	**Initial Weight of Blended *Moringa oleifera* (g)**	**Weight of *Moringa oleifera* extraction powder (g), (%)**	**Oil Yield Extracted (g), (%)**	**Husk Removal (g), (%)**
SFE	386.7 ± 0.7	162.7 ± 0.4 (42.1 ± 0.1%)	114.2 ± 0.2 (29.6 ± 0.1%)	109.4 ± 0.9 (28.3 ± 0.2%)
SE	100.0 ± 0.6	38.4 ± 0.3 (38.4 ± 0.2%)	28.2 ± 0.6 (28.4 ± 0.5%)	32.7 ± 0.2 (33 ± 0.3%)
P-value (t-test)	−	0.0006496	0.0222	0.000696

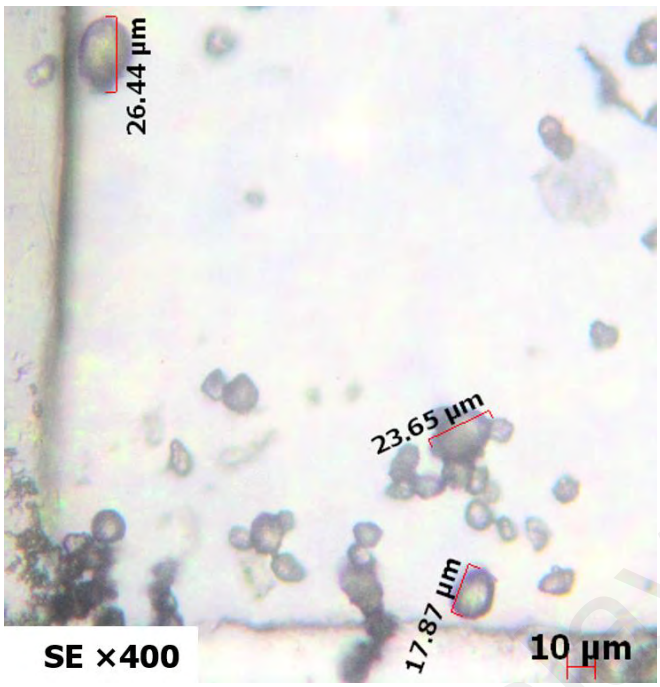

Figure 4-1: Photomicrographs of *Moringa oleifera* particles formed after extraction via SE methods, at ×400 magnification using a light microscope (Primo Star Zeiss, Germany)

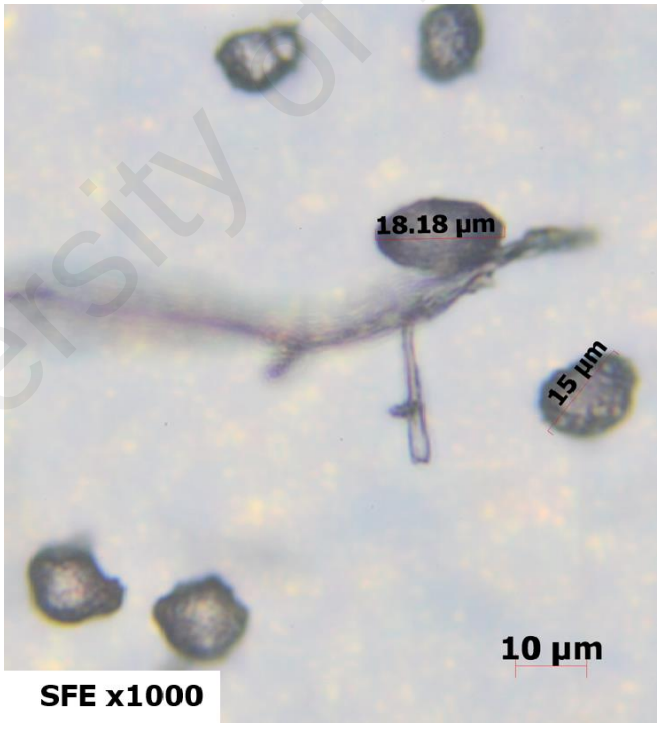

Figure 4-2: Photomicrographs of *Moringa oleifera* particles formed after extraction via SFE methods, at ×1000 magnification using a light microscope (Primo Star Zeiss, Germany)

4.2 Coagulation assay

The effectiveness of the bioflocculant from the SFE method was compared with that of the conventional alum in a series of coagulation assay. The average turbidity of the raw water sample for each assay ranged from 712 to 919 NTU (Nephelometric Turbidity Unit), and was highly turbid (Table 4.2). The amount of bioflocculant used for the coagulation assay ranged from 10 mg L^{-1} to 1000 mg L^{-1} (of raw river water to be treated), and the turbidity of the raw water was reduced by 95.0% to 98.6% ($F = 168.7$, $df = 5$, $p = 1.096 \times 10^{-10}$). Those reduction rates were less than these by alum which reduced water turbidity by 99.3% ($q > 6.53$, $p < 0.0061$). The amount of alum used was 25 mg L^{-1}. Similarly, TSS (suspended solids) reduction of raw water samples were 94.9% to 98.7% ($F = 661.1$, $df = 5$, $p = 3.27 \times 10^{-14}$) by bioflocculant (Table 4.3) which were less than the reduction rates achieved by alum (99.4%) ($q > 11.50$, $p < 0.0002$).

Table 4-2: Before and after between various concentration dosage of *Moringa oleifera* and alum treatment of raw river water

Dosage (mg L^{-1}) *M. oleifera*	**Turbidity (NTU)**		**% Reduction**
	Before	**After**	
1000	853 ±2	43 ±1	95.0
500	834 ±5	31 ±3	96.2
100	821 ±4	24 ±1	97.0
50	835 ±2	21 ±2	97.5
10	712 ±4	10 ±1	98.6
Alum 25	919 ± 3	6 ± 1	99.3

Statistical significance was evaluated at $p < 0.05$ using one-way Analysis of Variance (ANOVA)

p-value (ANOVA)= 1.1×10^{-10}***

Table 4-3: Before and after between various concentration dosage of *Moringa oleifera* and alum

Dosage (mg L^{-1}) *M. oleifera*	**Suspended Solids (mg L^{-1})**		**% Reduction**
	Before	**After**	
1000	2907 ±4	147 ±3	94.9
500	2846 ±5	87 ±1	96.9
100	2811 ±2	82 ±4	97.1
50	2863 ±7	61 ±5	97.9
10	2452 ±3	33 ±2	98.7
Alum 25	3153 ± 7	20 ± 1	99.4

Statistical significance was evaluated at $p < 0.05$ using one-way Analysis of Variance (ANOVA)

p-value (ANOVA)= 3.27×10^{-14}***

4.3 Enumeration and identification of culturable bacteria

The relationship between the amount of *M. oleifera* bioflocculant dosage applied and bacterial count of river water reduced (Table 4.4) was assessed on four different types of general microbiological media. The culturable bacterial community before and after treatment 10 mg L^{-1} by *M. oleifera* bioflocculant (Table 4.5) were compared to those 25 mg L^{-1} of alum was applied (Table 4.6), for example, in CGYA media agar, average total bacteria counts were from as high as $2.3 \pm 0.1 \times 10^4$ cfu mL^{-1} before treatment to as low as $9.1 \pm 0.9 \times 10^3$ cfu mL^{-1} in water column and $1.2 \pm 0.1 \times 10^4$ cfu g^{-1} in the sludge with an average of ~60% reduction of the total bacteria count.

Table 4-4: Reduction of bacterial count of river water (in sludge) on R2A, CGYA, TGYA and MacConkey agar before and after treatment of various dosage of *Moringa oleifera* and alum for 15 minutes

Dosage (mg L^{-1})	**Media**		**% Reduction**
	R2A (cfu mL^{-1})		
	Before	**After**	
MO 1000	$7.7 \pm 0.6 \times 10^4$	$2.9 \pm 0.9 \times 10^4$	61.6
MO 500	$7.4 \pm 0.5 \times 10^4$	$3.2 \pm 0.8 \times 10^4$	57.1
MO 100	$7.4 \pm 0.6 \times 10^4$	$3.9 \pm 1.7 \times 10^4$	47.2
MO 50	$7.3 \pm 0.6 \times 10^4$	$3.3 \pm 0.7 \times 10^4$	55.7
MO 10	$7.6 \pm 0.9 \times 10^4$	$3.4 \pm 0.9 \times 10^4$	54.9
Alum 25	$7.6 \pm 0.5 \times 10^4$	$5.9 \pm 1.8 \times 10^2$	99.2
	CGYA (cfu mL^{-1})		
	Before	**After**	
MO 1000	$2.4 \pm 0.5 \times 10^4$	$1.0 \pm 0.4 \times 10^4$	59.4
MO 500	$2.5 \pm 0.4 \times 10^4$	$1.0 \pm 0.5 \times 10^4$	59.7
MO 100	$2.6 \pm 0.5 \times 10^4$	$1.0 \pm 0.4 \times 10^4$	62.2
MO 50	$2.5 \pm 0.2 \times 10^4$	$1.1 \pm 0.6 \times 10^4$	57.6
MO 10	$2.5 \pm 0.3 \times 10^4$	$1.1 \pm 0.5 \times 10^4$	56.3
Alum 25	$2.3 \pm 0.5 \times 10^4$	$9.7 \pm 1.4 \times 10^1$	99.6
	TGYA (cfu mL^{-1})		
	Before	**After**	
MO 1000	$6.5 \pm 0.3 \times 10^4$	$3.0 \pm 0.9 \times 10^4$	53.4
MO 500	$6.6 \pm 0.5 \times 10^4$	$2.9 \pm 0.8 \times 10^4$	55.3
MO 100	$6.8 \pm 0.4 \times 10^4$	$3.0 \pm 0.9 \times 10^4$	56.0
MO 50	$6.4 \pm 0.3 \times 10^4$	$3.0 \pm 0.9 \times 10^4$	52.1
MO 10	$6.3 \pm 0.3 \times 10^4$	$3.3 \pm 0.9 \times 10^4$	47.4
Alum 25	$6.4 \pm 0.2 \times 10^4$	$3.3 \pm 1.4 \times 10^2$	99.5
	MacConkey agar (cfu mL^{-1})		
	Before	**After**	
MO 1000	$6.4 \pm 0.3 \times 10^4$	$2.9 \pm 0.7 \times 10^4$	53.4
MO 500	$6.1 \pm 0.4 \times 10^4$	$3.4 \pm 0.7 \times 10^4$	43.8
MO 100	$6.5 \pm 0.3 \times 10^4$	$3.3 \pm 0.7 \times 10^4$	49.2
MO 50	$6.4 \pm 0.3 \times 10^4$	$3.1 \pm 0.8 \times 10^4$	51.6
MO 10	$6.2 \pm 0.2 \times 10^4$	$2.9 \pm 0.6 \times 10^4$	53.3
Alum 25	$6.6 \pm 0.3 \times 10^4$	$5.7 \pm 1.6 \times 10^2$	99.1

Table 4-5: Bacterial community counts of river water and sludge determined from selective media, before and after treatment with 10 mg L^{-1} of *Moringa oleifera* bioflocculant for 15 minutes.

MEDIA	RIVER WATER BEFORE TREATMENT		RIVER WATER AFTER TREATMENT		SLUDGE AFTER TREATMENT	
	Identified Bacteria Communities	**Count cfu/ml**	**Identified Bacteria Communities**	**Count cfu/ml**	**Identified Bacteria Communities**	**Count cfu/g**
R2A	*Stenotrophomonas maltophilia*	$1.2 \pm 0.1 \times 10^4$	*Stenotrophomonas maltophilia*	$6.2 \pm 0.1 \times 10^3$	*Stenotrophomonas maltophilia*	$6.3 \pm 0.2 \times 10^3$
	Xanthomonas sp.	$1.2 \pm 0.2 \times 10^4$	*Xanthomonas* sp.	$6 \pm 0.4 \times 10^3$	*Xanthomonas* sp.	$6 \pm 0.2 \times 10^3$
	Bacillus cereus	$1.4 \pm 0.1 \times 10^4$	*Bacillus cereus*	$6.3 \pm 0.1 \times 10^3$	*Bacillus cereus*	$6.3 \pm 0.1 \times 10^3$
	Bacillus arsenicus	$1.5 \pm 0.1 \times 10^4$	*Bacillus arsenicus*	$7.5 \pm 0.1 \times 10^3$	*Bacillus arsenicus*	$7.5 \pm 0.1 \times 10^3$
	Pseudomonas geniculata	$1.2 \pm 0.1 \times 10^4$	*Pseudomonas geniculata*	$7 \pm 0.1 \times 10^3$	*Pseudomonas geniculata*	$7 \pm 0.1 \times 10^3$
	Klebsiella pneumoniae	$6.7 \pm 0.2 \times 10^3$				
	Total Count	$7.17 \pm 0.2 \times 10^4$		$3.3 \pm 0.1 \times 10^4$		$3.31 \pm 0.1 \times 10^4$
TGYA	*Chromobacterium* sp.	$1.6 \pm 0.1 \times 10^4$	*Chromobacterium* sp.	$5.7 \pm 2.3 \times 10^2$	*Chromobacterium* sp.	$7.3 \pm 0.2 \times 10^2$
	Chromobacterium violaceum	$1.4 \pm 0.1 \times 10^4$	*Chromobacterium violaceum*	$1.0 \pm 0.1 \times 10^4$	*Chromobacterium violaceum*	$1.15 \pm 0.3 \times 10^4$
	Xanthomonas sp.	$2 \pm 0.1 \times 10^4$	*Xanthomonas* sp.	$1.6 \pm 0.1 \times 10^4$	*Xanthomonas* sp.	$1.75 \pm 0.2 \times 10^4$
	Chromobacterium aquaticum	$1.1 \pm 0.1 \times 10^4$				
	Ralstonia mannitolilytica	$6.3 \pm 0.6 \times 10^3$				
	Total Count	$6.73 \pm 0.1 \times 10^4$		$2.65 \pm 0.1 \times 10^4$		$2.97 \pm 0.1 \times 10^4$
CGYA	*Chromobacterium* sp.	$2.4 \pm 0.2 \times 10^3$	*Chromobacterium* sp.	$1.1 \pm 0.2 \times 10^3$	*Chromobacterium* sp.	$1.2 \pm 0.2 \times 10^3$
	Chromobacterium violaceum	$1.2 \pm 0.1 \times 10^4$	*Chromobacterium violaceum*	$5.8 \pm 0.8 \times 10^3$	*Chromobacterium violaceum*	$8 \pm 0.3 \times 10^3$
	Xanthomonas sp.	$5 \pm 0.5 \times 10^3$	*Xanthomonas* sp.	$2.2 \pm 0.2 \times 10^3$	*Xanthomonas* sp.	$3.4 \pm 0.2 \times 10^3$
	Pandoraea sp.	$2.2 \pm 0.2 \times 10^3$				
	Acinetobacter baumannii	$1.5 \pm 0.2 \times 10^3$				
	Total Count	$2.31 \pm 0.1 \times 10^4$		$9.1 \pm 0.9 \times 10^3$		$1.26 \pm 0.1 \times 10^4$
Mac Conkey	*Escherichia coli*	$5.1 \pm 0.2 \times 10^4$	*Escherichia coli*	$2.8 \pm 0.1 \times 10^4$	*Escherichia coli*	$2.9 \pm 0.1 \times 10^4$
	Stenotrophomonas sp.	$1.1 \pm 0.1 \times 10^4$				
	Enterobacter asburiae	$2.5 \pm 0.3 \times 10^3$				
	Pantoea stewartii	$1.1 \pm 0.2 \times 10^3$				
	Pantoea ananatis	$1 \pm 0.3 \times 10^3$				
	Total Count	$6.66 \pm 0.2 \times 10^4$		$2.8 \pm 0.1 \times 10^4$		$2.9 \pm 0.1 \times 10^4$

Table 4-6: Bacterial community counts of river water and sludge determined from selective media, before and after treatment with 25 mg L^{-1} of alum coagulant for 15 minutes.

MEDIA	RIVER WATER BEFORE TREATMENT		RIVER WATER AFTER TREATMENT		SLUDGE AFTER TREATMENT	
	Identified Bacteria Communities	**Count cfu/ml**	**Identified Bacteria Communities**	**Count cfu/ml**	**Identified Bacteria Communities**	**Count cfu/g**
R2A	*Stenotrophomonas maltophilia*	$4.3 \pm 0.2 \times 10^4$	*Bacillus cereus*	$4.3 \pm 0.1 \times 10^2$	*Bacillus cereus*	$4.6 \pm 0.1 \times 10^2$
	Bacillus cereus	$4.1 \pm 0.2 \times 10^4$	*Escherichia coli*	$4.1 \pm 0.2 \times 10^2$	*Escherichia coli*	$4.1 \pm 0.2 \times 10^2$
	Klebsiella pneumoniae	$5 \pm 0.3 \times 10^2$				
	Xanthomonas sp.	$1.3 \pm 0.1 \times 10^2$				
	Escherichia coli	$1.9 \pm 0.2 \times 10^2$				
	Total Count	$8.4 \pm 0.2 \times 10^4$		$8.4 \pm 0.1 \times 10^2$		$8.7 \pm 0.1 \times 10^2$
TGYA	*Chromobacterium* sp.	$2.2 \pm 0.1 \times 10^4$	*Chromobacterium* sp.	$2.3 \pm 2.3 \times 10^2$	*Chromobacterium* sp.	$2.4 \pm 0.2 \times 10^2$
	Xanthomonas sp.	$3 \pm 0.1 \times 10^4$	*Xanthomonas* sp.	$2.8 \pm 0.1 \times 10^2$	*Xanthomonas* sp.	$2.5 \pm 0.2 \times 10^2$
	Chromobacterium aquaticum	$2.1 \pm 0.1 \times 10^4$				
	Total Count	$7.3 \pm 0.1 \times 10^4$		$5.1 \pm 0.1 \times 10^2$		$4.9 \pm 0.1 \times 10^2$
CGYA	*Chromobacterium* sp.	$1.5 \pm 0.1 \times 10^4$	*Chromobacterium* sp.	$1.4 \pm 0.2 \times 10^2$	*Chromobacterium* sp.	$1 \pm 0.2 \times 10^2$
	Xanthomonas sp.	$1.5 \pm 0.5 \times 10^4$	*Xanthomonas* sp.	$1.3 \pm 0.2 \times 10^2$	*Xanthomonas* sp.	$1.4 \pm 0.2 \times 10^2$
	Acinetobacter baumannii	$5 \pm 0.2 \times 10^3$				
	Total Count	$3.5 \pm 0.1 \times 10^4$		$2.7 \pm 0.9 \times 10^2$		$2.4 \pm 0.1 \times 10^2$
Mac Conkey	*Escherichia coli*	$6.1 \pm 0.2 \times 10^4$	*Escherichia coli*	$5.4 \pm 0.1 \times 10^2$	*Escherichia coli*	$5.3 \pm 0.1 \times 10^2$
	Stenotrophomonas sp.	$1.1 \pm 0.1 \times 10^4$				
	Total Count	$7.2 \pm 0.3 \times 10^4$		$5.4 \pm 0.1 \times 10^2$		$5.3 \pm 0.1 \times 10^2$

We also isolated culturable bacteria from *M. oleifera* seeds, and discovered a community profile made up of mostly *Bacillus sp*. and a few *Micrococcus sp*. (Table 4.7). There was also no presence of coliform bacteria on the MacConkey agar plates from the *M. oleifera* seeds.

Table 4-7: Result of 16S rRNA gene sequencing analysis

No.	Sample Code	Isolation Source	Name - strain	Phylogenetic affiliation	NCBI Accession code	Closest Relative (Accession code)	Similarity (%)
1	SC2 P10	*Moringa oleifera* seed	*Bacillus subtilis – AZR1*	Firmicutes	ZZAUKA7R014	*Bacillus subtilis* ZWQ-1 (FR729926.1)	99%
2	SC3 P1-1		*Bacillus megaterium – MKA1*	Firmicutes	ZZB4PFEK014	*Bacillus megaterium* PRE9 (EU880506.1)	99%
3	SC3 P1-2		*Bacillus subtilis – AZR2*	Firmicutes	ZZBGJ9ZV015	*Bacillus subtilis* L4 (GQ421472.1)	99%
4	SC3 P10 C-1		*Bacillus pumilus – IPH1*	Firmicutes	ZZBRUW0R015	*Bacillus pumilus* c10 (AY373359.1)	99%
5	SC2 P10 C-1		*Bacillus subtilis – AZR3*	Firmicutes	ZZCPWMSP014	*Bacillus subtilis* B4 (JX123316.1)	99%
6	SC2 P10 C-2		*Bacillus megaterium – MKA2*	Firmicutes	ZZCXJXCV015	*Bacillus megaterium* PRE9 (EU880506.1)	99%
7	SC3 S100-1		*Bacillus subtilis – AZR4*	Firmicutes	ZZD30X01014	*Bacillus subtilis* T2 (EF221612.1)	99%
8	SC3 P1-3		*Bacillus endophyticus – NRE1*	Firmicutes	ZZDA0YFP014	*Bacillus endophyticus* S160(2) (JF513184.1)	99%
9	SC4 P10 C-1		*Bacillus pumilus – IPH2*	Firmicutes	ZZDHBPA1014	*Bacillus pumilus*IHB B 12534 (KJ767390.1)	99%
10	SC4 P10 C-2		*Bacillus subtilis – AZR5*	Firmicutes	ZZDXSVME014	*Bacillus subtilis* A32 (DQ631809.1)	99%
11	SC4 P10X C-1		*Micrococcus* sp. – *SYM1*	Actinobacteria	00KAWMVB01R	*Micrococcus* sp.JL-76 (AY745846.1)	99%
12	SC4 P10X C-2		*Micrococcus luteus – SYM2*	Actinobacteria	00M25CSM01R	*Micrococcus luteus* A4 (HQ323416.1)	99%
13	SC2 P10 C-3		*Bacillus subtilis – AZR6*	Firmicutes	00MK2CC901R	*Bacillus subtilis* NB-01 (HM214542.1)	99%
14	SC2 P10 C-4		*Bacillus megaterium – MKA3*	Firmicutes	00MS3TBT01R	*Bacillus megaterium* Y20 (JQ798391.1)	99%

15	SC3 S100-2		*Bacillus cereus – WAN1*	Firmicutes	00N3NDE601R	*Bacillus cereus* DS (GQ149481.1)	99%
16	SC3 P10		*Bacillus cereus – WAN2*	Firmicutes	00NA74V9014	*Bacillus cereus* GXBC-1 (GU982920.1)	99%
17	SC3 P100		*Bacillus subtilis – AZR7*	Firmicutes	00P4V2SE01R	*Bacillus subtilis* YB-04 (KF725636.1)	99%
18	SC4 P10 C-3		*Bacillus subtilis – AZR8*	Firmicutes	00PG935R015	*Bacillus subtilis* B30 (KC686715.1)	99%
19	SC4 P10 C-4		*Bacillus subtilis – AZR9*	Firmicutes	00R26WJ701R	*Bacillus subtilis* IHB B 10201 (KR233775.1)	99%
20	T1-1	Raw Water	*Ralstonia mannitolilytica - RL1*	Proteobacteria	021FKY7V01R	*Ralstonia mannitolilytica* JN7 (KF150334.1)	99%
21	T1-2		*Chromobacterium violaceum - RL2*	Proteobacteria	035D1S8U015	*Chromobacterium violaceum* ATCC 12472 (AE016825.1)	99%
22	T2-3		*Chromobacterium aquaticum - RL3*	Proteobacteria	035UN9PD01R	*Chromobacterium aquaticum* YLNALPb2 (JQ582944.1)	97%
23	T2-4		*Xanthomonas* sp. - *RL4*	Proteobacteria	036YDGZU01R	*Xanthomonas* sp. BJQ-BAI3 (FJ600360.1)	99%
24	C1-25		*Xanthomonas* sp. - *RL5*	Proteobacteria	0379TEPX01R	*Xanthomonas* sp. KD2009-18 (FN645733.1)	99%
25	C2-26		*Escherichia coli - RL6*	Proteobacteria	037JRENE01R	*Escherichia coli* RR1 (CP011113.1)	99%
26	R1-13		*Bacillus arsenicus - RL7*	Firmicutes	037SV8PE01R	*Bacillus arsenicus* B3 (GQ304784.1)	99%
27	R1-14		*Pseudomonas geniculata - RL8*	Proteobacteria	0380XDGB01R	*Pseudomonas geniculata* OUT-d1 (KJ147086.1)	98%

28	R2-15		*Stenotrophomonas maltophilia - RL9*	Proteobacteria	038BKS7T01R	*Stenotrophomonas maltophilia* CanL-56 (KT580582.1)	98%
29	MI-27		*Enterobacter asburiae - RL10*	Proteobacteria	038N23B601R	*Enterobacter asburiae* L1 (CP007546.1)	99%
30	M2-28		*Pantoea stewartii - RL11*	Proteobacteria	038WKZMT01R	*Pantoea stewartii* GSPB 2626 (AF373198.1)	99%
31	TA2-5	Coagulated Water	*Mycobacterium mucogenisum - CL1*	Actinobacteria	0FA8TJBD016	*Mycobacterium mucogenisum* ATCC 49649 (AY457073.1)	99%
32	TA2-6		*Escherichia coli -CL2*	Proteobacteria	0FAFBZSS016	*Escherichia coli* DH1Ec169 (CP012127.1)	99%
33	TA1-7		*Chromobacterium violaceum - CL3*	Proteobacteria	0FANWSN001R	*Chromobacterium violaceum* ESBV 4400 (EU372837.1)	99%
34	TA1-8		*Chromobacterium* sp. - *CL4*	Proteobacteria	0FAXHNGH016	*Chromobacterium* sp. DS-1 (AB426118.1)	99%
35	TA1-9		*Bacillus cereus - CL5*	Firmicutes	0FB390AM014	*Bacillus cereus* Q1 (GQ280380.1)	99%
36	CA1-23		*Pandoraea* sp. - *CL6*	Proteobacteria	0JZX2JAB01R	*Pandoraea* sp. LB-7 (DQ831002.1)	99%
37	CA2-24		*Acinetobacter baumannii - CL7*	Proteobacteria	0K052MYG014	*Acinetobacter baumannii* CCGGD201101 (KF430814.1)	99%
38	RA1-18		*Klebsiella pneumoniae - CL8*	Proteobacteria	0K0D7U9Z016	*Klebsiella pneumoniae* S001 (KC524425.1)	99%
39	RA2-19		*Xanthomonas* sp. - *CL9*	Proteobacteria	0K12UMCR016	*Xanthomonas* sp. TE9 (GQ381284.1)	98%
40	MA1-29		*Pantoea ananatis - CL10*	Proteobacteria	0K2KWKPP014	*Pantoea ananatis* Dc-09 (KC153128.1)	99%

41	MA2-30	Sludge	*Bacillus cereus- CL11*	Firmicutes	0K334S61014	*Bacillus cereus* NK1 (AB295052.1)	100%
42	ST2-10		*Chromobacterium* sp. - *SL1*	Firmicutes	0K3MZ94N014	*Chromobacterium* sp. CV57 (FJ753571.1)	99%
43	ST2-11		*Xanthomonas* sp. - *SL2*	Proteobacteria	0K458D3X016	*Xanthomonas* sp. PHLE-3 (JN400504.1)	99%
44	ST1-12		*Chromobacterium violaceum - SL3*	Proteobacteria	0K4F8AHZ014	*Chromobacterium violaceum* ESBV 4561 (EU693450.1)	99%
45	SC1-20		*Xanthomonas* sp. – *SL4*	Proteobacteria	0K5GTXSV016	*Xanthomonas* sp. BJQ-BAI3 (FJ600360.1)	99%
46	SC2-21		*Klebsiella pneumoniae - SL5*	Proteobacteria	0K5W8Z8S016	*Klebsiella pneumoniae* HUB-IV-004 (JN848784.1)	99%
47	SC2-22		*Chromobacterium violaceum - SL6*	Proteobacteria	0K66DBFM01R	*Chromobacterium violaceum* CV09 (FJ753567.1)	99%
48	SR1-16		*Bacillus* sp. - *SL7*	Firmicutes	0K6KZF13016	*Bacillus* sp. STA (KC870063.1)	99%
49	SR2-17		*Stenotrophomonas* sp. - *SL8*	Proteobacteria	0K6TVNSR01R	*Stenotrophomonas* sp. EC-S105 (AB200253.1)	99%
50	SM1-31		*Stenotrophomonas maltophilia - SL9*	Proteobacteria	0K772VYF014	*Stenotrophomonas maltophilia* 2681 (HQ185399.1)	99%
51	SM2-32		*Escherichia coli - SL10*	Proteobacteria	0K7GWR1D014	*Escherichia coli* C10 (HG941666.1)	99%

4.4 Cost-benefits measurements

From Table 4.8, the comparison between two coagulants i.e. *M. oleifera* and alum in view of its market-price value, as the price per kilogram for *M. oleifera* is RM 50.00 Kg^{-1} and for alum is less than RM 0.35 Kg^{-1}. Treatment cost for *M. oleifera* would be RM 0.50 m^{-3}, and for alum is less than RM 0.01 m^{-3}. The sludge produced for both coagulants can be compared as for *M. oleifera* is estimated of 5 MT^{-1}, and for alum is 10 MT^{-1}. However, the cost of disposing the sludge would be zero cost for *M. oleifera* and for alum is totaling of RM 30,000.00 $month^{-1}$.

Table 4-8: Cost-benefit analysis of water treatment systems using *Moringa oleifera* bioflocculant and alum as coagulant.

	M. oleiferaifera	**Aluminium sulphate (alum)**
Origin	Protein polypeptides (organic)	Aluminium sulphate (chemical)
Turbidity (NTU) Removal Rate, %	98.6%	99.3%
Average price Kg^{-1}*	RM 50.00 Kg^{-1}	Less than RM 0.35 Kg^{-1}
Treatment Dosage	10 mg L^{-1} Estimated of 100 MLD WTP: 1000 Kg day^{-1} (1 MT day^{-1})	25 mg L^{-1}** Estimated of 100 MLD WTP: 2500 Kg day^{-1} ** (2.5 MT day^{-1})
Treatment Cost	RM 0.0005 L^{-1} (RM 0.50 m^{-3}) Estimated of RM 50,000.00 day^{-1} Estimated of RM 1.5 million $month^{-1}$	RM 0.00000875 L^{-1} (RM 0.00875 m^{-3}) Estimated of RM 875.00 day^{-1} Estimated of RM 26,250.00 $month^{-1}$**
Sludge	Sludge produced does not fall as scheduled waste category and considered as environmental harmless	Sludge produced are categorized as scheduled waste and need to be properly treated before dumping
Sludge Treatment by Kualiti Alam	none	RM 3,000.00 MT^{-1} (incineration)***
Sludge Produced	Estimated of 5 MT $month^{-1}$ Estimated values for organic fertilizer of RM 400.00 MT^{-1}	10 MT $month^{-1}$
Sludge Disposal Cost	none	RM 30,000.00 $month^{-1}$
Total Cost $month^{-1}$ (estimation)	RM1.5 million	RM 60,000.00
Side Effects	none	Disease related to excessive Al^{3+} ion residue in treated water**** Estimated of medicine per drug for Alzheimer disease cost : Aricept tab 5 mg (RM 400.00 $pack^{-1}$ of 28's)*****

Legends:
* Price based on RM (Ringgit Malaysia) at the market value in Malaysia (local)
** Dosage based on the routine work of local water treatment plant (WTP) operators
*** Price based on Kualiti Alam Sdn Bhd (local chemical waste handling company) quotation
**** Cited from Suarez-Fernandez, M. B. *et al.* (1999)
***** Price based on 2015 market value, internet website reference: *https://www.mims.com/MALAYSIA/drug/info/Aricept/*

CHAPTER 5: DISCUSSION

5.1 Preparation of *Moringa oleifera* as bioflocculant

It is better applying pressure in obtaining pure *M. oleifera* extraction powder (bioflocculant) via SFE technique, because it has a direct effect over yield compare to SE technique (Palafox *et al*., 2012). Particle size of *M. oleifera* obtained via SFE was smaller than SE this was probably due to the high pressure (250 bar) applied during the SFE extraction process which produces more stable and smaller sized particle (Pan *et al.,* 2013). In contrast, the SE method was significantly less efficient in extracting oil from *M. oleifera*, and the particles formed were larger and not uniform. Moreover, the bioflocculant from the SE method is readily contaminated with solvent (Knez and Weidner, 2003) that is toxic and harmful to the environment (Herrero *et al*., 2006; Ahangari & Sargolzaei, 2012). Consequently, additional processing steps have to be used in the SE extraction system to eliminate chemical residue. This is usually carried out via a series of distillation units under vacuum and other ancillary apparatuses such as deodorizer and degumming (Díaz-Reinoso *et al*., 2006).

5.2 Jar test analysis on water turbidity and total suspended solids

The main purpose of Jar Test was to prompt the WTP operators to optimize the treatment process. Jar testing is important so that variety of chemical treatment could be explored and examined without disturbing the full-scale treatment plant and wasting any valuable resources. We were able to achieve about 95% of reduction in turbidity and TSS

with the *M. oleifera* bioflocculant, and the highest reduction rates were obtained with only 10 mg L^{-1} dosage of the bioflocculant. By using filtered ground seed suspension, Katayon *et al*. (2006) achieved of 94% turbidity removal from 390 NTU to 23.6 NTU by using 400 mg L^{-1} of *M. oleifera.* However, by applying this method, the other seed composition e.g. lipids, carbohydrates and fatty acids were still present together with the active ingredient of protein coagulants. Moreover, the shelf life of *M. oleifera* bioflocculant was less than one month. Ndabigengesera & Narasiah (1998) used ether as extracting agent, and achieved 90% of turbidity reduction from 105 NTU to 10 NTU by using 500 mg L^{-1} raw dried seed and kernel of *M. oleifera*, and they suggest that the active coagulant property comes from the protein inside the kernel of *M. oleifera*

5.3 Jar test analysis on bacterial abundance

Before the jar test analysis, we isolated culturable bacteria from *M. oleifera* seeds and discovered a community profile made up of mostly *Bacillus* sp. and a few *Micrococcus* sp.. There were also no coliform bacteria isolated from the *M. oleifera* seeds. It is still unverified whether bacterial diversity promotes plant diversity or ecosystem functioning (Van Der Heijden *et al.,* 2008), the presence of *Bacillus* sp. and other Gram-positive bacteria in soil and on plants are well documented (Hong *et al.,* 2009).

Total bacterial counts in sludge were found to be more than water column because the sludge may constitute reservoir and substrate for bacterial growth (Pote *et al.,* 2009). From alum treatment counts, the bacterial reduction is at optimum level of 99.4%, supported by treatment comparison between *M. oleifera* and alum by Pritchard *et al*. (2010) where alum reduction in bacterial counts can reach 99.8%. The reduction of total bacterial count was the result of treatment using *M. oleifera*, as the seeds contain

polypeptides which coagulate particles and bacteria in suspension (Suarez *et al*., 2003), it also possessed a bactericidal compound to inhibit bacterial growth and might represent an environmental friendly substitute to commonly used disinfecting agents as corroborated by Bukar *et al*. (2010) and Thilza *et al.* (2010). The antimicrobial agent found in *M. oleifera* contains an active 4α-4-rhamnousyloxy-benzyf-isothiocynate as identified by Eilart *et al.* (1981).

In this study, bacterial reduction using the bioflocculant was from 44% to 62%, and was lower than with alum (> 99%) ($t = 41.15$, $p < 0.001$). Pritchard *et al.* (2010) who also used *M. oleifera* reported relatively higher bacterial reduction of 66 – 93%. However, the water sample used in their study had low initial counts (6 cfu mL^{-1} – 100 cfu mL^{-1}) (Pritchard *et al.,* 2010) which was more than two-order lower than in this study. The water sample used in this study represented typical raw water used in drinking water treatment systems in Malaysia, and our results showed that one of the challenges to using the bioflocculant was the residual bacterial counts. Although the addition of a second stage sand filtration (Pritchard *et al.,* 2010) or chlorination (Tchobanoglous *et al.,* 1991) can remove bacteria satisfactorily, further studies have to be carried out to confirm this.

In this study, we also assessed the culturable bacterial community by isolating and identifying morphologically unique colony forming units. Although a culture-dependent approach does not reflect total bacterial diversity (Oren, 2004), it is still a cheaper and easier approach when compared with culture-independent approaches, and is still practical for comparative studies (Lee *et al.,* 2009). We observed the number of unique species was lower after the jar test analysis.

5.4 Cost-benefit analysis

Unlike alum which are produced in high quantities in order to fulfil high demand by all water treatment plant operators nationwide, *M. oleifera* is only mass produced for vitamins and supplement manufacturers and there is limited published data to evaluate the effectiveness of *M. oleifera* and alum (Pritchard *et al.,* 2010). Thus the market price for *M. oleifera* is significantly higher than alum. If the operators opted for coagulants changeover from alum to ferric sulphate, the cost would be 1.5 times more expensive than alum resulting in an overall increase in operating cost (DeWolfe, 2003). Nevertheless, since the dosage of *M. oleifera* use for water treatment are lesser than alum, the predicted sludge produced by *M. oleifera* would be reduced and also the final stage of managing its sludge would be less cumbersome and is considered environmentally safe. This is in contrast to sludge produced when using alum which is categorized as scheduled waste and the disposal of this sludge incurs cost (Fulton, 1974). For non-economic benefits such as health and environment aspect, *M. oleifera* does not cause any harm to human health were as for alum, according to Suarez *et al.* (1999) it does cause Alzheimer disease. There is also a financially hidden cost in managing diseases related to excessive aluminium-ion (Al^{3+}) residue in treated water (Suarez-Fernandez *et al.,* 1999). At current prices, the use of *M. oleifera* as bioflocculant is untenable. However, if the production cost of *M. oleifera* as bioflocculant can be reduced by an order, its estimated water treatment cost would only be about 2.5 times more. This is probably more acceptable to the public since *M. oleifera* as bioflocculant has shown its capability of treating raw water and is environmentally friendly and safe towards human health.

CHAPTER 6: CONCLUSION

SFE can be used to produce bioflocculant from *M. oleifera* and the bioflocculant produced was better than that produced by the SE method in terms of quality. This bioflocculant can reduce more than 95% of turbidity and suspended solids of water quality parameter during this study. It can also reduce up to 60% of bacterial population in the river water with various dosages of *M. oleifera* bioflocculant ranging from 10 mg L^{-1} to 1000 mg L^{-1}. Thus, the coagulation performance by *M. oleifera* bioflocculant via SFE preparation shows its promising solution in eliminating the use of chemicals, i.e. hexane during its preparation and thus potentially replacing alum as a main coagulant use by the majority of WTP operators.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

1. Mohamed Yusoff Muhammad Azroie, Choon Weng Lee, Chui Wei Bong. The preparation of *Moringa oleifera* via supercritical fluid extraction as an alternative coagulant for water treatment.

2. The preparation of *Moringa oleifera* via supercritical fluid extraction as an alternative coagulant for water treatment. (Paper presented at the 2nd International Conference on Waste Management and Environment (ICWME), Kuala Lumpur, Malaysia, September 20 – 22.

APPENDIX

APPENDIX A: National Water Quality Standards for Malaysia (EQR 2015):-

PARAMETER	UNIT	CLASS				
		I	IIA/IIB	III#	IV	V
Al	mg/l		-	(0.06)	0.5	
As	mg/l		0.05	0.4 (0.05)	0.1	
Ba	mg/l		1	-	-	
Cd	mg/l		0.01	0.01* (0.001)	0.01	
Cr (IV)	mg/l		0.05	1.4 (0.05)	0.1	
Cr (III)	mg/l		-	2.5	-	
Cu	mg/l		0.02	-	0.2	
Hardness	mg/l		250	-	-	
Ca	mg/l		-	-	-	
Mg	mg/l		-	-	-	
Na	mg/l		-	-	3 SAR	
K	mg/l		-	-	-	
Fe	mg/l		1	1	1 (Leaf) 5 (Others)	
Pb	mg/l		0.05	0.02* (0.01)	5	
Mn	mg/l		0.1	0.1	0.2	
Hg	mg/l		0.001	0.004 (0.0001)	0.002	
Ni	mg/l		0.05	0.9*	0.2	
Se	mg/l		0.01	0.25 (0.04)	0.02	
Ag	mg/l		0.05	0.0002	-	
Sn	mg/l		-	0.004	-	
U	mg/l		-	-	-	
Zn	mg/l		5	0.4*	2	
B	mg/l		1	(3.4)	0.8	
Cl	mg/l		200	-	80	
Cl_2	mg/l		-	(0.02)	-	
CN	mg/l		0.02	0.06 (0.02)	-	
F	mg/l		1.5	10	1	
NO_2	mg/l		0.4	0.4 (0.03)	-	
NO_3	mg/l		7	-	5	
P	mg/l		0.2	0.1	-	
Silica	mg/l		50	-	-	
SO_4	mg/l		250	-	-	
S	mg/l		0.05	(0.001)	-	
CO_2	mg/l		-	-	-	
Gross-α	Bq/l		0.1	-	-	
Gross-β	Bq/l		1	-	-	
Ra-226	Bq/l		< 0.1	-	-	
Sr-90	Bq/l		< 1	-	-	
CCE	mg/l		500	-	-	-
MBAS/BAS	mg/l		500	5000 (200)	-	-
O & G (Mineral)	mg/l		40; N	N	-	-
O & G (Emulsified Edible)	mg/l		7000; N	N	-	-
PCB	mg/l		0.1	6 (0.05)	-	-
Phenol	mg/l		10	-	-	-
Aldrin/Dieldrin	mg/l		0.02	0.2 (0.01)	-	-
BHC	mg/l		2	9 (0.1)	-	-
Chlordane	mg/l		0.08	2 (0.02)	-	-
t-DDT	mg/l		0.1	(1)	-	-
Endosulfan	mg/l		10	-	-	-
Heptachlor/Epoxide	mg/l		0.05	0.9 (0.06)	-	-
Lindane	mg/l		2	3 (0.4)	-	-
2,4-D	mg/l		70	450	-	-
2,4,5-T	mg/l		10	160	-	-
2,4,5-TP	mg/l		4	850	-	-
Paraquat	mg/l		10	1800	-	-

NATURAL LEVELS OR ABSENT

LEVELS ABOVE IV

Notes :
* = At hardness 50 mg/l $CaCO_3$
# = Maximum (unbracketed) and 24-hour average (bracketed) concentrations
N = Free from visible film sheen, discolouration and deposits

NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 - 7	3 - 5	< 3	< 1
pH	-	6.5 - 8.5	6 - 9	6 - 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	mS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	°C	-	Normal + 2 °C	-	Normal + 2 °C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count/100 ml	10	100	400	5000 (20000)[a]	5000 (20000)[a]	-
Total Coliform	count/100 ml	100	5000	5000	50000	50000	> 50000

Notes :
N : No visible floatable materials or debris, no objectional odour or no objectional taste
* : Related parameters, only one recommended for use
** : Geometric mean
a : Maximum not to be exceeded

WATER CLASSES AND USES

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above.

DOE WATER QUALITY CLASSIFICATION BASED ON WATER QUALITY INDEX

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH_3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

DOE WATER QUALITY INDEX CLASSIFICATION

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	-	> 7.0	6.0 – 7.0	5.0 – 6.0	< 5.0	> 5.0
Total Suspended Solid	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index (WQI)		> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

APPENDIX B: National Standard for Drinking Water Quality, Ministry of Health

TABLE 2

DRINKING WATER QUALITY STANDARDS AND FREQUENCY OF MONITORING

NO	PARAMETERS	COLUMN I	COLUMN II				COLUMN III
		MAXIMUM ACCEPTABLE VALUE	FREQUENCY TO BE MONITORED				SOURCE OF REFERENCE
		mg/l (unless otherwise stated)	WATER TREATMENT PLANT OUTLET	SERVICE RESERVOIR OUTLET	DISTRIBUTION SYSTEM	WELL/ SPRING	
	GROUP I						
	MICROBIOLOGICAL						
1	TOTAL COLIFORM	MPN METHOD/MEMBRANE FILTRATION METHOD MUST NOT BE DETECTED IN ANY 100ml SAMPLE	W	W	M	2Y	MAL
2	E coli OR THERMOTOLERANT	ABSENT IN 100ml SAMPLE	W	W	M	2Y	WHO2
3	COLIFORM BACTERIA						
4	FAECAL STREPTOCOCCI	MEMBRANE FILTER METHOD ABSENT IN 100ml SAMPLE MPN METHOD < 1 IN 100ml SAMPLE	WN	WN	WN	WN	EEC
5	CLOSTRIDIUM PERFRINGENS	ABSENT	WN	WN	WN	WN	MAL 1990
6	VIRUSES	ABSENT IN 100ml	WN	WN	WN	WN	NZ
7	PROTOZOA	ABSENT IN 100ml	WN	WN	WN	WN	NZ
8	HELMINTHS	ABSENT IN 100ml	WN	WN	WN	WN	NZ
	PHYSICAL						
9	TURBIDITY	5 NTU	W	W	M	2Y	WHO2
10	COLOUR	15 TCU	W	W	M	2Y	WHO2
11	pH	6.5 – 9.0	W	W	M	2Y	MAL
12	FREE RESIDUAL CHLORINE	0.2 – 5.0	W	W	M	2Y	WHO1
13	COMBINED RESIDUAL CHLORINE	NOT LESS THAN 1.0	W	W	M	2Y	MAL1990
14	MONOCHLORAMINE	3	WN	WN	WN	WN	WHO2
	GROUP II						
	INORGANIC						
1	TOTAL DISSOLVED SOLIDS	1000	M	M	Y/2	2Y	WHO2
2	CHLORIDE	250	M	M	Y/2	2Y	WHO2
3	AMMONIA (as N)	1.5	M	M	Y/2	2Y	WHO2
4	NITRATE (as N)	10	M	M	Y/2	2Y	WHO1
5	IRON	0.3	M	M	Y/2	2Y	WHO2
6	FLUORIDE	0.4 – 0.6	M	M	Y/2	2Y	MAL
7	HARDNESS	500	M	M	Y/2	2Y	WHO1
8	ALUMINIUM	0.2	M	M	Y/2	2Y	WHO2
9	MANGANESE	0.1	M	M	Y/2	2Y	WHO2
	GROUP III						
1	MERCURY (TOTAL)	0.001	Y/4	Y/2	Y	2Y	WHO2
2	CADMIUM	0.003	Y/4	Y/2	Y	2Y	WHO2
3	ARSENIC	0.01	Y/4	Y/2	Y	2Y	WHO2
4	CYANIDE	0.07	Y/4	Y/2	Y	2Y	WHO2
5	LEAD	0.01	Y/4	Y/2	Y	2Y	WHO2
6	CHROMIUM	0.05	Y/4	Y/2	Y	2Y	WHO2
7	COPPER	1	Y/4	Y/2	Y	2Y	WHO1
8	ZINC	3	Y/4	Y/2	Y	2Y	WHO2
9	SODIUM	200	Y/4	Y/2	Y	2Y	WHO2
10	SULPHATE	250	Y/4	Y/2	Y	2Y	WHO2

Engineering Services Division,
Ministry of Health MALAYSIA.

iv

APPENDIX C: Media Formulation

Formulations of the microbiological media used in this study: -

All the microbiological media was prepared according to the manufacturer's instructions, and sterilized by autoclaving at 121°C at 15 p.s.i. for 20 minutes. Mix well and pour into sterile Petri plates.

Reasoner's 2 Agar (R2A)	Weight (g L^{-1})
Casein	0.25
Peptone	0.25
Yeast Extract	0.5
Glucose	0.5
Starch	0.5
Dipotassium Phosphate	0.3
Magnesium Sulphate Heptahydrate	0.05
Sodium Pyruvate	0.3
Agar	15

Final pH: 7.0 ± 0.2 at 25°C

(Continue)

Tryptone Glucose Yeast Agar (TGYA)	Weight (g L^{-1})
Casein	5
Yeast Extract	3
Glucose	1
Agar	15

Final pH: 7.0 ± 0.2 at 25°C

Casitone Glycerol Yeast Autolysate Agar (CGYA)	Weight (g L^{-1})
Casein	5
Yeast Extract	1
Glycerol	5
Agar	15

Final pH: 7.0 ± 0.2 at 25°C

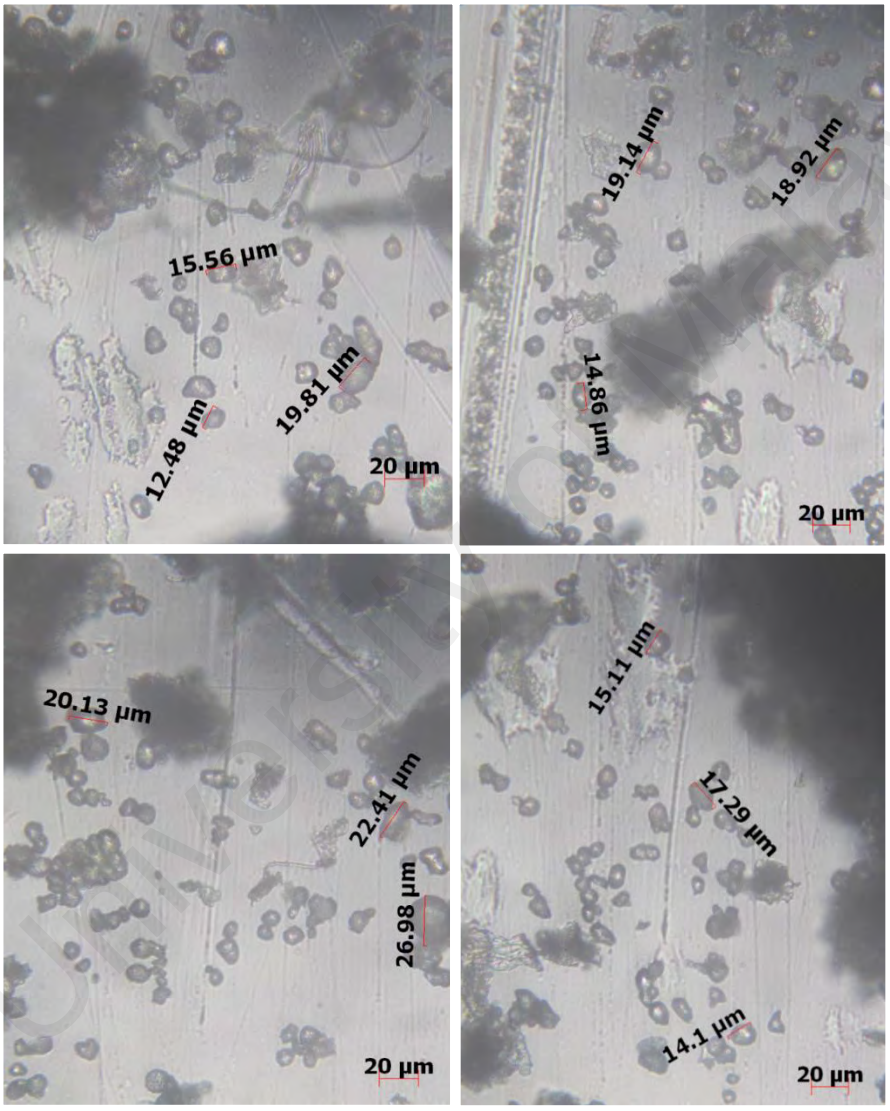
(Continue)

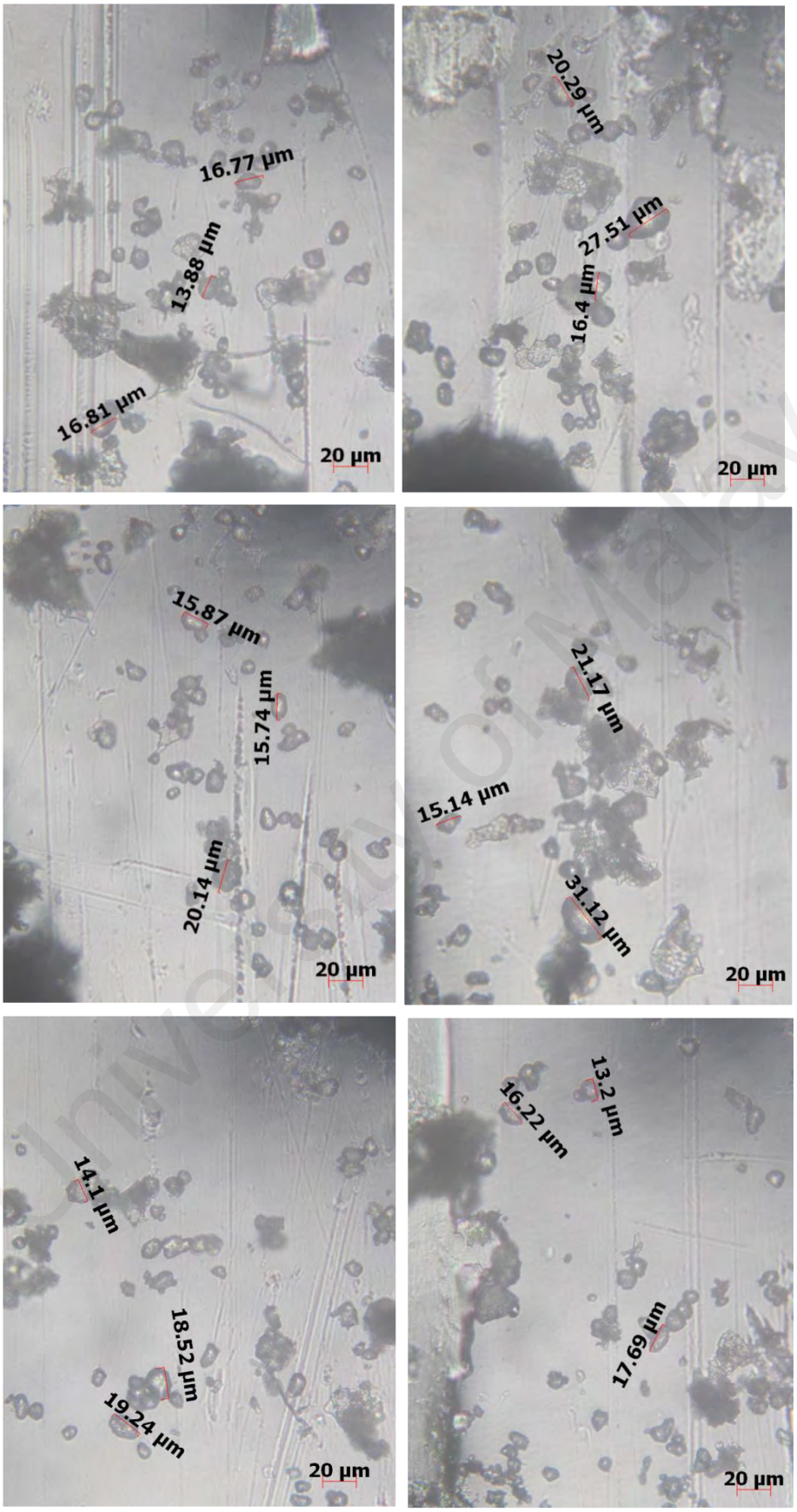
MacConkey agar	Weight (g L^{-1})
Casein	1.5
Gelatin	17
Lactose	10
Bile Salts	1.5
Sodium Chloride	5
Neutral Red	0.03
Crystal Violet	0.001
Animal Tissue	1.5
Agar	13.5

Final pH: 7.0 ± 0.2 at 25°C

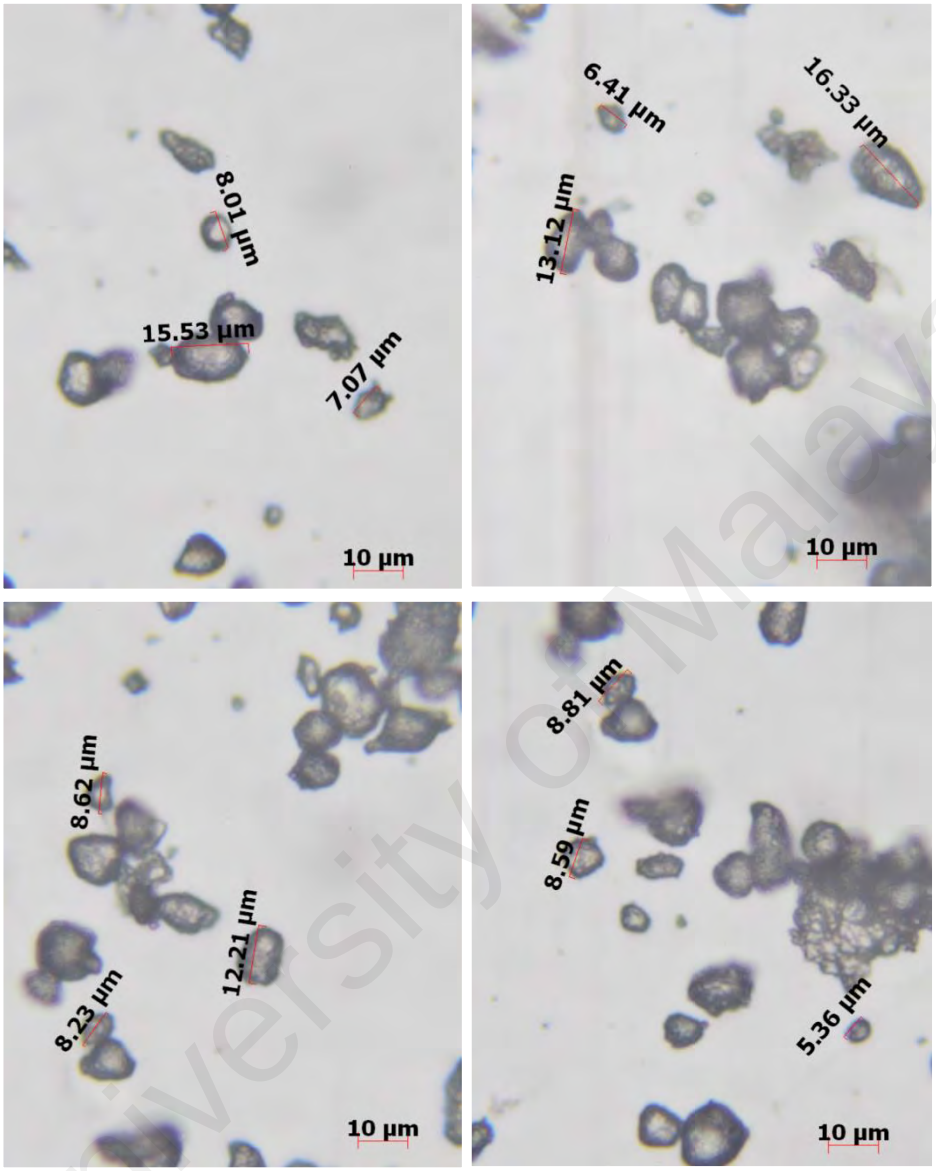
APPENDIX D: Photomicrographs

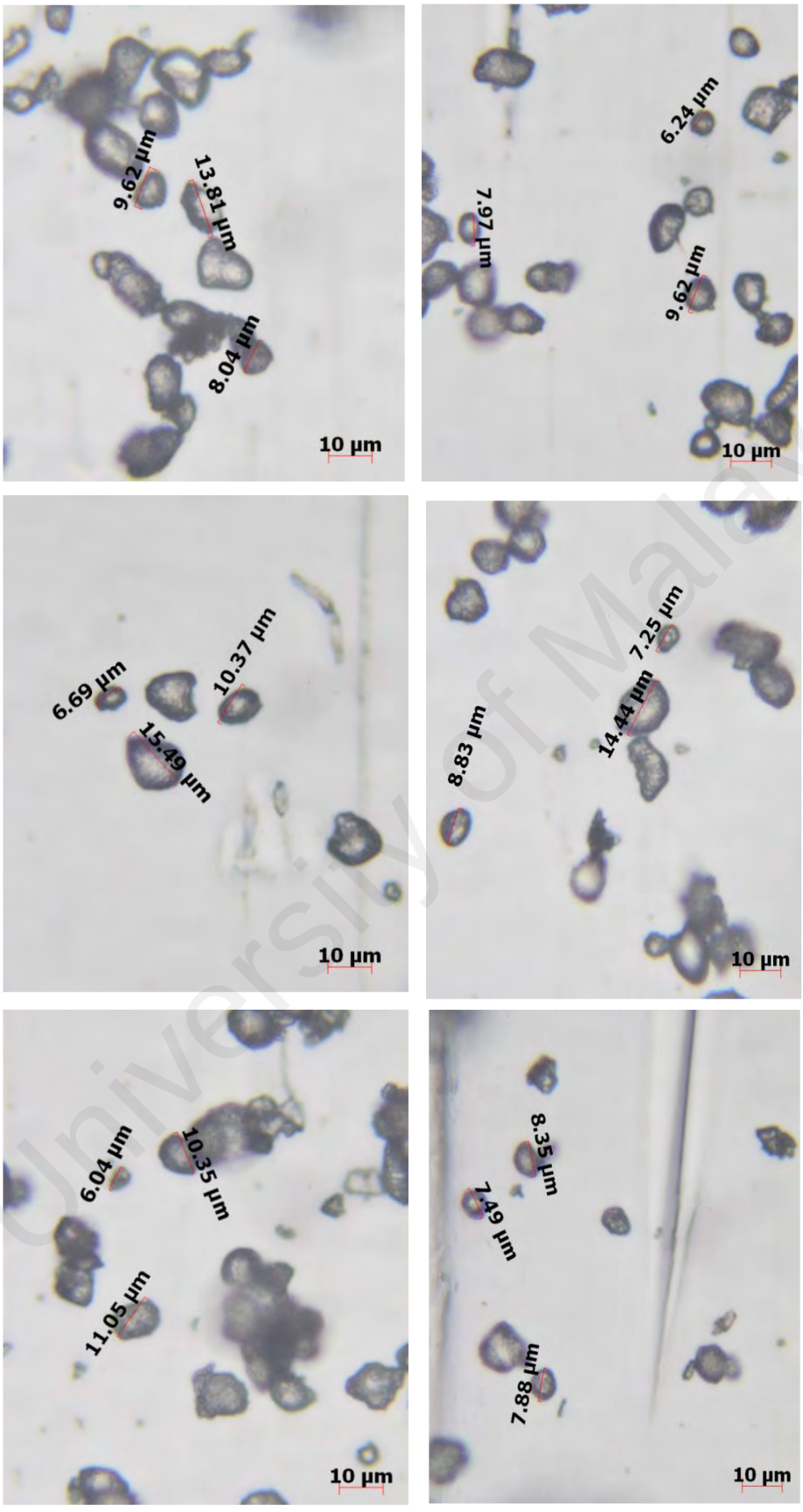
1. Photomicrographs of particles formed from *M. oleifera* after extraction via SE methods, at ×400 magnification using a light microscope (Primo Star Zeiss, Germany) carried out in this study.





2. Photomicrographs of particles formed from *M. oleifera* after extraction via SFE methods, at ×1000 magnification using a light microscope (Primo Star Zeiss, Germany)

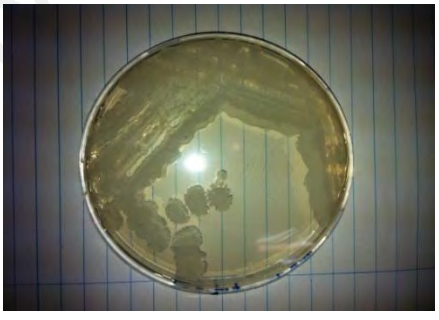


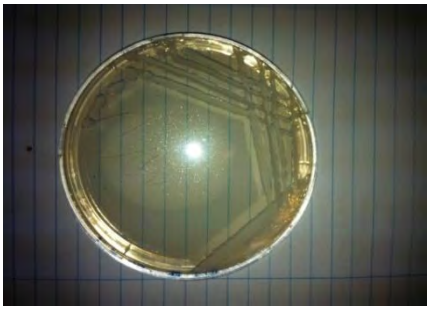


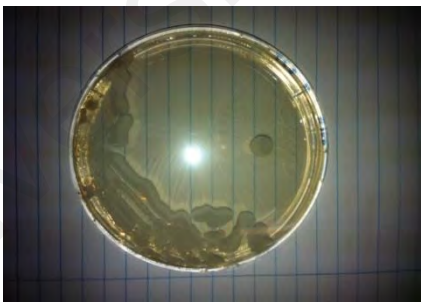
APPENDIX E: Photographs of purified isolates

Photographs of purified isolates of culturable microorganisms from *M. oleifera* seed, river water before treatment, river water after treatment, and sludge on various type of microbiological media agar

No.	1	2
Media	TGYA	TGYA
Sample Code	SC2 P10	SC3 P1-1
Strain	*AZR1*	*MKA1*
Bacteria name	*Bacillus subtilis*	*Bacillus megaterium*
Plate		

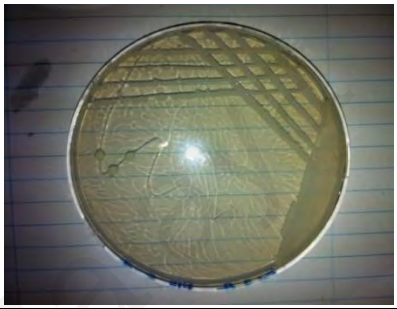
No.	3	4
Media	TGYA	TGYA
Sample Code	SC3 P1	SC3 P10 C-1
Strain	*AZR2*	*IPH1*
Bacteria name	*Bacillus subtilis*	*Bacillus pumilus*
Plate		

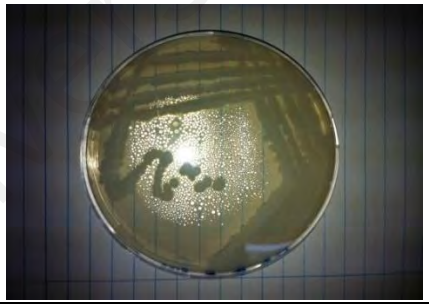
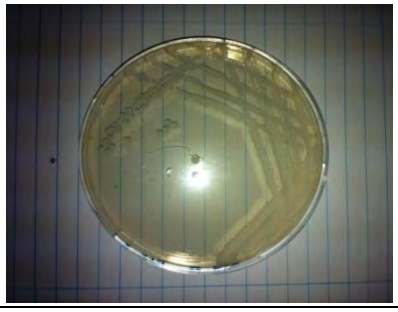
No.	5	6
Media	CGYA	CGYA
Sample Code	SC2 P10 C-1	SC2 P10 C-2
Strain	*AZR3*	*MKA2*
Bacteria name	*Bacillus subtilis*	*Bacillus megaterium*
Plate		

No.	7	8
Media	CGYA	CGYA
Sample Code	SC3 S100-1	SC3 P1-3
Strain	*AZR4*	*NRE1*
Bacteria name	*Bacillus subtilis*	*Bacillus endophyticus*
Plate		

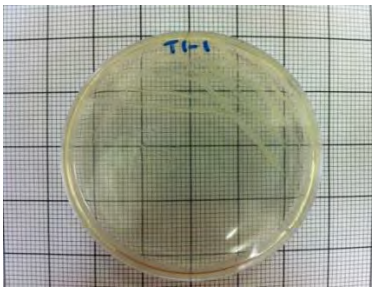
No.	9	10
Media	CGYA	CGYA
Sample Code	SC4 P10 C-1	SC4 P10 C-2
Strain	*IPH2*	*AZR5*
Bacteria name	*Bacillus pumilus*	*Bacillus subtilis*
Plate		

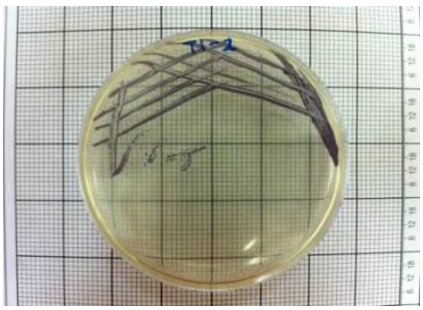
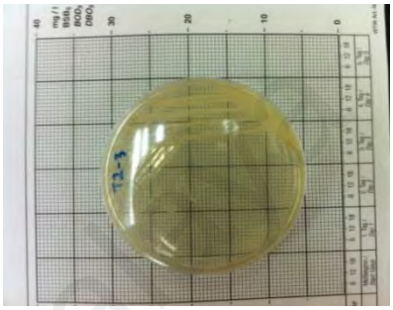
No.	11	12
Media	CGYA	CGYA
Sample Code	SC4 P10X C-1	SC4 P10X C-2
Strain	*SYM1*	*SYM2*
Bacteria name	*Micrococcus* sp.	*Micrococcus luteus*
Plate		

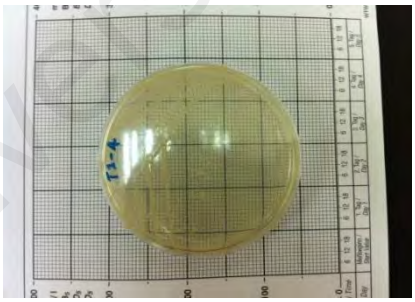
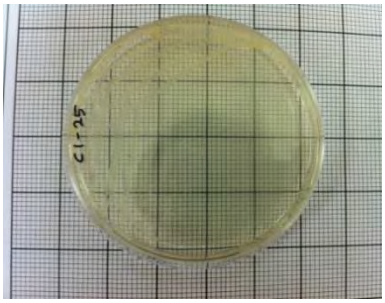
No.	13	14
Media	R2A	R2A
Sample Code	SC2 P10 C-3	SC2 P10 C-4
Strain	*AZR6*	*MKA3*
Bacteria name	*Bacillus subtilis*	*Bacillus megaterium*
Plate		

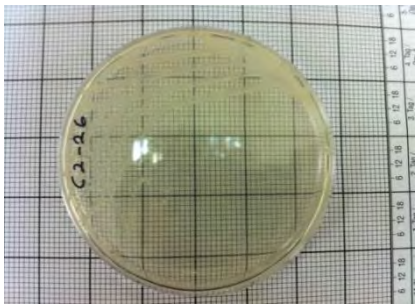
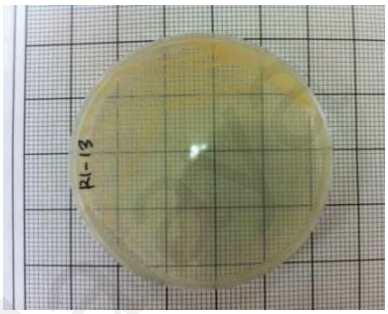
No.	15	16
Media	R2A	R2A
Sample Code	SC3 S100-2	SC3 P10
Strain	*WAN1*	*WAN2*
Bacteria name	*Bacillus cereus*	*Bacillus cereus*
Plate		

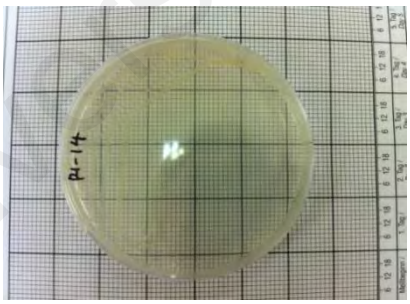
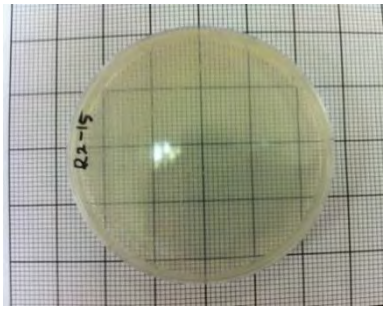
No.	17	18
Media	R2A	R2A
Sample Code	SC3 P100	SC4 P10 C-3
Strain	*AZR7*	*AZR8*
Bacteria name	*Bacillus subtilis*	*Bacillus subtilis*
Plate		

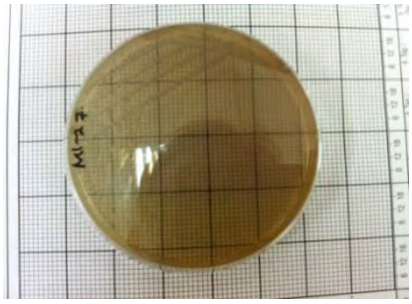
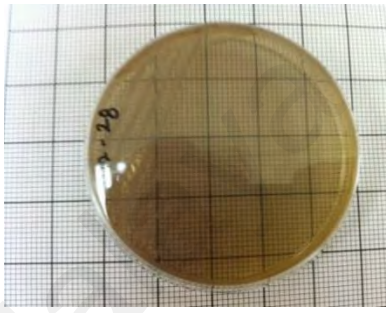
No.	19	20
Media	R2A	TGYA
Sample Code	SC4 P10 C-4	T1-1
Strain	*AZR9*	RL1
Bacteria name	*Bacillus subtilis*	*Ralstonia mannitolilytica*
Plate		

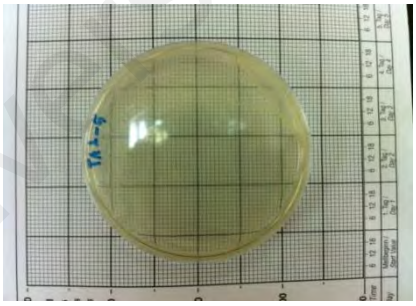
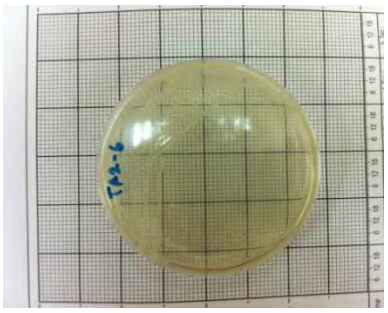
No.	21	22
Media	TGYA	TGYA
Sample Code	T1-2	T2-3
Strain	*RL2*	*RL3*
Bacteria name	*Chromobacterium violaceum*	*Chromobacterium aquaticum*
Plate		

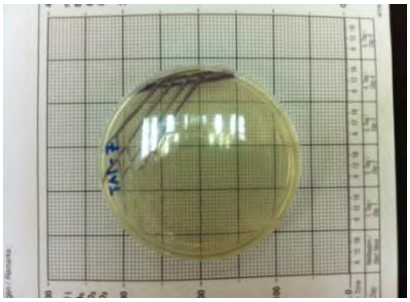
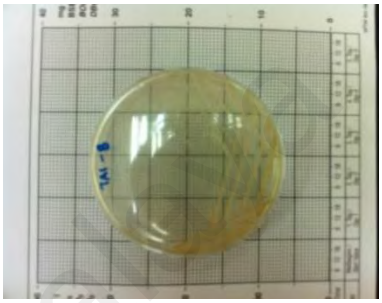
No.	23	24
Media	TGYA	CGYA
Sample Code	T2-4	C1-25
Strain	*RL4*	*RL5*
Bacteria name	*Xanthomonas* sp.	*Xanthomonas* sp.
Plate		

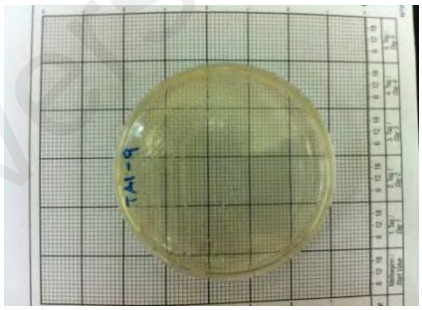
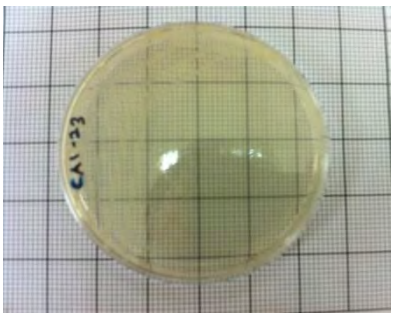
No.	25	26
Media	CGYA	R2A
Sample Code	C2-26	R1-13
Strain	*RL6*	*RL7*
Bacteria name	*Escherichia coli*	*Bacillus arsenicus*
Plate		

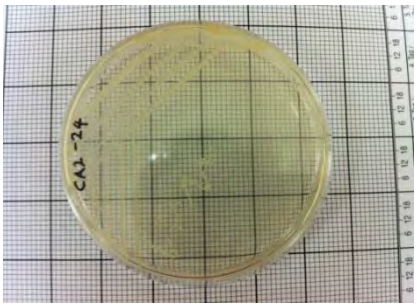
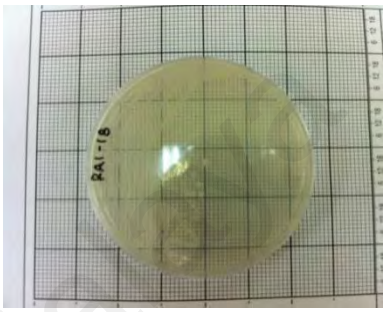
No.	27	28
Media	R2A	R2A
Sample Code	R1-14	R2-15
Strain	*RL8*	*RL9*
Bacteria name	*Pseudomonas geniculata*	*Stenotrophomonas maltophilia*
Plate		

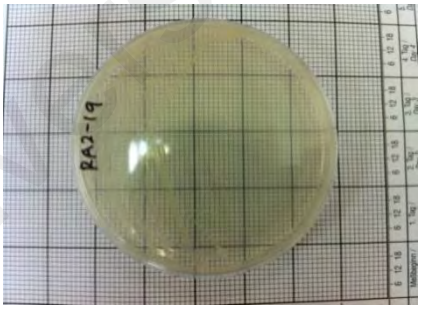
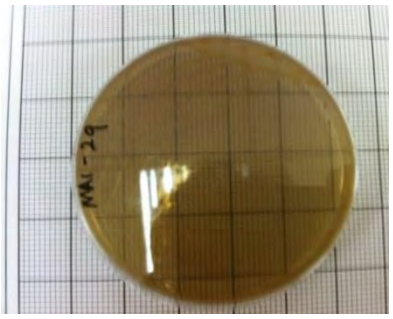
No.	29	30
Media	MacConkey	MacConkey
Sample Code	MI-27	M2-28
Strain	*RL10*	*RL11*
Bacteria name	*Enterobacter asburiae*	*Pantoea stewartii*
Plate		

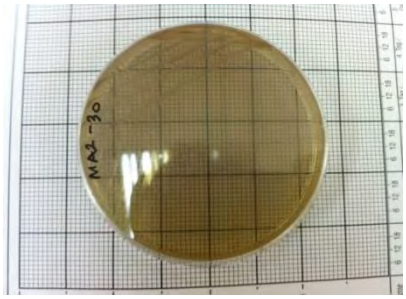
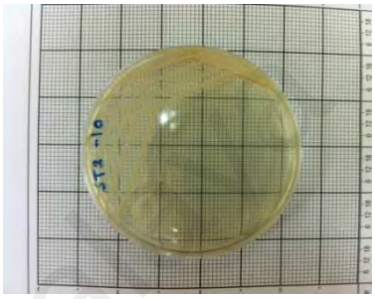
No.	31	32
Media	TGYA	TGYA
Sample Code	TA2-5	TA2-6
Strain	*CL1*	*CL2*
Bacteria name	*Mycobacterium mucogenisum*	*Escherichia coli*
Plate		

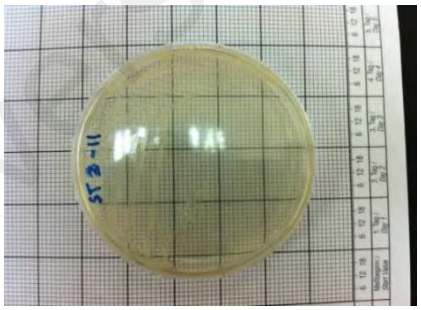
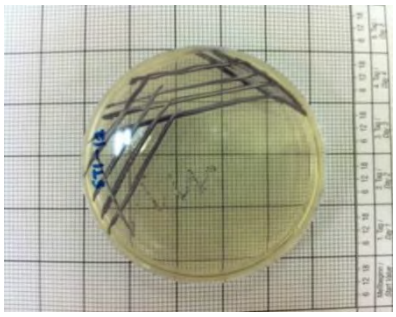
No.	33	34
Media	TGYA	TGYA
Sample Code	TA1-7	TA1-8
Strain	*CL3*	*CL4*
Bacteria name	*Chromobacterium violaceum*	*Chromobacterium* sp.
Plate		

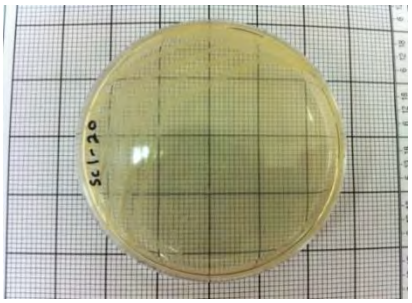
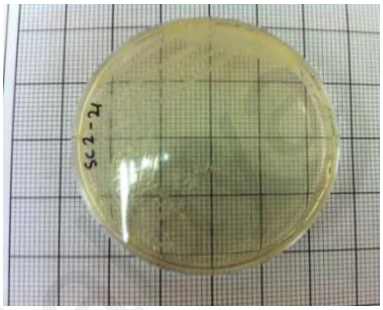
No.	35	36
Media	TGYA	CGYA
Sample Code	TA1-9	CA1-23
Strain	*CL5*	*CL6*
Bacteria name	*Bacillus cereus*	*Pandoraea* sp.
Plate		

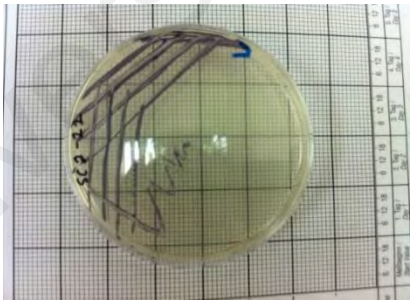
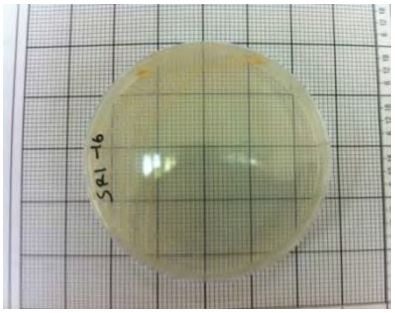
No.	37	38
Media	CGYA	R2A
Sample Code	CA2-24	RA1-18
Strain	*CL7*	*CL8*
Bacteria name	*Acinetobacter baumannii*	*Klebsiella pneumoniae*
Plate		

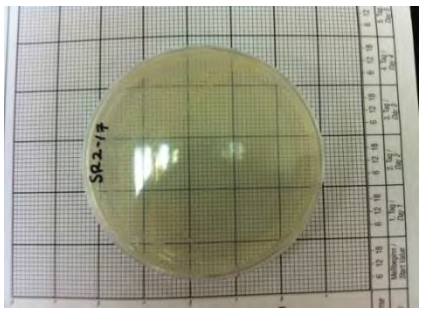
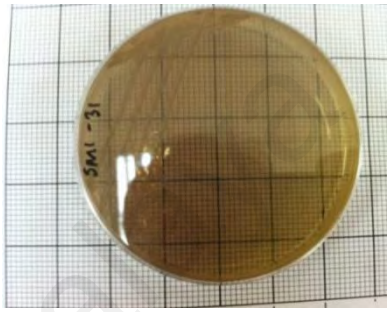
No.	39	40
Media	R2A	MacConkey
Sample Code	RA2-19	MA1-29
Strain	*CL9*	*CL10*
Bacteria name	*Xanthomonas* sp.	*Pantoea ananatis*
Plate		

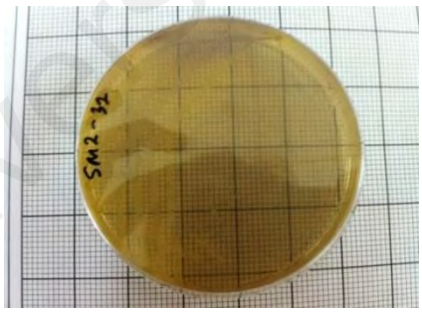
No.	41	42
Media	MacConkey	TGYA
Sample Code	MA2-30	ST2-10
Strain	*CL11*	*SL1*
Bacteria name	*Bacillus cereus*	*Chromobacterium* sp.
Plate		

No.	43	44
Media	TGYA	TGYA
Sample Code	ST2-11	ST1-12
Strain	*SL2*	*SL3*
Bacteria name	*Xanthomonas* sp.	*Chromobacterium violaceum*
Plate		

No.	45	46
Media	CGYA	CGYA
Sample Code	SC1-20	SC2-21
Strain	*SL4*	*SL5*
Bacteria name	*Xanthomonas* sp.	*Klebsiella pneumoniae*
Plate		

No.	47	48
Media	CGYA	R2A
Sample Code	SC2-22	SR1-16
Strain	*SL6*	*SL7*
Bacteria name	*Chromobacterium violaceum*	*Bacillus* sp.
Plate		

No.	49	50
Media	R2A	MacConkey
Sample Code	SR2-17	SM1-31
Strain	*SL8*	*SL9*
Bacteria name	*Stenotrophomonas* sp.	*Stenotrophomonas maltophilia*
Plate		

No.	51	
Media	MacConkey	
Sample Code	SM2-32	
Strain	*SL10*	
Bacteria name	*Escherichia coli*	
Plate		

APPENDIX F: Sequencing results for respectable bands (5’ – 3’)

Sequencing result for respectable bands (5' - 3') using bacterial universal primer 27F and 1525R from *M. oleifera* seed: -

Bacillus subtilis – AZR1

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTC
GGCGGCTGGCTCCTAAAAGGTTACCTCACCGACTTCGGGTGTTACAAACTCT
CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCGATTCCAGCTTCACGCAGTCGAGTTGCAGA
CTGCGATCCGAACTGAGAACAGATTTGTGGGATTGGCTTAACCTCGCGGTTT
CGCTACCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTGAATGCTGGCAACTAAGATCAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATG
CACCACCTGTCACTCTGCCCCCGAAGGGGACGTCCTATCTCTAGGATTGTCA
GAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACA
TGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGCG
ACCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAGCTACAGCACTAAGGGG
CGGAAACCCCCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAGG
GTATCTAATCCTGTTCGCTCCCCACGCTTTCGCTCCTCAGCGTCAGTTACAG
ACCAGAGAGTCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTCA
CCGCTACACGTGGAATTCCACTCTCCTCTTCTGCACTCAAGTTCCCCAGTTTC
CAATGACCCCCCCCCGGTTGAGCCGGGGGCTTTCACATCAGACTTAAGAAA
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CGTCAAGGTGCCGCCCTATTCGAACGGTACTTGTTCTTCCCTAACAACAGAG
CTTTACGATCCGAAAACCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTT
TCGTCCATTGCGGAAGATTCCCTACTGCTGCCTCCCGTAGGAGTCTGGGCCG
TGTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTT
GCCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGCCGCAGGTCCATCT
GTAAGTGGTAGCCGAAGCCACCTTTTATATTTGAACCATGCGGTTCAAATAA
GCATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGG
TTACCCACGTGTTACTCACCCGTCCGCCGCTAACATCAGGGAGCAAGCTCCC
ATCTGTCCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGA
GCCATGATCAAACTCTAATCACTAG

Bacillus megaterium – MKA1

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTA
GGCGGCTAGCTCCTTACGGTTACTCCACCGACTTCGGGTGTTACAAACTCTC
GTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGCA
TGCTGATCCGCGATTACTAGCGATTCCAGCTTCATGTAGGCGAGTTGCAGCC
TACAATCCGAACTGAGAATGGTTTTATGGGATTGGCTTGACCTCGCGGTCTT
GCAGCCCTTTGTACCATCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGGG
GCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTC
ACCTTAGAGTGCCCAACTAAATGCTGGCAACTAAGATCAAGGGTTGCGCTC
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ACCACCTGTCACTCTGTCCCCCGAAGGGGAACGCTCTATCTCTAGAGTTGTC
AGAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCAC
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GCGGAAACCCTCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAG
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GACCAAAAAGCCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTC
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CCAATGACCCTCCACGGTTGAGCCGTGGGCTTTCACATCAGACTTAAGAAA
CCGCCTGCGCGCGCTTTACGCCCAATAATTCCGGATAACGCTTGCCACCTAC
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CGTCAAGGTACGAGCAGTTACTCTCGTACTTGTTCTTCCCTAACAACAGAGT
TTTACGACCCGAAAGCCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTTT
CGTCCATTGCGGAAGATTCCCTACTGCTGCCTCCCGTAGGAGTCTGGGCCGT
GTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTATGCATCGTTG
CCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCACCGCGGGCCCATCTG
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TTGCCCACGTGTTACTCACCCGTCCGCCGCTAACGTCATAGAAGCAAGCTTC
TAATCAGTTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCATCCT
GAGCCATGATCAAACTCTAATCACTAG

Bacillus subtilis – AZR2

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTC
GGCGGCTGGCTCCTAAAAGGTTACCTCACCGACTTCGGGTGTTACAAACTCT
CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
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CTGCGATCCGAACTGAGAACAGATTTGTGGGATTGGCTTAACCTCGCGGTTT
CGCTGCCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTGAATGCTGGCAACTAAGATCAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATG
CACCACCTGTCACTCTGCCCCCGAAGGGGACGTCCTATCTCTAGGATTGTCA
GAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACA
TGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGCG
ACCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAGCTGCAGCACTAAGGGG
CGGAAACCCCCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAGG
GTATCTAATCCTGTTCGCTCCCCACGCTTTCGCTCCTCAGCGTCAGTTACAG
ACCAGAGAGTCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTCA
CCGCTACACGTGGAATTCCACTCTCCTCTTCTGCACTCAAGTTCCCCAGTTTC
CAATGACCCTCCCCGGTTTAGCCGGGGGCTTTCACATCAGACTTAAGAAACC
GCCTGCGAGCCCTTTACGCCCAATAATTCCGGACAACGCTTGCCACCTACGT
ATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTACCG
TCAAGGTACCGCCCTATTCGAACGGTACTTGTTCTTCCCTAACAACAGAGCT
TTACGATCCGAAAACCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTTTC
GTCCATTGCGGAAGATTCCCTACTGCTGCCTCCTGTAGGAGTCTGGGCCGTG
TCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTTGC
CTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGCCGCGGGTCCATCTGT

AAGTGGTAGCCGAAGCCACCTTTTATATTTGAACCATGCGGTTCAAATAAGC
ATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGGTT
ACCCACGTGTTACTCACCCGTCCGCCGCTAACATCAGGGAGCAAGCTCCCAT
CTGTCCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGAGC
CAGGATCAAACTCTAATCACTAG

Bacillus pumilus – IPH1

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGCCCCACCTTC
GGCGGCTGGCTCCATAAAGGTTACCTCACCGACTTCGGGTGTTGCAAACTCT
CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCGATTCCAGCTTCACGCAGTCGAGTTGCAGA
CTGCGATCCGAACTGAGAACAGATTTATGGGATTGGCTAAACCTTGCGGTCT
TGCAGCCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTGAATGCTGGCAACTAAGATCAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATG
CACCACCTGTCACTCTGTCCCCGAAGGGAAAGCCCTATCTCTAGGGTTGTCA
GAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACA
TGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGCG
ACCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAGCTGCAGCACTAAGGGG
CGGAAACCCCCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAGG
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ACCAGAGAGTCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTCA
CCGCTACACGTGGAATTCCACTCTCCTCTTCTGCACTCAAGTTTCCCAGTTTC
CAATGACCCTCCCCGGTTGAGCCGGGGGCTTTCACATCAGACTTAAGAAAC
CGCCTGCGAGCCCTTTACGCCCAATAATTCCGGACAACGCTTGCCACCTACG
TATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTACC
GTCAAGGTGCGAGCAGTTACTCTCGCACTTGTTCTTCCCTAACAACAGAGCT
TTACGATCCGAAAACCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTTTC
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TCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTCGC
CTTGGTGAGCCATTACCCCACCAACTAGCTAATGCGCCGCGGGTCCATCTGT
AAGTGACAGCCGAAACCGTCTTTCATCCTTGAACCATGCGGTTCAAGGAAC
TATCCGGTATTAGCTCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGGT
TACCCACGTGTTACTCACCCGTCCGCCGCTAACATCCGGGAGCAAGCTCCCT
TCTGTCCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGAG
CCATGATCAAACTCTAATCACTAG

Bacillus subtilis – AZR3

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTC
GGCGGCTGGCTCCTAAAAGGTTACCTCACCGACTTCGGGTGTTACAAACTCT
CGTGATGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCGATTCCAGCTTCACGCAGTCGAGTTGCAGA
CTGCGATCCGAACTGAGAACAGATTTGTGGGATTGGCTTAACCTCGCGGTTT
CGCTGCCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTGAATGCTGGCAACTAAGATCAAGGGTTGCGCT

CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATG
CACCACCTGTCACTCTGCCCCCGAAGGGGACGTCCTATCTCTAGGATTGTCA
GAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACA
TGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGCG
ACCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAGCTGCAGCACTAAGGGG
CGGAAACCCCCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAGG
GTATCTAATCCTGTTCGCTCCCCACGCTTTCGCTCCTCAGCGTCAGTTACAG
ACCAGAGAGTCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTCA
CCGCTACACGTGGAATTCCACTCTCCTCTTCTGCACTCAAGTTCCCCAGTTTC
CAATGACCCTCCCCGGTTGAGCCGGGGGCTTTCACATCAGACTTAAGAAAC
CGCCTGCGAGCCCTTTACGCCCAATAATTCCGGACAACGCTTGCCACCTACG
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CGTCCATTGCGGAAGATTCCCTACTGCTACCTCCCGTAGGAGTCTGGGCCGT
GTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTTG
CCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGCCGCGGGTCCATCTG
TAAGTGGTAGCCGAAGCCACCTTTTATATTTGAACCATGCGGTTCAAATAAG
CATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGGT
TACCCACGTGTTACTCACCCGTCCGCCGCTAACATCAGGGAGCAAGCTCCCA
TCTGTCCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGAG
CCATGATCAAACTCTAATCACTAG

Bacillus megaterium – MKA2

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTA
GGCGGCTAGCTCCTTACGGTTACTCCACCGACTTCGGGTGTTACAAACTCTC
GTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGCA
TGCTGATCCGCGATTACTAGCGATTCCAGCTTCATGTAGGCGAGTTGCAGCC
TACAATCCGAACTGAGAATGGTTTTATGGGATTGGCTTGACCTCGCGGTCTT
GCAGCCCTTTGTACCATCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGGG
GCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTC
ACCTTAGAGTGCCCAACTAAATGCTGGCAACTAAGATCAAGGGTTGCGCTC
GTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATGC
ACCACCTGTCACTCTGTCCCCCGAAGGGGAACGCTCTATCTCTAGAGTTGTC
AGAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCAC
ATGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGC
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GCGGAAACCCTCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAG
GGTATCTAATCCTGTTTGCTCCCCACGCTTTCGCGCCTCAGCGTCAGTTACA
GACCAAAAAGCCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTC
ACCGCTACACGTGGAATTCCGCTTTTCTCTTCTGCACTCAAGTTCCCCAGTTT
CCAATGACCCTCCACGGTTGAGCCGTGGGCTTTCACATCAGACTTAAGAAA
CCGCCTGCGCGCGCTTTACGCCCAATAATTCCGGATAACGCTTGCCACCTAC
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CGTCAAGGTACGAGCAGTTACTCTCGTACTTGTTCTTCCCTAACAACAGAGT
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CGTCCATTGCGGAAGATTCCCTACTGCTGCCTCCCGTAGGAGTCTGGGCCGT
GTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTATGCATCGTGG

CCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCACCGCGGGCCCATCTG
TAAGTGATAGCCGAAACCATCTTTCAATCATCTCCCATGAAGGAGAAGATC
CTATCCGGTATTAGCTTCGGTTTCCCGAAGTTATCCCAGTCTTACAGGCAGG
TTGCCCACGTGTTACTCACCCGTCCGCCGCTAACGTCATAGAAGCAAGCTTC
TAATCAGTTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCATCCT
GAGCCAGGATCAAACTCTAATCACTAG

Bacillus subtilis – AZR4

GAATTCGATTAGAGTTTGATCCTGGCTCAGGACGAACGCTGGCGGCGTGCC
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TCCGGGAAACCGGGGCTAATACCGGATGGTTGTTTGAACCGCATGGTTCAA
ACATAAAAGGTGGCTTCGGCTACCACTTACAGATGGACCCGCGGCGCATTA
GCTAGTTGGTGAGGTAACGGCTCACCAAGGCGACGATGCGTAGCCGACCTG
AGAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGG
AGGCAGCAGTAGGGAATCTTCCGCATGGACGAAAGTCTGACGGAGCAACGC
CGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGTTGTTAGGGAAGA
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CACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGTGGCAAGCGTT
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TGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAACTGGGGAACTTGA
GTGCAGAAGAGGAGAGTGGAATTCCACGTGTAGCGGTGAAATGCGTAGAG
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TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCC
ACGCCGTAAACGATGAGTGCTAAGTGTTAGGGGGTTTCCGCCCCTTAGTGCT
GCAGCTAACGCTTTAAGCACTCCGCCTGGGGAGTACGGTCGCAAGACTGAA
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TTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACATCCTCTGACAATCCT
AGAGATAGGACGTCCCCTTCGGGGGCAGAGTGACAGGTGGTGCATGGTTGT
CGTCAGCTCGTGTTGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACC
CTTGATCTTAGTTGCCAGCATTCAGTTGGGCACTCTAAGGTGACTGCCGGTG
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CTGGACTACACACGTGCTACAATGGACAGAACAAAGGGCAGCGAAACCGC
GAGGTTAAGCCAATCCCACAAATCTGTTCTCAGTTCGGATCGCAGTCTGCAA
CTCGACTGCGTGAAGCTGGAATCGCTAGTAATCGCGGATCAGCATGCCGCG
GTGAATACGTT*CCCGGGCCTTGTA*CACACCGCCCGTCACACCACGAGAGTTTGTAA
CAGCCGAAGTCGGTGAGGTAACCTTTTAGGAGCCAGCCGCCGAAGGTGGGA
CAGATGATTGGGGTGAAGTCGTAACAAGGTAACCAATCACTAGTGAATTC

Bacillus endophyticus – NRE1

AATTCGATTAGAGTTTGATCCTGGCTCAGGACGAACGCTGGCGGCGTGCCT
AATACATGCAAGTCGAGCGGAGTTTTGAAAAGCTTGCTTTTCAAAACTTAGC
GGCGGACGGGTGAGTAACACGTGGGCAACCTGCCCTTGAGACGGGGATAAC
TCCGGGAAACCGGAGCTAATACCGGATAACACATATCTTCGCATGAGGATA
TGTTAGAAGGTGGCTTTTAGCTACCACTCAAGGATGGGCCCGCGGCGCATT
AGCTAGTTGGTGAGGTAACGGCTCACCAAGGCGACGATGCGTAGCCGACCT
GAGAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGG

GAGGCAGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTGACGGAGCAA
CGCCGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGTTGTTAGGGA
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CGCTGAGGCGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGT
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GTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAA
CCCTTGATCTTAGTTGCCAGCATTCAGTTGGGCACTCTAAGGTGACTGCCGG
TGACGAACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATG
ACCTGGGCTACACACGTGCTACAATGGATGGTACAAAGGGCTGCAAAACCG
TGAGGTCGAGCCAATCCCATAAAACCATTCTCAGTTCGGATTGTAGGCTGCA
ACTCGCCTACATGAAGCCGGAATCGCTAGTAATCGCGGATCAGCATGCCGC
GGTGAATACGTTCCCGGGTCTTGTACACACCGCCCGTCACACCACGAGAGTT
TGTAACACCCGAAGTCGGTGAGGTAACCTTTTGGAGCCAGCCGCCGAAGGT
GGGACAGATGATTGGGGTGAAGTCGTAACAAGGTAACCAATCACTAG

Bacillus pumilus – IPH2

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGCCCCACCTTC
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CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCGATTCCAGCTTCACGCAGTCGAGTTGCAGA
CTGCGATCCGAACTGAGAACAGATTTATGGGATTGGCTAAACCTTGCGGTCT
TGCAGCCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
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GACCAGAGAGTCGCCTTCGCCACTGGTGTTCCTCCACATCTCTACGCATTTC
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CCAATGACCCTCCCCGGTTGAGCCGGGGGCTTTCACATCAGACTTAAGAAA
CCGCCTGCGAGCCCTTTACGCCCAATAATTCCGGACAACGCTTGCCACCTAC
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CGTCAAGGTGCGAGCAGTTACTCTCGCACTTGTTCTTCCCTAACAACAGAGC
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CGTCCATTGCGGAAGATTCCCTACTGCTGCCTTCCGTAGGAGTCTGGGCCGT

GTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTCG
CCTTGGTGAGCCATTACCCCACCAACTAGCTAATGCGCCGCGGGTCCATCTG
TAAGTGACAGCCGAAACCGTCTTTCATCCTTGAACCATGCGGTTCAAGGAA
CTATCCGGTATTAGCTCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGG
TTACCCACGTGTTACTCACCCGTCCGCCGCTAACATCCGGGAGCAAGCTCCC
TTCTGTTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGA
GCCAGGATCAAACTCTAATCACTAG

Bacillus subtilis – AZR5

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTC
GGCGGCTGGCTCCTAAAAGGTTACCTCACCGACTTCGGGTGTTACAAACTCT
CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCGATTCCAGCTTCACGCAGTCGAGTTGCAGA
CTGCGATCCGAACTGAGAACAGATTTGTGGGATTGGCTTAACCTCGCGGTTT
CGCTGCCCTTTGTTCTGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTAAATGCTGGCAACTAAGATCAAGGGTTGCGCT
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CACCACCTGTCACTCTGCCCCCGAAGGGGACGTCCTATCTCTAGGATTGTCA
GAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACA
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CCGCTACACGTGGAATTCCACTCTCCTCTTCTGCACTCAAGTTCCCCAGTTTC
CAATGACCCTCCCCGGTTGAGCCGGGGGCTTTCACATCAGACTTAAGAAAC
CGCCTGCGAGCCCTTTACGCCCAATAATTCCGGACAACGCTTGCCACCTACG
TATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTACC
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CCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGCCGCGGGTCCATCTG
TAAGTGGTAGCCGAAGCCACCTTTTATGTTTGAACCATGCGGTTCAAACAAC
CATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTACAGGCAGGT
TACCCACGTGTTACTCACCCGTCCGCCGCTAACATCAGGGAGCAAGCTCCCA
TCTGTCCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCGTCCTGAG
CCAGGATCAAACTCTAATCACTAG

Micrococcus sp. – SYM1

AATTCGATTGGTTACCTTGTTACGACTTAGTCCCAATCGCCGGTCCCACCTT
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TCGTGACTTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAG
CGTTGCTGATCTGCGACTACTAGCGACTCCGACTTCATGGGGTCGAGTTGCA
GACCCCAATCCGAACTGAGACCGGCTTTTTGGGATTAGCTCCACCTCACAGT
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AGGGGCATGATGATTTGACGTCGTCCTCACCTTCCTCCGAGTTGACCCCGGC
AGTCTCCCATGAGTCCCCACCATTACGTGCTGGCAACATGGAACGAGGGTT
GCGCTCGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAA
CCATGCACCACCTGTGAACCCGCCCCAAAGGGGAAACCGTATCTCTACGGC
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TCCGCATGCTCCGCCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTTAG
CCTTGCGGCCGTACTCCCCAGGCGGGGCACTTAATGCGTTAGCTGCGGCGC
GGAAACCGTGGAATGGTCCCCACACCTAGTGCCCAACGTTTACGGCATGGA
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CATTCCACCGCTACACCAGGAATTCCAGTCTCCCCTACTGCACTCTAGTCTG
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CAGGTACCGTCACTTTCGCTTCTTCCCTACTGAAAGAGGTTTACAACCCGAA
GGCCGTCATCCCTCACGCGGCGTCGCTGCATCAGGCTTGCGCCCATTGTGCA
ATATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGGCCGTGTCTCAGTCCCAG
TGTGGCCGGTCACCCTCTCAGGCCGGCTACCCGTCGTCGCCTTGGTGAGCCA
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CAGGCTTATCCCAGAGTTAAGGGCAGGTTACTCACGTGTTACTCACCCGTTC
GCCACTAATCCACCCAGCAAGCTGGGCTTCATCGTTCGACTTGCATGTGTTA
AGCACGCCGCCAGCGTTCATCCTGAGCCAGGATCAAACTCTAATCACTAG

Micrococcus luteus – SYM2

AATTCGATTGGTTACCTTGTTACGACTTAGTCCCAATCGCTGGTCCCACCTTC
GACGGCTCCCCCCACAAGGGTTAGGCCACCGGCTTCGGGTGTTACCAACTTT
CGTGACTTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGC
GTTGCTGATCTGCGATTACTAGCGACTCCGACTTCATGGGGTCGAGTTGCAG
ACCCCAATCCGAACTGAGACCGGCTTTTTGGGATTAGCTCCACCTCACAGTA
TCGCAACCCATTGTACCGGCCATTGTAGCATGCGTGAAGCCCAAGACATAA
GGGGCATGATGATTTGACGTCGTCCTCACCTTCCTCCGAGTTGACCTCGGCA
GTCTCCCATGAGTCCCCACCACGACGTGCTGGCAACATGGAACGAGGGTTG
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CATGCACCACCTGTGAACCCGCCCCAAAGGGGAAACCGTATCTCTACGGCG
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CCCGTACCCACCGCAGATCCGGGGTTAAGCCCCGGACTTTCACGACAGACG
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TCACCAACAAGCTGATAGGCCGCGAGTCCATCCAAAACCGATAAATCTTTC
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AGGCTTATCCCAGAGTTAAGGGCAGGTTACTCACGTGTTACTCACCCGTTCG
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Bacillus subtilis – AZR6

AATTCGATTAGAGTTTGATCATGGCTCAGGACGAACGCTGGCGGCGTGCCT
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CCGGGAAACCGGGGCTAATACCGGATGGTTGTTTGAACCGCATGGTTCAAA
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GAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGA
GGCAGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTGACGGAGCAACGC
CGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGTTGTTAGGGAAGA
ACAAGTACCGTTCGAATAGGGCGGTACCTTGACGGTACCTAACCAGAAAGC
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GTGCAGAAGAGGAGAGTGGAATTCCACGTGTAGCGGTGAAATGCGTAGAG
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TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCC
ACGCCGTAAACGATGAGTGCTAAGTGTTAGGGGGGTTTCCGCCCCTTAGTG
CTGCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGGTCGCAAGACTG
AAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTT
AATTCGAAGCAACGCG$_{AAGAACCTT}$ACCAGGTCTTGACATCCTCTGACAATCCT
AGAGATAGGACGTCCCCTTCGGGGGCAGAGTGACAGGTGGTGCATGGTTGT
CGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACC
CTTGATCTTAGTTGCCAGCATTTAGTTGGGCACTCTAAGGTGACTGCCGGTG
ACAAACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATGAC
CTGGGCTACACACGTGCTACAATGGACAGAACAAAGGGCAGCGAAACCG
CGAGGTTAAGCCAATCCCACAAATCTGTTCTCAGTTCGGATCGCAGTCTGCA
ACTCGACTGCGTGAAGCTGGAATCGCTAGTAATCGCGGATCAGCATGCCGC
GGTGAATACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCACGAGAGT
TTGTAACACCCGAAGTCGGTGAGGTAACCTTTTAGGAGCCAGCCGCCGAAG
GTGGGACAGATGATTGGGGTGAAGTCGTAACAAGGTAACCAATCACTAG

Bacillus megaterium – MKA3

GATTTGGGGGGTGCTATAATGCAGTCGAGCGACTGATTAGAAGCTTGCTTCT
ATGACGTTAGCGGCGGACGGGTGAGTAACACGTGGGCAACCTGCCTGTAAG
ACTGGGATAACTTCGGGAAACCGAAGCTAATACCGGATAGGATCTTCTCCT
TCATGGGAGATGATTGAAAGATGGTTTCGGCTATCACTTACAGATGGGCCC
GCGGTGCATTAGCTAGTTGGTGAGGTAACGGCTCACCAAGGCCACGATGCA
TAGCCGACCTGAGAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAG
ACTCCTACGGGAGGCAGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTG

ACGGAGCAACGCCGCGTGAGTGATGAAGGCTTTCGGGTCGTAAAACTCTGT
TGTTAGGGAAGAACAAGTATGAGAGTAACTGCTCGTACCTTGACGGTACCT
AACCAGAAAGCCACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGG
TGGCAAGCGTTATCCGGAATTATTGGGCGTAAAGCGCGCGCAGGCGGTTTC
TTAAGTCTGATGTGAAAGCCCACGGCTCAACCGTGGAGGGTCATTGGAAAC
TGGGGAACTTGAGTGCAGAAGAGAAAAGCGGAATTCCACGTGTAGCGGTG
AAATGCGTAGAGATGTGGAGGAACACCAGTGGCGAAGGCGGCTTTTTGGTC
TGTAACTGACGCTGAGGCGCGAAAGCGTGGGGAGCAAACAGGATTAGATA
CCCTGGTAGTCCACGCCGTAAACGATGAGTGCTAAGTGTTAGAGGGTTTCC
GCCCTTTAGTGCTGCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGGT
CGCAAGACTGAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGA
GCATGTGGTTTAATTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACAT
CCTCTGACAACTCTAGAGATAGAGCGTTCCCCTTCGGGGGACAGAGTGACA
GGTGGTGCATGGTTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCC
GCAACGAGCGCAACCCTTTGATCTTAGTTGCCAGCATTTAGTTGGGCACTCT
AAGGGGACTGCCGGTGACAAACCGGAAGGAAGGTGGGGATGACGTCAAAT
CATCATGCCCCTTATGACCTGGGCTACCCCCGGGCTACAATGGATGGAACA
AAGGCTTGCAAGACCCCGGAGGTCAACCCATTCCCTTAAAACCATTTTCCAN
GTTCGGATTGGAAGGTGGAAACTTGCCTAACTGGAAGCTGGGAATCCTTTT
AAATCCCGGGATACCCATTGCCCGGGGGTAAATACTTTCCCCGGCCCTTTG
TACCCCCCGCCCCGTTCCACCCCGG

Bacillus cereus – WAN1

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTA
GGCGGCTGGCTCCAAAAAGGTTACCCCACCGACTTCGGGTGTTACAAACTC
TCGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGG
CATGCTGATCCGCGATTACTAGCGATTCCAGCTTCATGTAGGCGAGTTGCAG
CCTACAATCCGAACTGAGAACGGTTTCATGAGATTAGCTCCACCTCGCGGTC
TTGCAGCTCTTTGTACCGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAG
GGGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAG
TCACCTTAGAGTGCCCAACTTAATGATGGCAACTAAGATCAAGGGTTGCGC
TCGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCAT
GCACCACCTGTCACTCTGCTCCCGAAGGAGAAGCCCTATCTCTAGGGTTTTC
AGAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCAC
ATGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGCCTTG
CGGCCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAACTTCAGCACTAAAG
GGCGGAAACCCTCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCA
GGGTATCTAATCCTGTTTGCTCCCCACGCTTTCGCGCCTCAGTGTCAGTTAC
AGACCAGAAAGTCGCCTTCGCCACTGGTGTTCCTCCATATCTCTACGCATTT
CACCGCTACACATGGAATTCCACTTTCCTCTTCTGCACTCAAGTCTCCCAGTT
TCCAATGACCCTCCACGGTTGAGCCGTGGGCTTTCACATCAGACTTAAGAAA
CCACCTGCGCGCGCTTTACGCCCAATAATTCCGGATAACGCTTGCCACCTAC
GTATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTAC
CGTCAAGGTGCCAGCTTATTCAACTAGCACTTGTTCTTCCCTAACAACAGAG
TTTTACGACCCGAAAGCCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTT
TCGTCCATTGCGGAAGATTCCCTACTGCTGCCTCCCGTAGGAGTCTGGGCCG
TGTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTT
GCCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGACGCGGGTCCATCC

ATAAGTGACAGCCGAAGCCGCCTTTCAATTTCGAACCATGCGGTTCAAAAT
GTTATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTATGGGCAG
GTTACCCACGTGTTACTCACCCGTCCGCCGCTAACTTCATAAGAGCAAGCTC
TTAATCCATTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCATCC
TGAGCCATGATCAAACTCTAATCACTAG

Bacillus cereus – WAN2

AATTCGATTGGTTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTA
GGCGGCTGGCTCCAAAAAGGTTACCCCACCGACTTCGGGTGTTACAAACTC
TCGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGG
CATGCTGATCCGCGATTACTAGCGATTCCAGCTTCATGTAGGCGAGTTGCAG
CCTACAATCCGAACTGAGAACGGTTTTATGAGATTAGCTCCACCTCGCGGTC
TTGCAGCTCTTTGTACCGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAG
GGGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAG
TCACCTTAGAGTGCCCAACTTAATGATGGCAACTAAGATCAAGGGTTGCGC
TCGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCAT
GCACCACCTGTCACTCTGCTCCCGAAGGAGAAGCCCTATCTCTAGGGTTTTC
AGAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCAC
ATGCTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGCCTTG
CGGCCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAACTTCAGCACTAAAG
GGCGGAAACCCTCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCA
GGGTATCTAATCCTGTTTGCTCCCCACGCTTTCGCGCCTCAGTGTCAGTTAC
AGACCAGAAAGTCGCCTTCGCCACTGGTGTTCCTCCATATCTCTACGCATTT
CACCGCTACACATGGAATTCCACTTTCCTCTTCTGCACTCAAGTCTCCCAGTT
TCCAATGACCCTCCACGGTTGAGCCGTGGGCTTTCACATCAGACTTAAGAAA
CCACCTGCGCGCGCTTTACGCCCAATAATTCCGGATAACGCTTGCCACCTAC
GTATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTAC
CGTCAAGGTGCCAGCTTATTCAACTAGCACTTGTTCTTCCCTAACAACAGAG
TTTTACGACCCGAAAGCCTTCATCACTCACGCGGCGTTGCTCCGTCAGACTT
TCGTCCATTGCGGAAGATACCCTACTGCTGCCTCCCGTAGGAGTCTGGGCCG
TGTCTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTT
GCCTTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGACGCGGGTCCATCC
ATAAGTGACAGCCGAAGCCGCCTTTCAATTTCGAACCATGCAGTTCAAATTG
TTATCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCAGTCTTATGGGCAGG
TTACCCACGTGTTACTCACCCGTCCGCCGCTAACTTCATAAGAGCAAGCTCT
TAATCCATTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCATCCT
GAGCCATGATCAAACTCTAATCACTAG

Bacillus subtilis – AZR7

AATTCGATTAGAGTTTGATCATGGCTCAGGACGAACGCTGGCGGCGTGCCT
AATACATGCAAGTCGAGCGGACAGATGGGAGCTTGCTCCCTGATGTTAGCG
GCGGACGGGTGAGTAACACGTGGATAACCTGCCTGTAAGACTGGGATAACT
CCGGGAAACCGGGGCTAATACCGGATGGTTGTTTGAACCGCATGGTTCAAA
CATAAAAGGTGGCTTCGGCTACCACTTACAGATGGACCCGCGTCGCATTAG
CTAGTTGGTGAGGTAATGGCTCACCAAGGCAACGATGCGTAGCCGACCTGA
GAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGA
GGCAGCGGTAGGGAATCTTCCGCAATGGACGAAAGTCTGACGGAGCAACGC

CGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGTTGTTAGGGAAGA
ACAAGTACCGTTCGAATAGGGCGGTACCTTGACGGTACCTAACCAGAAAGC
CACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGTGGCAAGCGTT
GTCCGGAATTATTGGGCGTAAAGGGCTCGCAGGCGGTTTCTTAAGTCTGATG
TGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAACTGGGGAACTTGA
GTGCAGAAGAGGAGAGTGGAATTCCACGTGTAGCGGTGAAATGCGTAGAG
ATGTGGAGGAACACCAGTGGCGAAGGCGACTCTCTGGTCTGTAACTGACGC
TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCC
ACGCCGTAAACGATGAGTGCTAAGTGTTAGGGGGTTTCCGCCCCTTAGTGCT
GCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGGTCGCAAGACTGAA
ACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAA
TTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACATCCTCTGACAATCCT
AGAGATAGGACGTCCCCTTCGGGGGCAGAGTGACAGGTGGTGCATGGTTGT
CGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACC
CTTGATCTTAGTTGCCAGCATTCAGTTGGGCACTCTAAGGTGACTGCCGGTG
ACAAACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATGAC
CTGGGCTACACACGTGCTACAATGGACAGAACAAAGGGCAGCGAAACCGC
GAGGTTAAGCCAATCCCACAAATCTGTTCTCAGTTCGGATCGCAGTCTGCAA
CTCGACTGCGTGAAGCTGGAATCGCTAGTAATCGCGGATCAGCATGCCGCG
GTGAATACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCACGAGAGTTT
GTAACACCCGAAGTCGGTGAGGTAACCTTTTAGGAGCCAGCCGCCGAAGGT
GGGACAGATGATTGGGGTGAAGTCGTAACAAGGTAACCAATCACTAG

Bacillus subtilis – AZR8

GGAATGCGGGAGCTATAATGCAGTCGAGCGGACAGATGGGAGCTTGCTCCC
TGATGTTAGCGGCGGACGGGTGAGTAACACGTGGGTAACCTGCCTGTAAGA
CTGGGATAACTCCGGGAAACCGGGGCTAATACCGGATGGTTGTTTGAACCG
CATGGTTCAAACATAAAAGGTGGCTTCGGCTACCACTTACAGATGGACCCG
CGGCGCATTAGCTAGTTGGTGAGGTAACGGCTCACCAAGGCGACGATGCGT
AGCCGACCTGAGAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAG
ACTCCTACGGGAGGCAGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTG
ACGGAGCAACGCCGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGT
TGTTAGGGAAGAACAAGTACCGTTCGAATAGGGCGGTACCTTGACGGTACC
TAACCAGAAAGCCACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAG
GTGGCAAGCGTTGTCCGGAATTATTGGGCGTAAAGGGCTCGCAGGCGGTTT
CTTAAGTCTGATGTGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAA
CTGGGGAACTTGAGTGCAGAAGAGGAGAGTGGAATTCCACGTGTAGCGGTG
AAATGCGTAGAGATGTGGAGGAACACCAGTGGCGAAGGCGACTCTCTGGTC
TGTAACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATA
CCCTGGTAGTCCACGCCGTAAACGATGAGTGCTAAGTGTTAGGGGGTTTCC
GCCCCTTAGTGCTGCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGG
TCGCAAGACTGAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGG
AGCATGTGGTTTAATTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACA
TCCTCTGACAATCCTAGAGATAGGACGTCCCCTTCGGGGGCAAAATGACAA
GTGGTGCATGGTTGTCGTCAGCTCGTGTCGGGAGATGTTGGGTTAAGTCCCG
CAACGAGCGCAACCCTTGATCTTAGTTGCCAGCATTTAGTTGGGCACTCTAA
GGTGACTGCCGGTGACAAACCGGAAGAAGGTGGGGATGACGTCAAATCATC
ATGCCCCTTATGACCTGGGCTACCACGTGCTACATGGACAGAAAAAGGGCA

GCGAACCCCGAGGTTAACCAATCCCCAAATTTGTTCCAATTCGGATCCGANC
TTGAACTCCACGGCGGGAACTGGAACCCTAGAAATCCCGAATCCAATGCCC
GGGGAATACTTTCCCGGGCTTTGAAC

Bacillus subtilis – AZR9

AATTCGATTAGAGTTTGATCCTGGCTCAGGACGAACGCTGGCGGCGTGCCT
AATACATGCAAGTCGAGCGGACAGATGGGTGCTTGCTCCCTGATGTTAGCG
GCGGACGGGTGAGTAACACGTGGGTAACCTGCCTGTAAGACTGGGATAACT
CCGGGAAACCGGGGCTAATACCGGATGGTTGTTTGAACCGCATGGTTCAAA
CATAAAAGGTGGCTTCGGCTACCACTTACAGATGGACCCGCGGCGCATTAG
CTAGTTGGTGAGGTAACGGCTCACCAAGGCAACGATGCGTAGCCGACCTGA
GAGGGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGA
GGCAGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTGACGGAGCAACGC
CGCGTGAGTGATGAAGGTTTTCGGATCGTAAAGCTCTGTTGTTAGGGAAGA
ACAAGTACCGTTCGAATAGGGCGGTACCTTGACGGTACCTAACCAGAAAGC
CACGGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGTGGCAAGCGTT
GTCCGGAATTATTGGGCGTAAAGGGCTCGCAGGCGGTTTCTTAAGTCTGATG
TGAAAGCCCCCGGCTCAACCGGGGAGGGTCATTGGAAACTGGGGAACTTGA
GTGCAGAAGAGGAGAGTGGAATTCCACGTGTAGCGGTGAAATGCGTAGAG
ATGTGGAGGAACACCAGTGGCGAAGGCGACTCTCTGGTCTGTAACTGACGC
TGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGATACCCTGGTAGTCC
ACGCCGTAAACGATGAGTGCTAAGTGTTAGGGGGTTTCCGCCCCTTAGTGCT
GCAGCTAACGCATTAAGCACTCCGCCTGGGGAGTACGGTCGCAAGACTGAA
ACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAA
TTCGAAGCAACGCGAAGAACCTTACCAGGTCTTGACATCCTCTGAAAATCCT
AGAGATAGGACGTCCCCTTCGGGGGCAGAGTGACAGGTGGTGCATGGTTGT
CGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACC
CTTGATCTTAGTTGCCAGCATTCAGTTGGGCACTCTAAGGTGACTGCCGGTG
ACAAACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATGAC
CTGGGCTACACACGTGCTACAATGGACAGAACAAAGGGCAGCGAAACCGC
GAGGTTAAGCCAATCCCACAAATCTGTTCTCAGTTCGGATCGCAGTCTGCAA
CTCGACTGCGTGAAGCTGGAATCGCTAGTAATCGCGGATCAGCATGCCGCG
GTGAATACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCACGAGAGTTT
GTAACACCCGAAGTCGGTGAGGTAACCTTTTAGGAGCCAGCCGCCGAAGGT
GGGACAGATGATTGGGGTGAAGTCGTAACAAGGTAACCATCACTAGTGAAT

Sequencing result for respectable bands (5' - 3') using bacterial universal primer 27F and 1525R from river water: -

Ralstonia mannitolilytica - RL1

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCCTTACAC
ATGCAAGTCGAACGGCAGCGGGGGAAAGCTTGCTTTCCTGCCGGCGAGTGG
CGAACGGGTGAGTAATACATCGGAACGTGCCCTGTAGTGGGGGATAACTAG
TCGAAAGATTAGCTAATACCGCATACGACCTGAGGGTGAAAGTGGGGGACC
GCAAGGCCTCATGCTATAGGAGCGGCCGATGTCTGATTAGCTAGTTGGTGG
GGTAAAGGCCCACCAAGGCGACGATCAGTAGCTGGTCTGAGAGGACGATCA
GCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGG

GGAATTTTGGACAATGGGCGAAAGCCTGATCCAGCAATGCCGCGTGTGTGA
AGAAGGCCTTCGGGTTGTAAAGCACTTTTGTCCGGAAAGAAATGGCTCTGG
TTAATACCTGGGGTCGATGACGGTACCGGAAGAATAAGGACCGGCTAACTA
CGTGCCAGCAGCCGCGGTAATACGTAGGGTCCAAGCGTTAATCGGAATTAC
TGGGCGTAAAGCGTGCGCAGGCGGTTGTGCAAGACCGATGTGAAATCCCCG
AGCTTAACTTGGGAATTGCATTGGTGACTGCACGGCTAGAGTGTGTCAGAG
GGGGGTAGAATTCCACGTGTAGCAGTGAAATGCGTAGAGATGTGGAGGAAT
ACCGATGGCGAAGGCAGCCCCCTGGGATAACACTGACGCTCATGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGA
TGTCAACTAGTTGTTGGGGATTCATTTCCTTAGTAACGTAGCTAACGCGTGA
AGTTGACCGCCTGGGGAGTACGGTCGCAAGATTAAAACTCAAAGGAATTGA
CGGGGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGA
AAAACCTTACCTACCCTTGACATGCCACTAACGAAGCAGAGATGCATTAGG
TGCTCGAAAGAGAAAGTGGACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCTCTAGT
TGCTACGAAAGGGCACTCTAGAGAGACTGCCGGTGACAAACCGGAGGAAG
GTGGGGATGACGTCAAGTCCTCATGGCCCTTATGGGTAGGGCTTCACACGTC
ATACAATGGTGCATACAGAGGGTTGCCAAGCCGCGAGGTGGAGCTAATCCC
AGAAAATGCATCGTAGTCCGGATCGTAGTCTGCAACTCGACTACGTGAAGC
TGGAATCGCTAGTAATCGCGGATCAGCATGCCGCGGTGAATACGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGGAGTGGGCTTTACCAGAAGTA
GTTAGCCTAACCGCAAGGAGGGCGATTACCACGGTAGGGTTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Chromobacterium violaceum - RL2

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCTTTACAC
ATGCAAGTCGAACGGTAACAGGGTGCTTGCACCGCTGACGAGTGGCGAACG
GGTGAGTAATGCGTCGGAATGTACCGTGTAATGGGGGATAGCTCGGCGAAA
GCCGGATTAATACCGCATACGCCCTGAGGGGGAAAGCGGGGGATCGAAAG
ACCTCGCGTTATACGAGCAGCCGACGTCTGATTAGCTAGTTGGTGAGGTAA
GAGCTCACCAAGGCGACGATCAGTAGCGGGTCTGAGAGGATGATCCGCCAC
ACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAA
TTTTGGACAATGGGGGCAACCCTGATCCAGCCATGCCGCGTGTCTGAAGAA
GGCCTTCGGGTTGTAAAGGACTTTTGTCAGGGAGGAAATCCCGCTGGTTAAT
ACCCGGCGGGGATGACAGTACCTGAAGAATAAGCACCGGCTAACTACGTGC
CAGCAGCCGCGGTAATACGTAGGGTGCGAGCGTTAATCGGAATTACTGGGC
GTAAAGCGTGCGCAGGCGGTTGTGCAAGTCTGATGTGAAAGCCCCGGGCTT
AACCTGGGAACGGCATTGGAGACTGCACAGCTAGAGTGCGTCAGAGGGGG
GTAGAATTCCACGTGTAGCAGTGAAATGCGTAGAGATGTGGAGGAATACCG
ATGGCGAAGGCAGCCCCCTGGGATGACACTGACGCTCATGCACGAAAGCGT
GGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGTC
AACTAGCTGTTGGGGGTTTGAATCCTTGGTAGCGTAGCTAACGCGTGAAGTT
GACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTGCTCTTGACATGTACGGAACTTGCCAGAGATGGCTTGGTGCCC
GAAAGGGAGCCGTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGT
GAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCATTAGTTGCCA
TCATTCAGTTGGGCACTCTAATGAGACTGCCGGTGACAAACCGGAGGAAGG

TGGGGATGACGTCAAGTCCTCATGGCCCTTATGAGCAGGGCTTCACACGTC
ATACAATGGTCGGTACAGAGGGTTGCCAAGCCGCGAGGTGGAGCTAATCTC
AGAAAACCGATCGTAGTCCGGATCGCACTCTGCAACTCGAGTGCGTGAAGT
CGGAATCGCTAGTAATCGCAGATCAGCATGCTGCGGTGAATGCGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGAAGTGAGTTTCACCAGAAGTG
GGTAGGCTAACCGCAAGGAGGCCGCTTACCACGGTGGGATTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Chromobacterium aquaticum - RL3

CGATTACGGGTACCTTGTTACGACTTCACCCCAGTCATGAATCCCACCGTGG
TAAGCGGCCTCCTTACGGTTAGCCTACCCACTTCTGGTGAAACTCACTCCCA
TGGTGTGACGGGCGGTGTGTACAAGACCCGGGAACGTATTCACCGCAGCAT
GCTGATCTGCGATTACTAGCGATTCCGACTTCACGCACTCGAGTTGCAGAGT
GCGATCCGGACTACGATCGGTTTTATGAGATTGGCTCCACCTCGCGGCTTCG
CGACCCTCTGTACCGACCATTGTATGACGTGTGAAGCCCTGGTCATAAGGGC
CATGAGGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTCC
CATTAGAGTGCCCAACTTAAGGATGGCAACTAATGGCAAGGGTTGCGCTCG
TTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAGCCATGCA
GCACCTGTGTTAACGCTCCCTTTCGGGCACTCCTCAATCTCTCAAGGATTCG
TTACATGTCAAGACCAGGTAAGGTTTTTCGCGTTGCATCGAATTAATCCACA
TCATCCACCGCTTGTGCGGGTCCCCGTCAATTCCTTTGAGTTTTAACCTTGCG
GCCGTACTCCCCAGGCGGTCAACTTCTCGCGTTAGCTACGCTACCAAGGATT
CAAACCCCCAACAGCTAGTTGACATCGTTTAGGGCGTGGACTACCAGGGCA
TCTAATCCTGTTTGCTCCCCACGCTTTCGTGCATGAGCGTCAGTGTCATCCCA
GGGGGCTGCCTTCGCCATCGGTATTCCTCCGCATCTCTACGCATTTCACTGC
TACACGCGGAATTCTACCCCCCTCTGACGCACTCTAGTCGTGCAGTCTCCAA
TGCCGTTCCCAGGTTGAGCCCGGGGCTTTCACATCAGACTTGCACAACCGCC
TGCGCACGCTTTACGCCCAGTAATTCCGATTAACGCTTGCACCCTACGTATT
ACCGCGGCTGCTGGCACGTAGTTAGCCGGTGCTTATTCTTCCGGTACTCTCA
GACCCAGCGGTTATTAACCACTAGGATTTGCTCCCGGACAAAAGTCCTTTAC
AACCCGAAGGCCTTCTTCAGACACGCGGCATGGCTGGATCAGGCTTGCGCC
CATTGTCCAAAATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGGCCGTGTCT
CAGTCCCAGTGTGGCGGATCATCCTCTCAGACCCGCTACTGATCGACGCCTT
GGTGAGCCTTTACCTCACCAACTAGCTAATCAGACATCGGCTGCTCGTATAA
CGTGAGGCCTTTCGATCCCCCACTTTCCCCCTCAGGGCGTATGCGGTATTAA
TCCGGCTTTCGCCGAGCTATCCCCCATTACACGGTACATTCCGATGCATTAC
TCACCCGTTCGCCACTCGTCAGCGGTGCAAGCACCCTGTTACCGTTCGACTT
GCATGTGTAAAGCATGCCGCCAGCGTTCAATCTGAGCCACGATCAAACTCT
AATCAC

Xanthomonas sp. - RL4

CGATTACGGGTACCTTGTTACGACTTCACCCCAGTCATCGGCCACACCGTGG
CAAGCGCCCTCCCGAAGGTTAAGCTACCTGCTTCTGGTGCAACAAACTCCCA
TGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGCAA
TGCTGATCTGCGATTACTAGCGATTCCGACTTCATGGAGTCGAGTTGCAGAC
TCCAATCCGGACTGAGATAGGGTTTCTGGGATTGGCTTACCGTCGCCGGCTT
GCAGCCCTCTGTCCCTACCATTGTAGTACGTGTGTAGCCCTGGCCGTAAGGG

CCATGATGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCGGTC
TCCTTAGAGTTCCCACCATTACGTGCTGGCAACTAAGGACAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAGCCATG
CAGCACCTGTGTTCGAGTTCCCGAAGGCACCAATCCATCTCTGGAAAGTTCT
CGACATGTCAAGGCCAGGTAAGGTTCTTCGCGTTGCATCGAATTAAACCAC
ATACTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGC
GACCGTACTCCCCAGGCGGCGAACTTAACGCGTTAGCTTCGATACTGCGTGC
CAAATTGCACCCAACATCCAGTTCGCATCGTTTAGGGCGTGGACTACCAGG
GTATCTAATCCTGTTTGCTCCCCACGCTTTCGTGCCTCAGTGTCAATGTTGGT
CCAGGTAGCTGCCTTCGCCATGGATGTTCCTCCTGATCTCTACGCATTTCACT
GCTACACCAGGAATTCCGCTACCCTCTACCACATTCTAGTCGCCCAGTATCC
ACTGCAGTTCCCAGGTTGAGCCCAGGGCTTTCACAACGGACTTAAACGACC
ACCTACGCACGCTTTACGCCCAGTAATTCCGAGTAACGCTTGCACCCTTCGT
ATTACCGCGGCTGCTGGCACGAAGTTAGCCGGTGCTTATTCTTTGGGTACCG
TCATCCCAACCGGGTATTAGCCAGCCGGATTTCTTTCCCAACAAAGGGCTT
TACAACCCGAAGGCCTTCTTCACCCACGCGGTATGGCTGGATCAGGCTTGCG
CCCATTGTCCAATATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGACCGTGT
CTCAGTTCCAGTGTGGCTGATCATCCTCTCAGACCAGCTACGGATCGTCGCC
TTGGTGGGCCTTTACCCCGCCAACTAGCTAATCCGACATCGGCTCATTCAAT
CGCGCAAGGCCCGAAGGTCCCCTGCTTTCACCCGTAGGTCGTATGCGGTATT
AGCGTAAGTTTCCCTACGTTATCCCCCACGAAAAAGTAGATTCCGATGTATT
CCTCACCCGTCCGCCACTCGCCACCCAGAGAGCAAGCTCTCCTGTGCTGCCG
TTCGACTTGCATGTGTTAGGCCTACCGCCAGCGTTCACTCTGAGCCACGATC
AAACTCTAATCAC

Xanthomonas sp. - RL5

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
CATGCAAGTCGAACGGCAGCACAGGAGAGCTTGCTCTCTGGGTGGCGAGTG
GCGGACGGGTGAGGAATACATCGGAATCTACTTTTTCGTGGGGGATAACGT
AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCCAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTGG
CTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACTT
CGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTAC
TGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCTG
GGCTCAACCTGGGAACTGCAGTGGATACTGGGCGACTAGAATGTGGTAGAG
GGTAGCGGAATTCCTGGTGTAGCAGTGAAATGCGTAGAGATCAGGAGGAAC
ATCCATGGCGAAGGCAGCTACCTGGACCAACATTGACACTGAGGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGA
TGCGAACTGGATGTTGGGTGCAATTTGGCACGCAGTATCGAAGCTAACGCG
TTAAGTTCGCCGCCTGGGGAGTACGGTCGCAAGACTGAAACTCAAAGGAAT
TGACGGGGGCCCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACG
CGAAGAACCTTACCTGGCCTTGACATGTCGAGAACTTTCCAGAGATGGATT
GGTGCCTTCGGGAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGT

TGCCAGCACGTAATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTAC
ACACGTACTACAATGGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAG
CCAATCCCAGAAACCCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATTC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACC
AGAAGCAGGTAGCTTAACCTTCGGGAGGGCGCTTGCCACGGTGTGGCCGAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Escherichia coli - RL6

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAACGGTAACAGGAAGAAGCTTGCTTCTTTGCTGACGAGTG
GCGGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTA
CTGGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGAGGGGGA
CCTTCGGGCCTCTTGCCATCGGATGTGCCCAGATGGGATTAGCTAGTAGGTG
GGGTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACC
AGCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTG
GGGAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTATG
AAGAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGGAGTAAA
GTTAATACCTTTGCTCATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTC
CGTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAACCGGAATTAC
TGGGCGTAAAGCGCACGCAGGCGGTTTGTTAAGTCAGATGTGAAATCCCCG
GGCTCAACCTGGGAACTGCATCTGATACTGGCAAGCTTGAGTCTCGTAGAG
GGGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAAT
ACCGGTGGCGAAGGCGGCCCCCTGGACGAAGACTGACGCTCAGGTGCGAA
AGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACG
ATGTCGACTTGGAGGTTGTGCCCTTGAGGCGTGGCTTCCGGAGCTAACGCGT
TAAGTCGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGAATT
GACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGC
GAAGAACCTTACCTGGTCTTGACATCCACGGAAGTTTTCAGAGATGAGAAT
GTGCCTTCGGGAACCGTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGT
TGTGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTG
CCAGCGGTCCGGCCGGGAACTCAAAGGAGACTGCCAGTGATAAACTGGAG
GAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGACCAGGGCTACAC
ACGTGCTACAATGGCGCATACAAAGAGAAGCGACCTCGCGAGAGCAAGCG
GACCTCATAAAGTGCGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCAT
GAAGTCGGAATCGCTAGTAATCGTGGATCAGAATGCCACGGTGAATACGTT
CCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAAAG
AAGTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATGAC
TGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Bacillus arsenicus - RL7

CGATTAGAGTTTGATCGTGGCTCAGGATGAACGCTGGCGGCGTGCCTAATA
CATGCAAGTCGAGCGAATGATGAGGAGCTTGCTCCTCTGATTTAGCGGCGG
ACGGGTGAGTAACACGTGGGTAATCTGCCTGTAAGACGGGGATAACTCCGG
GAAACCGGGGCTAATACCGGATAATAAGAGAAGAAGCATTTCTTCTTTTTG
AAAGTCGGTTTCGGCTGACACTTACAGATGAGCCCGCGGCGCATTAGCTAG

TTGGTGAGGTAACGGCTCACCAAGGCGACGATGCGTAGCCGACCTGAGAGG
GTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCA
GCAGTAGGGAATCTTCGGCAATGGGCGAAAGCCTGACCGAGCAACGCCGCG
TGAGCGATGAAGGCCTTCGGGTCGTAAAGCTCTGTTGTTAGAGAAGAACAA
GTACGAGAGTAACTGCTCGTACCTTGACGGTACCTAACCAGAAAGCCACGG
CTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGTGGCAAGCGTTATCCG
GAATTATTGGGCGTAAAGCGCGCGCAGGCGGTCTCTTAAGTCTGATGTGAA
AGCCCACGGCTCAACCGTGGAGGGTCATTGGAAACTGGGAGACTTGAGTGC
AGGAGAGAAAAGTGGAATTCCACGTGTAGCGGTGAAATGCGTAGAGATGT
GGAGGAACACCAGTGGCGAAGGCGGCTTTTTGGCCTGTAACTGACGCTGAG
GCGCGAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCC
GTAAACGATGAGTGCTAGGTGTTGGGGGGTTCCACCCTCAGTGCTGAAGTT
AACACATTAAGCACTCCGCCTGGGGAGTACGACCGCAAGGTTGAAACTCAA
AGGAATTGACGGGGGCCCGCACAAGCAGTGGAGCATGTGGTTTAATTCGAA
GCAACGCGAAGAACCTTACCAGGTCTTGACATCCTTTGACCACTCTAGAGAT
AGAGCTTTCCCCTTCGGGGGACAAAGTGACAGGTGGTGCATGGTTGTCGTC
AGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTG
ACCTTAGTTGCCAGCATTCAGTTGGGCACTCTAAGGTGACTGCCGGTGACAA
ACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATGACCTGG
GCTACACACGTGCTACAATGGACGATACAAAGGGTTGCGAAGCCGCGAGGC
CAAGCCAATCCCAAAAAGTCATTCTCAGTTCGGATTGTAGGCTGCAACTCGC
CTACATGAAGCCGGAATTGCTAGTAATCGCGGATCAGCATGCCGCGGTGAA
TACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCACGAGAGTTTGTAAC
ACCCGAAGTCGGTGGGGTAACCCTTTTGGGAGCCAGCCGCCGAAGGTGGGA
CAGATGATTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Pseudomonas geniculata - RL8

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
CATGCAAGTCGAACGGCAGCACAGAGGAGCTTGCTCCTTGGGTGGCGAGTG
GCGGACGGGTGAGGAATACATCGGAATCTACTTTTTCGTGGGGGATAACGT
AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCCAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTGG
CTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACTT
CGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTAC
TGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCTG
GGCTCAACCTGGGAACTGCAGTGGATACTGGGCGACTAGAGTGTGGTAGAG
GGTAGCGGAATTCCTGGTGTAGCAGTGAAATGCGTAGAGATCAGGAGGAAC
ATCCATGGCGAAGGCAGCTACCTGGACCAACACTGACACTGAGGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCATGGCGA
AGGCAGCTACCTGGACCAACACTGACACTGAGGCACGAAAGCGTGGGGAG
CAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGCGAACTGG
ATGTTGGGTGCAATTTGGCACGCAGTATCGAAGCTAACGCGTTAAGTTCGCC
GCCTGGGGAGTACGGTCGCAAGACTGAAACTCAAAGGAATTGACGGGGGC
CCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACGCGAAGAACCT

TACCTGGCCTTGACATGTCGAGAACTTTCCAGAGATGGATTGGTGCCTTCGG
GAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATG
TTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGTTGCCAGCACGT
AATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGGAGGAAGGTGG
GGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTACACACGTACTACAAT
GGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAGCCAATCCCAGAAAC
CCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCCATGAAGTCGGAATC
GCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATACGTTCCCGGGCCTTGT
ACACACCGCCCGTCACACCATGGGAGTTTGTTGCACCAGAAGCAGGTAGCT
TAACCTTCGGGAGGGCGCTTGCCACGGTGTGGCCGATGACTGGGGTGAAGT
CGTAACAAGGTACCCGTAATCAC

Stenotrophomonas maltophilia - RL9

CGATTACGGGTACCTTGTTACGACTTCACCCCAGTCATCGGCCACACCGTGG
CAAGCGCCCTCCCGAAGGTTAAGCTACCTGCTTCTGGTGCAACAAACTCCCA
TGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGCAA
TGCTGATCTGCGATTACTAGCGATTCCGACTTCATGGAGTCGAGTTGCAGAC
TCCAATCCGGACTGAGATAGGGTTTCTGGGATTGGCTTACCGTCGCCGGCTTGC
AGCCCTCTGTCCCTACCATTGTAGTACGTGTGTAGCCCTGGCCGTAAGGGCC
ATGATGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCGGTCTC
CTTAGAGTTCCCACCATTACGTGCTGGCAACTAAGGACAAGGGTTGCGCTCGTTG
CGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAGCCATGCAGCA
CCTGTGTTCGAGTTCCCGAAGGCACCAATCCATCTCTGGAAAGTTCTCGACA
TGTCAAGGCCAGGTAAGGTTCTTCGCGTTGCATCGAATTAAACCACATACTC
CACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGCGACCG
TACTCCCCAGGCGGCGAACTTAACGCGTTAGCTTCGATACTGCGTGCCAAAT
TGCACCCAACATCCAGTTCGCATCGTTTAGGGCGTGGACTACCAGGGTATCT
AATCCTGTTTGCTCCCCACGCTTTCGTGCCTCAGTGTCAATGTTGGTCCAGGT
AGCTGCCTTCGCCATGGATGTTCCTCCTGATCTCTACGCATTTCACTGCTACA
CCAGGAATTCCGCTACCCTCTACCACACTCTAGTCGCCCAGTATCCACTGCA
GTTCCCAGGTTGAGCCCAGGGCTTTCACAACGGACTTAAACGACCACCTAC
GCACGCTTTACGCCCAGTAATTCCGAGTAACGCTTGCACCCTTCGTATTACC
GCGGCTGCTGGCACGAAGTTAGCCTGTGCTTATTCTTTGGGTACCGTCATCCCAAC
CGGGTATTAGCCAGCTGGATTTCTTTCCCAACAAAAGGGCTTTACAACCCGA
AGGCCTTCTTCACCCACGCGGTATGGCTGGATCAGGCTTGCGCCCATTGTCC
AATATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGACCGTGTCTCAGTTCCA
GTGTGGCTGATCATCCTCTCAGACCAGCTACGGATCGTCGCCTTGGTGGGCC
TTTACCCCGCCAACTAGCTAATCCGACATCGGCTCATTCAATCGCGCAAGGC
CCGAAGGTCCCCTGCTTTCACCCGTAGGTCGTATGCGGTATTAGCGTAAGTT
TCCCTACGTTATCCCCCACGAAAAAGTAGATTCCGATGTATTCCTCACCCGT
CCGCCACTCGCCACCCAAGGAGCAAGCTCCTCTGTGCTGCCGTTCGACTTGC
ATGTGTTAGGCCTACCGCCAGCGTTCACTCTGAGCCACGATCAAACTCTAAT
CAC

Enterobacter asburiae - RL10

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAGCGGTAACACAGGGAGCTTGCTCCTGGGTGACGAGCGGC

GGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTACT
GGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGAGGGGGACC
TTCGGGCCTCTTGCCATCAGATGTGCCCAGATGGGATTAGCTAGTAGGTGGG
GTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACCAG
CCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGGG
GAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTATGAA
GAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGTGTTGAGGT
TAATAACCTCAGCAATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTCC
GTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAATTACT
GGGCGTAAAGCGCACGCAGGCGGTCTGTCAAGTCGGATGTGAAATCCCCGG
GCTCAACCTGGGAACTGCATTCGAAACTGGCAGGCTAGAGTCTTGTAGAGG
GGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAATA
CCGGTGGCGAAGGCGGCCCCCTGGACAAAGACTGACGCTCAGGTGCGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGA
TGTCGACTTGGAGGTTGTGCCCTTGAGGCGTGGCTTCCGGAGCTAACGCGTT
AAGTCGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGAATTG
ACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGCG
AAGAACCTTACCTACTCTTGACATCCAGAGAACTTTCCAGAGATGGATTGGT
GCCTTCGGGAACTCTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTTG
TGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTGCC
AGCGGTTAGGCCGGGAACTCAAAGGAGACTGCCAGTGATAAACTGGAGGA
AGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGAGTAGGGCTACACAC
GTGCTACAATGGCGCATACAAAGAGAAGCGACCTCGCGAGAGCAAGCGGA
CCTCATAAAGTGCGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCATGA
AGTCGGAATCGCTAGTAATCGTAGATCAGAATGCTACGGTGAATACGTTCC
CGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAAAGAA
GTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATGACTG
GGGTGAAGTCGTAACAAGGTACCCGTAATCACCGATTAGAGTTTGATCGTG
GCTCAGATTGAACGCTGGCGGCAGGCCTAACACATGCAAGTCGGACGGTAG
CACAGAGGAGCTTGCTCCTCGGGTGACGAGTGGCGGACGGGTGAGTAATGT
CTGGGAAACTGCCCGATGGAGGGGGATAACTACTGGAAACGGTAGCTAATA
CCGCATAACGTCGCAAGACCAAAGTGGGGGACCTTCGGGCCTCACACCATC
GGATGTGCCCAGATGGGATTAGCTTGTAGGCGGGGTAACGGCCCACCTAGG
CGACGATCCCTAGCTGGTCTGAGAGGATGACCAGCCACACTGGAACTGAGA
CACGGTCCAGACTCCTACGGGAGGCAGCAGTGGGGAATATTGCACAATGGG
CGCAAGCCTGATGCAGCCATGCCGCGTGTATGAAGAAGGCCTTCGGGTTGT
AAAGTACTTTCAGCGGGGAGGAAGGTGGTGAGGTTAATAACCTCATCAATT
GACGTTACCCGCAGAAGAAGCACCGGCTAACTCCGTGCCAGCAGCCGCGGT
AATACGGAGGGTGCAAGCGTTAATCGGAATTACTGGGCGTAAAGCGCACGC
AGGCGGTCTGTTAAGTCAGATGTGAAATCCCCGGGCTTAACCTGGGAACTG
CATTTGAAACTGGCAGGCTTGAGTCTCGTAGAGGGGGGTAGAATTCCAGGT
GTAGCGGTGAAATGCGTAGAGATCTGGAGGAATACCGGTGGCGAAGGCGG
CCCCCTGGACGAAGACTGACGCTCAGGTGCGAAAGCGTGGGGAGCAAACA
GGATTAGATACCCTGGTAGTCCACGCCGTAAACGATGTCGACTTGGAGGTT
GTTCCCTTGAGGAGTGGCTTCCGGAGCTAACGCGTTAAGTCGACCGCCTGG
GGAGTACGGCCGCAAGGTTAAAACTCAAATGAATTGACGGGGGCCCGCACA
AGCGGTGGAGCATGTGGTTTAATTCGATGCAACGCGAAGAACCTTACCTAC
TCTTGACATCCAGCGAACTTGGCAGAGATGCCCTGGTGCCTTCGGGAACGCT
GAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTTGTGAAATGTTGGGTTA

AGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTGCCAGCGATTCGGTCGGG
AACTCAAAGGAGACTGCCGGTGATAAACCGGAGGAAGGTGGGGATGACGT
CAAGTCATCATGGCCCTTACGAGTAGGGCTACACACGTGCTACAATGGCGC
ATACAAAGAGAAGCGACCTCGCGAGAGCAAGCGGACCTCATAAAGTGCGT
CGTAGTCCGGATCGGAGTCTGCAACTCGACTCCGTGAAGTCGGAATCGCTA
GTAATCGTGGATCAGAATGCCACGGTGAATACGTTCCCGGGCCTTGTACAC
ACCGCCCGTCACACCATGGGAGTGGGTTGCAAAGGAAGTAGGTAGCTTAAC
CCCCGGGAGGGCGCTTACCACTTTGTGATTCATGACTGGGGTGAAGTCGTA
ACAAGGTACCCGTAATCAC

Sequencing result for respectable bands (5' - 3') from coagulated water: -

Mycobacterium mucogenisum - CL1

CGATTAGAGTTTGATCGTGGCTCAGGACGAACGCTGGCGGCGTGCTTAACA
CATGCAAGTCGAACGGAAAGGCCCTTCGGGGTACTCGAGTGGCGAACGGGT
GAGTAACACGTGGGTGATCTGCCCTGCACTTTGGGATAAGCCTGGGAAACT
GGGTCTAATACCGAATAGGACCACGCGCTTCATGGTGTGTGGTGGAAAGCT
TTTGCGGTGTGGGATGGGCCCGCGGCCTATCAGCTTGTTGGTGGGGTAATGG
CCTACCAAGGCGACGACGGGTAGCCGGCCTGAGAGGGTGACCGGCCACACT
GGGACTGAGATACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAATATT
GCACAATGGGCGCAAGCCTGATGCAGCGACGCCGCGTGAGGGATGACGGC
CTTCGGGTTGTAAACCTCTTTCACCAGGGACGAAGCGTAAGTGACGGTACCT
GGAGAAGAAGCACCGGCCAACTACGTGCCAGCAGCCGCGGTAATACGTAG
GGTGCGAGCGTTGTCCGGAATTACTGGGCGTAAAGAGCTCGTAGGTGGTTT
GTCGCGTTGTTCGTGAAAACTCACAGCTTAACTGTGGGCGTGCGGGCGATA
CGGGCAGACTAGAGTACTGCAGGGGAGACTGGAATTCCTGGTGTAGCGGTG
GAATGCGCAGATATCAGGAGGAACACCGGTGGCGAAGGCGGGTCTCTGGG
CAGTAACTGACGCTGAGGAGCGAAAGCGTGGGGAGCGAACAGGATTAGAT
ACCCTGGTAGTCCACGCCGTAAACGGTGGGTACTAGGTGTGGGTTCCTTCCT
TGGGATCCGTGCCGTAGCTAACGCATTAAGTACCCCGCCTGGGGAGTACGG
CCGCAAGGCTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGCGG
AGCATGTGGATTAATTCGATGCAACGCGAAGAACCTTACCTGGGTTTGGCA
TGCACAGGACGCCGGCAGAGATGTCGGTTCCCTTGTGGCCTGTGTGCAGGT
GGTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCA
ACGAGCGCAACCCTTGTCCTATGTTGCCAGCGGGTTATGCCGGGGACTCGTA
GGAGACTGCCGGGGTCAACTCGGAGGAAGGTGGGGATGACGTCAAGTCATC
ATGCCCCTTATGTCCAGGGCTTCACACATGCTACAATGGCCGGTACAAAGG
GCTGCGATGCCGTGAGGTGGAGCGAATCCTTTCAAAGCCGGTCTCAGTTCG
GATCGGGGTCTGCAACTCGACCCCGTGAAGTCGGAGTCGCTAGTAATCGCA
GATCAGCAACGCTGCGGTGAATACGTTCCCGGGCCTTGTACACACCGCCCG
TCACGTCATGAAAGTCGGTAACACCCGAAGCCGGTGGCCTAACCCTTGTGG
AGGGAGCCGTCGAAGGTGGGATCGGCGATTGGGACGAAGTCGTAACAAGG
TACCCGTAATCACT

Escherichia coli - CL2

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAACGGTAACAGGAAGAAGCTTGCTTCTTTGCTGACGAGTG

GCGGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTA
CTGGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGAGGGGGA
CCTTCGGGCCTCTTGCCATCGGATGTGCCCAGATGGGATTAGCTAGTAGGTG
GGGTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACC
AGCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTG
GGGAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTATG
AAGAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGGAGTAAA
GTTAATACCTTTGCTCATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTC
CGTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAATTAC
TGGGCGTAAAGCGCACGCAGGCGGTTTGTTAAGTCAGATGTGAAATCCCCG
GGCTCAACCTGGGAACTGCATCTGATACTGGCAAGCTTGAGTCTCGTAGAG
GGGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAAT
ACCGGTGGCGAAGGCGGCCCCCTGGACGAAGACTGACGCTCAGGTGCGAA
AGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACG
ATGTCGACTTGGAGGTTGTGCCCTTGAGGCGTGGCTTCCGGAGCTAACGCGT
TAAGTCGACCGCCTGGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGAAT
TGACGGGGGCCCGCACAAGCGGTGGGAGCATGTGGTTTAATTCGATGCAAC
GCGAAGAACCTTACCTGGTCTTGACATCCACGGAAGTTTTCAGAGATGAGA
ATGTGCCTTCGGGAACCGTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTTGTGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGT
TGCCAGCGGTCCGGCCGGGAACTCAAAGGAGACTGCCAGTGATAAACTGGA
GGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGACCAGGGCTACA
CACGTGCTACAATGGCGCATACAAAGAGAAGCGACCTCGCGAGAGCAAGC
GGACCTCATAAAGTGCGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGTGGATCAGAATGCCACGGTGAATACG
TTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAA
AGAAGTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATG
ACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Chromobacterium violaceum - CL3

CGATTACGGGTACCTTGTTACGACTTCACCCCAGTCATGAATCCCACCGTGG
TAAGCGGCCTCCTTACGGTTAGCCTACCCACTTCTGGTGAAACTCACTCCCA
TGGTGTGACGGGCGGTGTGTACAAGACCCGGGAACGTATTCACCGCAGCAT
GCTGATCTGCGATTACTAGCGATTCCGACTTCACGCACTCGAGTTGCAGAGT
GCGATCCGGACTACGATCGGTTTTCTGAGATTAGCTCCACCTCGCGGCTTGG
CAACCCTCTGTACCGACCATTGTATGACGTGTGAAGCCCTGCTCATAAGGGC
CATGAGGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTCT
CATTAGAGTGCCCAACTTAATGATGGCAACTAATGACAAGGGTTGCGCTCG
TTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAGCCATGCA
GCACCTGTGTTACGGCTCCCTTTCGGGCACCAAGCTATCTCTAGCAAGTTCC
GTACATGTCAAGAGCAGGTAAGGTTTTTCGCGTTGCATCGAATTAATCCACA
TCATCCACCGCTTGTGCGGGTCCCCGTCAATTCCTTTGAGTTTTAACCTTGCG
GCCGTACTCCCCAGGCGGTCAACTTCACGCGTTAGCTACGCTACCAAGGATT
CAAACCCCCAACAGCTAGTTGACATCGTTTAGGGCGTGGACTACCAGGGTA
TCTAATCCTGTTTGCTCCCCACGCTTTCGTGCATGAGCGTCAGTGTCATCCCA
GGGGGCTGCCTTCGCCATCGGTATTCCTCCACATCTCTACGCATTTCACTGC
TACACGTGGAATTCTACCCCCCTCTGACGCACTCTAGTCGTGCAGTCTCCAA
TGCCGTTCCCAGGTTGAGCCCGGGGCTTTCACATCGGACTTGCACAACCGCC

TGCGCACGCTTTACGCCCAGTAATTCCGATTAACGCTTGCACCCTACGTATT
ACCGCGGCTGCTGGCACGTAGTTAGCCGGTGCTTATTCTTCCGGTACTGTCA
TCCCCGCCAGGTATTAACCAGCGGGATTTCCTCCCGAACAAAAGTCCTTTAC
AACCCGAAGGCCTTCTTCAGACACGCGGCATGGCTGGATCAGGCTTGCGCC
CATTGTCCAAAATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGGCCGTGTCT
CAGTCCCAGTGTGGCGGATCATCCTCTCAGACCCGCTACTGATCGTCGCCTT
GGTGAGCTCTTACCTCACCAACTAGCTAATCAGACGTCGGCTGCTCGTATAA
CGTGAGGCCTTACGGTCCCCCACTTTCCCCCTCAGGGCGTATGCGGTATTAA
TCCGGCTTTCGCCGAGCTATCCCCCATTACACGGTACATTCCGACGCATTAC
TCACCCGTTCGCCACTCGTCAGCGGTGCAAGCACCCTGTTACCGTTCGACTT
GCATGTGTAAAGCATGCCGCCAGCGTTCAATCTGAGCCACGATCAAACTCT
AATCAC

Chromobacterium sp. - CL4

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCTTTACAC
ATGCAAGTCGAACGGTAACAGGGTGCTTGCACCGCTGACGAGTGGCGAACG
GGTGAGTAATGCATCGGAATGTACCGTGTAATGGGGGATAGCTCGGCGAAA
GCCGGATTAATACCGCATACGCCCTGAGGGGGAAAGTGGGGGACCGTAAG
GCCTCACGTTATACGAGCAGCCGATGTCTGATTAGCTAGTTGGTGGGGTAA
AGGCTCACCAAGGCTTCGATCAGTAGCGGGTCTGAGAGGATGATCCGCCAC
ACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAA
TTTTGGACAATGGGCGCAAGCCTGATCCAGCCATGCCGCGTGTCTGAAGAA
GGCCTTCGGGTTGTAAAGGACTTTTGTCCGGGAGCAAATCCCAGTGGTTAAT
ACCTACTGGGGCTGAGAGTACCGGAAGAATAAGCACCGGCTAACTACGTGC
CAGCAGCCGCGGTAATACGTAGGGTGCAAGCGTTAATCGGAATTACTGGGC
GTAAAGCGTGCGCAGGCGGTTGTGCAAGTCTGATGTGAAAGCCCCGGGCTT
AACCTGGGAACGGCATTGGAGACTGCACGACTAGAGTGCGTCAGAGGGGG
GTAGAATTCCGCGTGTAGCAGTGAAATGCGTAGAGATGCGGAGGAATACCG
ATGGCGAAGGCAGCCCCCTGGGATGACACTGACGCTCATGCACGAAAGCGT
GGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGTC
AACTAGCTGTTGGGGGTTTGAATCCTTGGTAGCGAAGCTAACGCGAGAAGT
TGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTGGTCTTGACATGTAACGAACGCTGCAGAGATGTGGCGGTGCC
CGAAAGGGAGCGTTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCG
TGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGCCATTAGTTGCC
ATCATTAAGTTGGGCACTCTAATGGGACTGCCGGTGACAAACCGGAGGAAG
GTGGGGATGACGTCAAGTCCTCATGGCCCTTATGACCAGGGCTTCACACGTC
ATACAATGGTCGGTACAGAGGGTCGCGAAGCCGCGAGGTGGAGCCAATCTC
ATAAAACCGATCGTAGTCCGGATCGCACTCTGCAACTCGAGTGCGTGAAGT
CGGAATCGCTAGTAATCGCAGATCAGCATGCTGCGGTGAATACGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGGAGTGAGTTTCACCAGAAGTG
GGTAGGCTAACCGTAAGGAGGCCGCTTACCACGGTGGGATTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Bacillus cereus - CL5

CGATTAGAGTTTGATCGTGGCTCAGGATGAACGCTGGCGGCGTGCCTAATA
CATGCAAGTCGAGCGAATGGATTAAGAGCTTGCTCTTATGAAGTTAGCGGC
GGACGGGTGAGTAACACGTGGGTAACCTGCCCATAAGACTGGGATAACTCC
GGGAAACCGGGGCTAATACCGGATAACATTTTGAACCGCATGGTTCGAAAT
TGAAAGGCGGCTTCGGCTGTCACTTATGGATGGACCCGCGTCGCATTAGCTA
GTTGGTGAGGTAACGGCTCACCAAGGCAACGATGCGTAGCCGACCTGAGAG
GGTGATCGGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGC
AGCAGTAGGGAATCTTCCGCAATGGACGAAAGTCTGACGGAGCAACGCCGC
GTGAGTGATGAAGGCTTTCGGGTCGTAAAACTCTGTTGTTAGGGAAGAACA
AGTGCTAGTTGAATAAGCTGGCACCTTGACGGTACCTAACCAGAAAGCCAC
GGCTAACTACGTGCCAGCAGCCGCGGTAATACGTAGGTGGCAAGCGTTATC
CGGAATTATTGGGCGTAAAGCGCGCGCAGGTGGTTTCTTAAGTCTGATGTG
AAAGCCCACGGCTCAACCGTGGAGGGTCATTGGAAACTGGGAGACTTGAGT
GCAGAAGAGGAAAGTGGAATTCCATGTGTAGCGGTGAAATGCGTAGAGAT
ATGGAGGAACACCAGTGGCGAAGGCGACTTTCTGGTCTGTAACTGACACTG
AGGCGCGAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCAC
GCCGTAAACGATGAGTGCTAAGTGTTAGAGGGTTTCCGCCCTTTAGTGCTGA
AGTTAACGCATTAAGCACTCCGCCTGGGGAGTACGGCCGCAAGGCTGAAAC
TCAAAGGAATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATT
CGAAGCAACGCGAAGAACCTTACCAGGTCTTGACATCCTCTGACAACCCTA
GAGATAGGGCTTCTCCTTCGGGAGCAGAGTGACAGGTGGTGCATGGTTGTC
GTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCC
TTGATCTTAGTTGCCATCATTAAGTTGGGCACTCTAAGGTGACTGCCGGTGA
CAAACCGGAGGAAGGTGGGGATGACGTCAAATCATCATGCCCCTTATGACC
TGGGCTACACACGTGCTACAATGGACGGTACAAAGAGCTGCAAGACCGCGA
GGTGGAGCTAATCTCATAAAACCGTTCTCAGTTCGGATTGTAGGCTGCAACT
CGCCTACATGAAGCTGGAATCGCTAGTAATCGCAGATCAGCATGCCGCGGT
GAATACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCACGAGAGTTTGT
AACACCCGAAGTCGGTGGGGTAACCTTTTGGAGCCAGCCGCCTAAGGTGGG
ACAGATGATTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Pandoraea sp. - CL6

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCCTTACAC
ATGCAAGTCGAACGGCAGCACGGGTGCTTGCACCTGGTGGCGAGTGGCGAA
CGGGTGAGTAATACATCGGAACGTACCTTGTAGTGGGGGATAGCTCGGCGA
AAGCCGGATTAATACCGCATACGCTCTGAGGAGGAAAGCGGGGGACCTTCG
GGCCTCGCGCTACAAGAGCGGCCGATGTCAGATTAGCTAGTTGGTGGGGTA
AAAGCTCACCAAGGCGACGATCTGTAGCTGGTCTGAGAGGACGACCAGCCA
CACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGA
ATTTTGGACAATGGGCGAAAGCCTGATCCAGCAATGCCGCGTGTGTGAAGA
AGGCCTTCGGGTTGTAAAGCACTTTTGTCCGGAAAGAAATCCTCTGGGTTAA
TACCTCGGGGGGATGACGGTACCGGAAGAATAAGCACCGGCTAACTACGTG
CCAGCAGCCGCGGTAATACGTAGGGTGCAAGCGTTAATCGGAATTACTGGG
CGTAAAGCGTGCGCAGGCGGTTTCGTAAGACGGATGTGAAATCCCCGGGCT
TAACCTGGGAACTGCATTCGTGACTGCAAGGCTAGAGTATGGCAGAGGGGG
GTAGAATTCCACGTGTAGCAGTGAAATGCGTAGAGATGTGGAGGAATACCG

ATGGCGAAGGCAGCCCCCTGGGCCAATACTGACGCTCATGCACGAAAGCGT
GGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGTC
AACTAGTTGTTGGGGATTCATTTCCTTAGTAACGTAGCTAACGCGTGAAGTT
GACCGCCTGGGGAGTACGGTCGCAAGATTAAAACTAAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTACCCTTGACATGTACGGAATCCTGCTGAGAGGTGGGAGTGCTC
GAAAGAGAACCGTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGT
GAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGTTGCTA
CGCAAGAGCACTCTAAGGAGACTGCCGGTGACAAACCGGAGGAAGGTGGG
GATGACGTCAAGTCCTCATGGCCCTTATGGGTAGGGCTTCACACGTCATACA
ATGGTCGGTACAGAGGGCTGCCAAACCGCGAGGTGGAGCTAACCCCAGAA
AACCGATCGTAGTCCGGATCGCAGTCTGCAACTCGACTGCGTGAAGCTGGA
ATCGCTAGTAATCGCGGATCAGCATGTCGCGGTGAATACGTTCCCGGGTCTT
GTACACACCGCCCGTCACACCATGGGAGTGGGTTTTGCCAGAAGTAGGTAG
CCTAACCGCAAGGAGGGCGCTTACCACGGCAGGATTCATGACTGGGGTGAA
GTCGTAACAAGGTACCCGTAATCAC

Acinetobacter baumannii - CL7

TCGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCTTAAC
ACATGCAAGTCGAGCGGGGGAAGGTAGCTTGCTACCGGACCTAGCGGCGGA
CGGGTGAGTAATGCTTAGGAATCTGCCTATTAGTGGGGGACAACATCTCGA
AAGGGATGCTAATACCGCATACGTCCTACGGGAGAAAGCAGGGGATCTTCG
GACCTTGCGCTAATAGATGAGCCTAAGTCGGATTAGCTAGTTGGTGGGGTA
AAGGCCTACCAAGGCGACGATCTGTAGCGGGTCTGAGAGGATGATCCGCCA
CACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGA
ATATTGGACAATGGGGGGAACCCTGATCCAGCCATGCCGCGTGTGTGAAGA
AGGCCTTATGGTTGTAAAGCACTTTAAGCGAGGAGGAGGCTACTTTAGTTA
ATACCTAGAGATAGTGGACGTTACTCGCAGAATAAGCACCGGCTAACTCTG
TGCCAGCAGCCGCGGTAATACAGAGGGTGCGAGCGTTAATCGGATTTACTG
GGCGTAAAGCGTGCGTAGGCGGCTTATTAAGTCGGATGTGAAATCCCCGAG
CTTAACTTGGGAATTGCATTCGATACTGGTGAGCTAGAGTATGGGAGAGGA
TGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAATAC
CGATGGCGAAGGCAGCCATCTGGCCTAATACTGACGCTGAGGTACGAAAGC
ATGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCATGCCGTAAACGATG
TCTACTAGCCGTTGGGGCCTTTGAGGCTTTAGTGGCGCAGCTAACGCGATAA
GTAGACCGCCTGGGGAGTACGGTCGCAAGACTAAAACTCAAATGAATTGAC
GGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGCGAA
GAACCTTACCTGGCCTTGACATACTAGAAACTTTCCAGAGATGGATTGGTGC
CTTCGGGAATCTAGATACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGTG
AGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTTTCCTTACTTGCCAG
CATTTCGGATGGGAACTTTAAGGATACTGCCAGTGACAAACTGGAGGAAGG
CGGGGACGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTACACACGTG
CTACAATGGTCGGTACAAAGGGTTGCTACACAGCGATGTGATGCTAATCTC
AAAAAGCCGATCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCATGAAGT
CGGAATCGCTAGTAATCGCGGATCAGAATGCCGCGGTGAATACGTTCCCGG
GCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACCAGAAGTA
GCTAGCCTAACTGCAAAGAGGGCGGTTACCACGGTGTGGCCGATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Klebsiella pneumoniae - CL8

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAGCGGTAGCACAGAGAGCTTGCTCTCGGGTGACGAGCGGC
GGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTACT
GGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGTGGGGGACCT
TCGGGCCTCATGCCATCAGATGTGCCCAGATGGGATTAGCTAGTAGGTGGG
GTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACCAG
CCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGGG
GAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTATGAA
GAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGCGATAAGGT
TAATAACCTTGTCGATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTCC
GTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAATTACT
GGGCGTAAAGCGCACGCAGGCGGTCTGTCAAGTCGGATGTGAAATCCCCGG
GCTCAACCTGGGAACTGCATTCGAAACTGGCAGGCTAGAGTCTTGTAGAGG
GGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAATA
CCGGTGGCGAAGGCGGCCCCCTGAACAAAGACTGACGCTCAGGTGCGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACGA
TGTCGATTTGGAGGTTGTGCCCTTGAGGCGTGGCTTCCGGAGCTAACGCGTT
AAATCGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGAATTG
ACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGCG
AAGAACCTTACCTGGTCTTGACATCCACAGAACTTAGCAGAGATGCTTTGGT
GCCTTCGGGAACTGTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTTG
TGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTGCC
AGCGGTTCGGCCGGGAACTCAAAGGAGACTGCCAGTGATAAACTGGAGGA
AGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGACCAGGGCTACACAC
GTGCTACAATGGCATATACAAAGAGAAGCGACCTCGCGAGAGCAAGCGGA
CCTCATAAAGTATGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCATGA
AGTCGGAATCGCTAGTAATCGTAGATCAGAATGCTACGGTGAATACGTTCC
CGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAAAGAA
GTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATGACTG
GGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Xanthomonas sp. - CL9

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
CATGCAAGTCGAACGGCAGCACAGGAGAGCTTGCTCTCTGGGTGGCGAGTG
GCGGACGGGTGAGGAATACATCGGAATCTACTTTTTCGTGGGGGATAACGT
AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCCAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTGG
CTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACTT
CGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTAC
TGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCTG
GGCTCAACCTGGGAACTGCAGTGGATACTGGGCGACTAGAATGTGGTAGAG
GGTAGCGGAATTCCTGGTGTAGCAGTGAAATGCGTAGAGATCAGGAGGAAC

ATCCATGGCGAAGGCAGCTACCTGGACCAACATTGACACTGAGGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGA
TGCGAACTGGATGTTGGGTGCAATTTGGCACGCAGTATCGAAGCTAACGCG
TTAAGTTCGCCGCCTGGGGAGTACGGTCGCAAGACTGAAACTCAAAGGAAT
TGACGGGGGCCCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACG
CGAAGAACCTTACCTGGCCTTGACATGTCGAGAACTTTCCAGAGATGGATT
GGTGCCTTCGGGAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGT
TGCCAGCACGTAATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTAC
ACACGTACTACAATGGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAG
CCAATCCCAGAAACCCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATAC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACC
AGAAGCAGGTAGCTTAACCTTCGGGAGGGCGCTTGCCACGGTGTGGCCGAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Pantoea ananatis - CL10

TCGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAAC
ACATGCAAGTCGGACGGTAGCACAGAGGAGCTTGCTCCTTGGGTGACGAGT
GGCGGACGGGTGAGTAATGTCTGGGGATCTGCCCGATAGAGGGGGATAACC
ACTGGAAACGGTGGCTAATACCGCATAACGTCGCAAGACCAAAGAGGGGG
ACCTTCGGGCCTCTCACTATCGGATGAACCCAGATGGGATTAGCTAGTAGG
CGGGGTAATGGCCCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGA
CCAGCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAG
TGGGGAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTA
TGAAGAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGCGGTG
AGGTTAATAACCTCACCGATTGACGTTACCCGCAGAAGAAGCACCGGCTAA
CTCCGTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAAT
TACTGGGCGTAAAGCGCACGCAGGCGGTCTGTTAAGTCAGATGTGAAATCC
CCGGGCTTAACCTGGGAACTGCATTTGAAACTGGCAGGCTTGAGTCTCGTA
GAGGGGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAG
GAATACCGGTGGCGAAGGCGGCCCCCTGGACGAAGACTGACGCTCAGGTGC
GAAAGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAA
ACGATGTCGACTTGGAGGTTGTTCCCTTGAGGAGTGGCTTCCGGAGCTAACG
CGTTAAGTCGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGA
ATTGACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAA
CGCGAAGAACCTTACCTACTCTTGACATCCAGAGAACTTAGCAGAGATGCT
TTGGTGCCTTCGGGAACTCTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCG
TGTTGTGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTG
TTGCCAGCGGTTCGGTCGGGAACTCAAAGGAGACTGCCGGTGATAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGAGTAGGGCTAC
ACACGTGCTACAATGGCGCATACAAAGAGAAGCGACCTCGCGAGAGCAAG
CGGACCTCACAAAGTGCGTCGTAGTCCGGATCGGAGTCTGCAACTCGACTC
CGTGAAGTCGGAATCGCTAGTAATCGTGGATCAGAATGCCACGGTGAATAC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAA
AAGAAGTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Bacillus cereus- CL11

CGATTACGGGTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTAG
GCGGCTGGCTCCAAAAGGTTACCCCACCGACTTCGGGTGTTACAAACTCTCG
TGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGCAT
GCTGATCCGCGATTACTAGCGATTCCAGCTTCATGTAGGCGAGTTGCAGCCT
ACAATCCGAACTGAGAACGGTTTTATGAGATTAGCTCCACCTCGCGGTCTTG
CAGCTCTTTGTACCGTCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGGGG
CATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGTCA
CCTTAGAGTGCCCAACTTAATGATGGCAACTAAGATCAAGGGTTGCGCTCG
TTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATGCA
CCACCTGTCACTCTGCTCCCGAAGGAGAAGCCCTATCTCTAGGGTTGTCAGA
GGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCACATG
CTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGCCTTGCGG
CCGTACTCCCCAGGCGGAGTGCTTAATGCGTTAACTTCAGCACTAAAGGGC
GGAAACCCTCTAACACTTAGCACTCATCGTTTACGGCGTGGACTACCAGGGT
ATCTAATCCTGTTTGCTCCCCACGCTTTCGCGCCTCAGTGTCAGTTACAGAC
CAGAAAGTCGCCTTCGCCACTGGTGTTCCTCCATATCTCTACGCATTTCACC
GCTACACATGGAATTCCACTTTCCTCTTCTGCACTCAAGTCTCCCAGTTTCCA
ATGACCCTCCACGGTTGAGCCGTGGGCTTTCACATCAGACTTAAGAAACCA
CCTGCGCGCGCTTTACGC

Sequencing result for respective 16S rRNA bands (5' - 3') using bacterial universal primer 27F and 1525R from sludge: -

Chromobacterium sp. - SL1

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCTTTACAC
ATGCAAGTCGAACGGTAACAGGGTGCTTGCACCGCTGACGAGTGGCGAACG
GGTGAGTAATGCATCGGAATGTACCGTGTAATGGGGGATAGCTCGGCGAAA
GCCGGATTAATACCGCATACGCCCTGAGGGGGAAAGTGGGGGACCGTAAG
GCCTCACGTTATACGAGCAGCCGATGTCTGATTAGCTAGTTGGTGGGGTAA
AGGCTCACCAAGGCTTCGATCAGTAGCGGGTCTGAGAGGATGATCCGCCAC
ACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAA
TTTTGGACAATGGGCGCAAGCCTGATCCAGCCATGCCGCGTGTCTGAAGAA
GGCCTTCGGGTTGTAAAGGACTTTTGTCCGGGAGCAAATCCCAGTGGTTAAT
ACCTACTGGGGCTGAGAGTACCGGAAGAATAAGCACCGGCTAACTACGTGC
CAGCAGCCGCGGTAATACGTAGGGTGCAAGCGTTAATCGGAATTACTGGGC
GTAAAGCGTGCGCAGGCGGTTGTGCAAGTCTGATGTGAAAGCCCCGGGCTT
AACCTGGGAACGGCATTGGAGACTGCACGACTAGAGTGCGTCAGAGGGGG
GTAGAATTCCGCGTGTAGCAGTGAAATGCGTAGAGATGCGGAGGAATACCG
ATGGCGAAGGCAGCCCCCTGGGATGACACTGACGCTCATGCACGAAAGCGT
GGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGTC
AACTAGCTGTTGGGGGTTTGAATCCTTGGTAGCGAAGCTAACGCGAGAAGT
TGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTGGTCTTGACATGTAACGAACGCTGCAGAGATGTGGCGGTGCC
CGAAAGGGAGCGTTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCG
TGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGCCATTAGTTGCC

ATCATTAAGTTGGGCACTCTAATGGGACTGCCGGTGACAAACCGGAGGAAG
GTGGGGATGACGTCAAGTCCTCATGGCCCTTATGACCAGGGCTTCACACGTC
ATACAATGGTCGGTACAGAGGGTCGCGAAGCCGCGAGGTGGAGCCAATCTC
ATAAAACCGATCGTAGTCCGGATCGCACTCTGCAACTCGAGTGCGTGAAGT
CGGAATCGCTAGTAATCGCAGATCAGCATGCTGCGGTGAATACGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGGAGTGAGTTTCACCAGAAGTG
GGTAGGCTAACCGTAAGGAGGCCGCTTACCACGGTGGGATTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Xanthomonas sp. - SL2

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
CATGCAAGTCGAACGGCAGCACAGGAGAGCTTGCTCTCTGGGTGGCGAGTG
GCGGACGGGTGAGGAACACATCGGAATCTACTTTTTCGTGGGGGATAACGT
AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCCAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTGG
CTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACTT
CGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTAC
TGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCTG
GGCTCAACCTGGGAACTGCAGTGGATACTGGGCGACTAGAATGTGGTAGAG
GGTAGCGGAATTCCTGGTGTAGCAGTGAAATGCGTAGAGATCAGGAGGAAC
ATCCATGGCGAAGGCAGCTACCTGGACCAACATTGACACTGAGGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGA
TGCGAACTGGATGTTGGGTGCAATTTGGCACGCAGTATCGAAGCTAACGCG
TTAAGTTCGCCGCCTGGGGAGTACGGTCGCAAGACTGAAACTCAAAGGAAT
TGACGGGGGCCCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACG
CGAAGAACCTTACCTGGCCTTGACATGTCGAGAACTTTCCAGAGATGGATT
GGTGCCTTCGGGAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGT
TGCCAGCACGTAATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTAC
ACACGTACTACAATGGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAG
CCAATCCCAGAAACCCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATAC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACC
AGAAGCAGGTAGCTTAACCTTCGGGAGGGCGCTTGCCACGGTGCGGCCGAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Chromobacterium violaceum - SL3

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCTTTACAC
ATGCAAGTCGAACGGTAACAGGGTGCTTGCACCGCTGACGAGTGGCGAACG
GGTGAGTAATGCGTCGGAATGTACCGTGTAATGGGGGATAGCTCGGCGAAA
GCCGGATTAATACCGCATACGCCCTGAGGGGGAAAGTGGGGGACCGTAAG
GCCTCACGTTATACGAGCAGCCGACGTCTGATTAGCTAGTTGGTGAGGTAA

GAGCTCACCAAGGCGACGATCAGTAGCGGGTCTGAGAGGATGATCCGCCAC
ACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAA
TTTTGGACAATGGGCGCAAGCCTGATCCAGCCATGCCGCGTGTCTGAAGAA
GGCCTTCGGGTTGTAAAGGACTTTTGTTCGGGAGGAAATCCCGCTGGTTAAT
ACCTGGCGGGGATGACAGTACCGGAAGAATAAGCACCGGCTAACTACGTGC
CAGCAGCCGCGGTAATACGTAGGGTGCAAGCGTTAATCGGAATTACTGGGC
GTAAAGCGTGCGCAGGCGGTTGTGCAAGTCTGATGTGAAAGCCCCGGGCTT
AACCTGGGAACGGCATTGGAGACTGCACGACTAGAGTGCGTCAGAGGGGG
GTAGAATTCCACGTGTAGCAGTGAAATGCGTAGAGATGTGGAGGAATACCG
ATGGCGAAGGCAGCCCCCTGGGATGACACTGACGCTCATGCACGAAAGCGT
GGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGATGTC
AACTAGCTGTTGGGGGTTTGAATCCTTGGTAGCGTAGCTAACGCGTGAAGTT
GACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTGCTCTTGACATGTACGGAACTTGCTAGAGATAGCTTGGTGCCC
GAAAGGGAGCCGTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGT
GAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCATTAGTTGCCA
TCATTAAGTTGGGCACTCTAATGAGACTGCCGGTGACAAACCGGAGGAAGG
TGGGGATGACGTCAAGTCCTCATGGCCCTTATGAGCAGGGCTTCACACGTC
ATACAATGGTCGGTACAGAGGGTTGCCAAGCCGCGAGGTGGAGCTAATCTC
AGAAAACCGATCGTAGTCCGGATCGCACTCTGCAACTCGAGTGCGTGAAGT
CGGAATCGCTAGTAATCGCAGATCAGCATGCTGCGGTGAATACGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGGAGTGAGTTTCACCAGAAGTG
GGTAGGCTAACCGCAAGGAGGCCGCTTACCACGGTGGGATTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCAC

Xanthomonas sp. - SL4

CGATTACGGGTACCTTGTTACGACTTCACCCCAGTCATCGGCCACACCGTGG
CAAGCGCCCTCCCGAAGGTTAAGCTACCTGCTTCTGGTGCAACAAACTCCCA
TGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCAGCAA
TGCTGATCTGCGATTACTAGCGATTCCGACTTCATGGAGTCGAGTTGCAGAC
TCCAATCCGGACTGAGATAGGGTTTCTGGGATTGGCTTACCGTCGCCGGCTT
GCAGCCCTCTGTCCCTACCATTGTAGTACGTGTGTAGCCCTGGCCGTAAGGG
CCATGATGACTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCGGTC
TCCTTAGAGTTCCCACCATTACGTGCTGGCAACTAAGGACAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAGCCATG
CAGCACCTGTGTTCGAGTTCCCGAAGGCACCAATCCATCTCTGGAAAGTTCT
CGACATGTCAAGGCCAGGTAAGGTTCTTCGCGTTGCATCGAATTAAACCAC
ATACTCCACCGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAGTCTTGC
GACCGTACTCCCCAGGCGGCGAACTTAACGCGTTAGCTTCGATACTGCGTGC
CAAATTGCACCCAACATCCAGTTCGCATCGTTTAGGGCGTGGACTACCAGG
GTATCTAATCCTGTTTGCTCCCCACGCTTTCGTGCCTCAGTGTCAATGTTGGT
CCAGGTAGCTGCCTTCGCCATGGATGTTCCTCCTGATCTCTACGCATTTCACT
GCTACACCAGGAATTCCGCTACCCTCTACCACATTCTAGTCGCCCAGTATCC
ACTGCAGTTCCCAGGTTGAGCCCAGGGCTTTCACAACGGACTTAAACGACC
ACCTACGCACGCTTTACGCCCAGTAATTCCGAGTAACGCTTGCACCCTTCGT
ATTACCGCGGCTGCTGGCACGAAGTTAGCCGGTGCTTATTCTTTGGGTACCG
TCATCCCAACCGGGTATTAGCCAGCTGGATTTCTTTCCCAACAAAAGGGCTT

TACAACCCGAAGGCCTTCTTCACCCACGCGGTATGGCTGGATCAGGCTTGCG
CCCATTGTCCAATATTCCCCACTGCTGCCTCCCGTAGGAGTCTGGACCGTGT
CTCAGTTCCAGTGTGGCTGATCATCCTCTCAGACCAGCTACGGATCGTCGCC
TTGGTGGGCCTTTACCCCGCCAACTAGCTAATCCGACATCGGCTCATTCAAT
CGCGCAAGGCCCGAAGGTCCCCTGCTTTCACCCGTAGGTCGTATGCGGTATT
AGCGTAAGTTTCCCTACGTTATCCCCCACGAAAAAGTAGATTCCGATGTATT
CCTCACCCGTCCGCCACTCGCCACCCAGAGAGCAAGCTCTCCTGTGCTGCCG
TTCGACTTGCATGTGTTAGGCCTACCGCCAGCGTTCACTCTGAGCCACGATC
AAACTCTAATCAC

Klebsiella pneumoniae - SL5

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAGCGGTAGCACAGAGAGCTTGCTCTCGGGTGACGAGCGGC
GGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTACT
GGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGTGGGGGACCT
TCGGGCCTCATGCCATCAGATGTGCCCAGATGGGATTAGCTGGTAGGTGGG
GTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACCAG
CCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGGG
GAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTGTGAA
GAAGGCCTTCGGGTTGTAAAGCACTTTCAGCGGGGAGGAAGGCGGTGAGGT
TAATAACCTCATCGATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTCC
GTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAATTACT
GGGCGTAAAGCGCACGCAGGCGGTCTGTCAAGTCGGATGTGAAATCCCCGG
GCTCAACCTGGGAACTGCATTCGAAACTGGCAGGCTAGAGTCTTGTAGAGG
GGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAATA
CCGGTGGCGAAGGCGGCCCCCTGGACAAAGACTGACGCTCAGGTGCGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCTGTAAACGA
TGTCGATTTGGAGGTTGTGCCCTTGAGGCGTGGCTTCCGGAGCTAACGCGTT
AAATCGACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAATGAATTG
ACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGCG
AAGAACCTTACCTGGTCTTGACATCCACAGAACTTTCCAGAGATGGATTGGT
GCCTTCGGGAACTGTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTTG
TGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTGCC
AGCGGTTAGGCCGGGAACTCAAAGGAGACTGCCAGTGATAAACTGGAGGA
AGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGACCAGGGCTACACAC
GTGCTACAATGGCATATACAAAGAGAAGCGACCTCGCGAGAGCAAGCGGA
CCTCATAAAGTATGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCATGA
AGTCGGAATCGCTAGTAATCGTAGATCAGAATGCTACGGTGAATACGTTCC
CGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAAAGAA
GTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATGACTG
GGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Chromobacterium violaceum - SL6

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCATGCTTTACAC
ATGCAAGTCGAACGGTAACAGGGTGCTTGCACCGCTGACGAGTGGCGAACG
GGTGAGTAATGCGTCGGAATGTACCGTGTAATGGGGGATAGCTCGGCGAAA
GCCGGATTAATACCGCATACGCCCTGAGGGGGAAAGCGGGGGATCGAAAG

ACCTCGCGTTATACGAGCAGCCGACGTCTGATTAGCTAGTTGGTGAGGTAA
GAGCTCACCAAGGCGACGATCAGTAGCGGGTCTGAGAGGATGATCCGCCAC
ACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGTGGGGAA
TTTTGGACAATGGGGGCAACCCTGATCCAGCCATGCCGCGTGTCTGAAGAA
GGCCCTCGGGTTGTAAAGGACTTTTGTCAGGGAGGAAATCCCGCTGGTTAA
TACCCGGCGGGGATGACAGTACCTGAAGAATAAGCACCGGCTAACTACGTG
CCAGCAGCCGCGGTAATACGTAGGGTGCGAGCGTTAATCGGAATTACTGGG
CGTAAAGCGTGCGCAGGCGGTTGTGCAAGTCTGATGTGAAAGCCCCGGGCT
TAACCTGGGAACGGCATTGGAGACTGCACAGCTAGAGTGCGTCAGAGGGGG
GTAGAATTCCACGTGTAGCAGTGAAATGCGTAGAGATGTGGAGGAATACCG
ATGGCGAAGGCAGCCCCCTGGGATGACACTGACGCTCATGCACGAAAGCGT
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AACTAGCTGTTGGGGGTTTGAATCCTTGGTAGCGTAGCTAACGCGTGAAGTT
GACCGCCTGGGGAGTACGGCCGCAAGGTTAAAACTCAAAGGAATTGACGG
GGACCCGCACAAGCGGTGGATGATGTGGATTAATTCGATGCAACGCGAAAA
ACCTTACCTGCTCTTGACATGTACGGAACTTGCCAGAGATGGCTTGGTGCCC
GAAAGGGAGCCGTAACACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGT
GAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCATTAGTTGCCA
TCATTCAGTTGGGCACTCTAATGAGACTGCCGGTGACAAACCGGAGGAAGG
TGGGGATGACGTCAAGTCCTCATGGCCCTTATGAGCAGGGCTTCACACGTC
ATACAATGGTCGGTACAGAGGGTTGCCAAGCCGCGAGGTGGAGCTAATCTC
AGAAAACCGATCGTAGTCCGGATCGCACTCTGCAACTCGAGTGCGTGAAGT
CGGAATCGCTAGTAATCGCAGATCAGCATGCTGCGGTGAATACGTTCCCGG
GTCTTGTACACACCGCCCGTCACACCATGGGAGTGAGTTTCACCAGAAGTG
GGTAGGCTAACCGCAAGGAGGCCGCTTACCACGGTGGGATTCATGACTGGG
GTGAAGTCGTAACAAGGTACCCGTAATCACT

Bacillus sp. - SL7

CGATTACGGGTACCTTGTTACGACTTCACCCCAATCATCTGTCCCACCTTCG
GCGGCTGGCTCCCAAAAGGGTTACCCCACCGACTTCGGGTGTTACAAACTCT
CGTGGTGTGACGGGCGGTGTGTACAAGGCCCGGGAACGTATTCACCGCGGC
ATGCTGATCCGCGATTACTAGCAATTCCGGCTTCATGTAGGCGAGTTGCAGC
CTACAATCCGAACTGAGAATGACTTTTTGGGATTGGCTTGGCCTCGCGGCTT
CGCAACCCTTTGTATCATCCATTGTAGCACGTGTGTAGCCCAGGTCATAAGG
GGCATGATGATTTGACGTCATCCCCACCTTCCTCCGGTTTGTCACCGGCAGT
CACCTTAGAGTGCCCAACTGAATGCTGGCAACTAAGGTCAAGGGTTGCGCT
CGTTGCGGGACTTAACCCAACATCTCACGACACGAGCTGACGACAACCATG
CACCACCTGTCACTTTGTCCCCCGAAGGGGAAAGCTCTATCTCTAGAGTGGT
CAAAGGATGTCAAGACCTGGTAAGGTTCTTCGCGTTGCTTCGAATTAAACCA
CATGCTCCACTGCTTGTGCGGGCCCCCGTCAATTCCTTTGAGTTTCAACCTTG
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CGCTACACGTGGAATTCCACTTTTCTCTCCTGCACTCAAGTCTCCCAGTTTCC
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ATTACCGCGGCTGCTGGCACGTAGTTAGCCGTGGCTTTCTGGTTAGGTACCG

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CTCAGTCCCAGTGTGGCCGATCACCCTCTCAGGTCGGCTACGCATCGTCGCC
TTGGTGAGCCGTTACCTCACCAACTAGCTAATGCGCCGCGGGCTCATCTGTA
AGTGTCAGCCGAAACCGACTTTCAAAAAGAAGAAATGCTTCTTCTCTTGTTA
TCCGGTATTAGCCCCGGTTTCCCGGAGTTATCCCCGTCTTACAGGCAGATTA
CCCACGTGTTACTCACCCGTCCGCCGCTAAATCAGAGGAGCAAGCTCCTCAT
CATTCGCTCGACTTGCATGTATTAGGCACGCCGCCAGCGTTCATCCTGAGCC
ACGATCAAACTCTAATCAC

Stenotrophomonas sp. - SL8

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
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AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCTAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTG
GCTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACC
TCGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTA
CTGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCT
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CATCCATGGCGAAGGCAGCTACCTGGACCAACACTGACACTGAGGCACGAA
AGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACG
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GTTAAGTTCGCCGCCTGGGGAGTACGGTCGCAAGACTGAAACTCAAAGAAT
TGACGGGGGCCCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACG
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GGTGCCTTCGGGAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
GTCGTGAGATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTGTCCTTAGT
TGCCAGCACGTAATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTAC
ACACGTACTACAATGGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAG
CCAATCCCAGAAACCCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATAC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACC
AGAAGCAGGTAGCTTAACCTTCGGGAGGGCGCTTGCCACGGTGTGGCCGAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Stenotrophomonas maltophilia - SL9

CGATTAGAGTTTGATCGTGGCTCAGAGTGAACGCTGGCGGTAGGCCTAACA
CATGCAAGTCGAACGGCAGCACAGGAGAGCTTGCTCTCTGGGTGGCGAGTG
GCGGACGGGTGAGGAATACATCGGAATCTACTTTTTCGTGGGGGATAACGT

AGGGAAACTTACGCTAATACCGCATACGACCTACGGGTGAAAGCAGGGGAC
CTTCGGGCCTTGCGCGATTGAATGAGCCGATGTCGGATTAGCTAGTTGGCGG
GGTAAAGGCCCACCAAGGCGACGATCCGTAGCTGGTCTGAGAGGATGATCA
GCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTGG
GGAATATTGGACAATGGGCGCAAGCCTGATCCAGCCATACCGCGTGGGTGA
AGAAGGCCTTCGGGTTGTAAAGCCCTTTTGTTGGGAAAGAAATCCAGCTGG
CTAATACCCGGTTGGGATGACGGTACCCAAAGAATAAGCACCGGCTAACTT
CGTGCCAGCAGCCGCGGTAATACGAAGGGTGCAAGCGTTACTCGGAATTAC
TGGGCGTAAAGCGTGCGTAGGTGGTCGTTTAAGTCCGTTGTGAAAGCCCTG
GGCTCAACCTGGGAACTGCAGTGGATACTGGGCGACTAGAGTGTGGTAGAG
GGTAGCGGAATTCCTGGTGTAGCAGTGAAATGCGTAGAGATCAGGAGGAAC
ATCCATGGCGAAGGCAGCTACCTGGACCAACACTGACACTGAGGCACGAAA
GCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCCTAAACGA
TGCGAACTGGATGTTGGGTGCAATTTGGCACGCAGTATCGAAGCTAACGCG
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TGACGGGGGCCCGCACAAGCGGTGGAGTATGTGGTTTAATTCGATGCAACG
CGAAGAACCTTACCTGGCCTTGACATGTCGAGAACTTTCCAGAGATGGATT
GGTGCCTTCGGGAACTCGAACACAGGTGCTGCATGGCTGTCGTCAGCTCGT
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TGCCAGCACGTAATGGTGGGAACTCTAAGGAGACCGCCGGTGACAAACCGG
AGGAAGGTGGGGATGACGTCAAGTCATCATGGCCCTTACGGCCAGGGCTAC
ACACGTACTACAATGGTAGGGACAGAGGGCTGCAAGCCGGCGACGGTAAG
CCAATCCCAGAAACCCTATCTCAGTCCGGATTGGAGTCTGCAACTCGACTCC
ATGAAGTCGGAATCGCTAGTAATCGCAGATCAGCATTGCTGCGGTGAATAC
GTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTTTGTTGCACC
AGAAGCAGGTAGCTTAACCTTCGGGAGGGCGCTTGCCACGGTGTGGCCGAT
GACTGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC

Escherichia coli - SL10

CGATTAGAGTTTGATCGTGGCTCAGATTGAACGCTGGCGGCAGGCCTAACA
CATGCAAGTCGAACGGTAACAGGAAGCAGCTTGCTGCTTCGCTGACGAGTG
GCGGACGGGTGAGTAATGTCTGGGAAACTGCCTGATGGAGGGGGATAACTA
CTGGAAACGGTAGCTAATACCGCATAACGTCGCAAGACCAAAGAGGGGGA
CCTTCGGGCCTCTTGCCATCGGATGTGCCCAGATGGGATTAGCTAGTAGGTG
GGGTAACGGCTCACCTAGGCGACGATCCCTAGCTGGTCTGAGAGGATGACC
AGCCACACTGGAACTGAGACACGGTCCAGACTCCTACGGGAGGCAGCAGTG
GGGAATATTGCACAATGGGCGCAAGCCTGATGCAGCCATGCCGCGTGTATG
AAGAAGGCCTTCGGGTTGTAAAGTACTTTCAGCGGGGAGGAAGGGAGTAAA
GTTAATACCTTTGCTCATTGACGTTACCCGCAGAAGAAGCACCGGCTAACTC
CGTGCCAGCAGCCGCGGTAATACGGAGGGTGCAAGCGTTAATCGGAATTAC
TGGGCGTAAAGCGCACGCAGGCGGTTTGTTAGGTCAGATGTGAAATCCCCG
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GGGGGTAGAATTCCAGGTGTAGCGGTGAAATGCGTAGAGATCTGGAGGAAT
ACCGGTGGCGAAGGCGGCCCCCTGGACGAAGACTGACGCTCAGGTGCGAA
AGCGTGGGGAGCAAACAGGATTAGATACCCTGGTAGTCCACGCCGTAAACG
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GACGGGGGCCCGCACAAGCGGTGGAGCATGTGGTTTAATTCGATGCAACGC

GAAGAACCTTACCTGGTCTTGACATCCACGGAAGTTTTCAGAGATGAGAAT
GTGCCTTCGGGAACCGTGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGT
TGTGAAATGTTGGGTTAAGTCCCGCAACGAGCGCAACCCTTATCCTTTGTTG
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ACGTGCTACAATGGCGCATACAAAGAGAAGCGACCTCGCGAGAGCAAGCG
GACCTCATAAAGTGCGTCGTAGTCCGGATTGGAGTCTGCAACTCGACTCCAT
GAAGTCGGAATCGCTAGTAATCGTGGATCAGAATGCCACGGTGAATACGTT
CCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTGGGTTGCAAAAG
AAGTAGGTAGCTTAACCTTCGGGAGGGCGCTTACCACTTTGTGATTCATGAC
TGGGGTGAAGTCGTAACAAGGTACCCGTAATCAC