

Isolation and Characterization of Indigenous Potash Mobilizing Bacteria from Coastal Salt-Affected Soils of Gir Somnath, Gujarat, India, and Their Potential for Biofertilizer Application

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Abstract

Salt-affected coastal soils often suffer from nutrient imbalance and reduced availability of essential macronutrients such as potassium, which adversely affects soil fertility and crop productivity. The present study aimed to isolate, characterize, and evaluate indigenous potash mobilizing bacteria (KMB) from coastal saline soils of Gir Somnath district, Gujarat, India. Soil samples were collected from four coastal villages—Kaj, Sarakhadi, Chhara, and Mul-Dwarka—and subjected to serial dilution and plating on Aleksandrow agar medium. A total of 20 morphologically distinct bacterial isolates were successfully obtained, indicating the presence of diverse and viable microbial populations adapted to saline conditions. Functional screening revealed that all isolates exhibited potassium mobilizing activity, demonstrating their ability to solubilize insoluble potassium compounds. Morphological characterization showed variation in colony size, pigmentation, texture, and elevation, reflecting microbial diversity. Gram staining analysis revealed that all isolates were Gram-positive, suggesting dominance of stress-tolerant bacterial groups, possibly belonging to *Bacillus* and related genera. The ability of these isolates to grow efficiently on potassium-containing selective media confirms their functional role in nutrient cycling. These findings highlight the ecological significance and biofertilizer potential of native potash mobilizing bacteria for improving soil fertility and promoting sustainable agriculture in coastal and salt-affected regions.

Keywords

Potash mobilizing bacteria; Coastal saline soil; Biofertilizer; Potassium solubilization; Soil microbiology; Sustainable agriculture

1. Introduction:

Potassium (K) is an essential macronutrient required for plant growth and development, playing a crucial role in enzyme activation, photosynthesis, osmoregulation, protein synthesis, stomatal regulation, and stress tolerance. It is the third most important plant nutrient after nitrogen and phosphorus and significantly influences crop yield, quality, and resistance to abiotic and biotic stresses (Cakmak, 2018; Alloway, 2019).

Although potassium is the seventh most abundant element in the Earth's crust, only about 1–2% exists in plant-available forms such as water-soluble and exchangeable potassium, while the majority is present in insoluble mineral forms including feldspar, mica, biotite, and illite (Rengel, 2015; Sparks, 2018). In Indian soils, total potassium content ranges between 0.5% and 3%; however, its availability to plants remains limited due to fixation and slow mineral weathering (Singh, 2020). Moreover, India and several developing countries lack sufficient potassium-bearing mineral deposits for fertilizer production and therefore rely heavily on imported potassic fertilizers such as potassium chloride and potassium sulfate, increasing agricultural production costs and creating nutrient imbalances in soils (Indian Fertilizer Association, 2022; Food and Agriculture Organization [FAO], 2021).

The excessive and continuous use of chemical fertilizers to overcome potassium deficiency has resulted in soil degradation, reduced microbial diversity, and environmental pollution. In addition, fertilizers such as potassium chloride may contribute to soil salinity and negatively affect soil structure and biological activity (FAO, 2021; Paul & Lade, 2019). This situation highlights the urgent need for sustainable and eco-friendly alternatives to enhance potassium availability and maintain soil fertility. Soil microorganisms play a vital role in nutrient cycling by mineralizing organic matter and converting insoluble mineral nutrients into plant-available forms. Among them, potassium-solubilizing microorganisms (KSMs), particularly potassium-solubilizing bacteria (KSB), have gained attention due to their ability to release potassium from insoluble mineral sources through mechanisms such as organic acid production, acidolysis, chelation, polysaccharide secretion, and mineral dissolution (Etesami et al., 2017; Basak&Biswas, 2020).

Several bacterial genera, including *Bacillus*, *Paenibacillus*, *Pseudomonas*, and *Enterobacter*, have been reported as efficient potassium solubilizers capable of improving potassium uptake and enhancing plant growth. These bacteria not only mobilize potassium but also produce plant growth-promoting substances such as phytohormones, siderophores, and exopolysaccharides, which help plants tolerate abiotic stresses such as salinity and drought (Meena et al., 2016; Nawaz et al., 2023). Coastal saline soils, in particular, represent unique ecosystems that harbor diverse halotolerant and stress-adapted microbial communities with significant potential for nutrient solubilization and plant growth promotion. Soil salinity is a major agricultural problem affecting more than 800 million hectares globally and significantly limiting crop productivity due to nutrient imbalance, osmotic stress, and reduced microbial activity (Rengel, 2015; Zhao et al., 2022).

The coastal regions of Gujarat, especially the Saurashtra belt, are characterized by saline soils and harsh environmental conditions, making them ideal sites for exploring stress-tolerant potassium-solubilizing bacteria. Indigenous microbial populations from such environments are naturally adapted to saline stress and may serve as efficient bioinoculants for sustainable agriculture. Recent studies have highlighted the role of such microbes in improving nutrient availability, soil health, and crop productivity under stress conditions (Sood et al., 2023; Damathia et al., 2025; Gao et al., 2025). Therefore, isolation and characterization of native potassium-solubilizing bacteria from coastal saline soils is essential for developing biofertilizers that improve potassium availability, enhance soil fertility, and promote sustainable crop production. The present study aims to isolate, characterize, and evaluate potassium-

solubilizing bacteria from coastal saline soils of Gir Somnath district, Gujarat, and assess their potential application in sustainable nutrient management and biofertilizer development.

2. Materials and Method:

2.1 Soil Sample Collection

Soil samples were collected from four coastal saline locations, namely Kaj, Sarakhadi, Chhara, and Mul-Dwarka villages of Kodinar taluka, Gir Somnath district, Gujarat, India. Samples were collected from non-rhizospheric soil at a depth of 1–20 cm using sterile tools. The collected samples were transferred into sterile polyethylene bags, transported to the laboratory, and stored at 4 °C until further analysis.

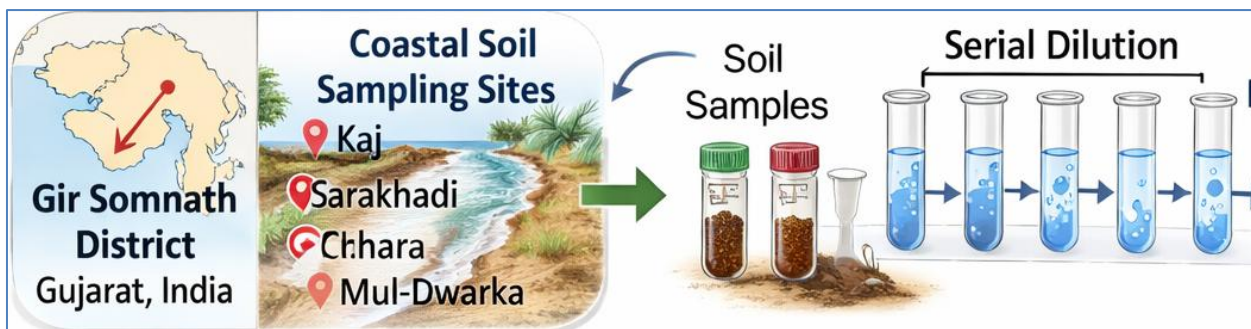


Fig: 01 soil sample collection for KSB isolation

2.2 Isolation of Potassium-Solubilizing Bacteria

Potassium-solubilizing bacteria (KSB) were isolated using the serial dilution and spread plate technique on Aleksandrov agar medium containing insoluble potassium aluminum silicate (5.0 g/L) as the potassium source. Soil suspensions were serially diluted up to 10^{-6} , and 0.1 mL aliquots were spread onto agar plates. The plates were incubated at 30 ± 1 °C for 2–3 days. Colonies exhibiting clear halo zones around bacterial growth were considered potassium solubilizers. Selected colonies were purified by repeated streaking and maintained on nutrient agar slants at 4 °C for further study (Table:01).

2.3 Quantitative Estimation of Potassium Solubilization

Quantitative potassium solubilization was determined using Aleksandrov broth supplemented with insoluble potassium source (0.3 g/100 mL). Each isolate (1 mL) was inoculated into sterile broth and incubated at 37 °C for 5 days on a rotary shaker (150 rpm). After incubation, cultures were centrifuged at 10,000 rpm for 30 min. The concentration of solubilized potassium in the supernatant was determined colorimetrically at 420 nm using KCl as a standard. Uninoculated broth served as the control.

2.4 Effect of Physiological Factors on Potassium Solubilization

The effect of temperature, pH, and salinity on potassium solubilization was evaluated using Aleksandrov medium. The isolates were incubated at different temperatures (25 °C, 30 °C, 35 °C, and 40 °C), pH levels (6.0, 7.0, 8.0, and 9.0), and NaCl concentrations (1%, 2.5%, and 5%). Potassium solubilization efficiency was recorded to determine optimal growth conditions.

2.5 Morphological and Biochemical Characterization

Selected isolates were characterized based on colony morphology, Gram staining, motility, and endospore staining. Biochemical tests including indole, methyl red, Voges–Proskauer, citrate utilization, catalase, oxidase, Triple Sugar Iron (TSI), and carbohydrate fermentation tests were performed according to standard microbiological methods to identify and characterize potassium-solubilizing bacterial isolates.

3. Results and discussion:

3.1 Isolation and Screening of Potash-Mobilizing Bacteria

A total of twenty bacterial isolates were obtained from saline coastal soil samples collected from Gir Somnath district (Fig: 01 & Table: 01). Initial screening on potassium-bearing insoluble mineral medium revealed clear halo zone formation around several colonies, indicating their potassium-mobilizing potential. The formation of halo zones confirms the ability of isolates to solubilize insoluble potassium through the secretion of organic acids, chelating compounds, or enzymatic activity (Basak&Biswas, 2010; Meena et al., 2016). Variability in the solubilization index among isolates indicates strain-specific efficiency, which is commonly observed in potassium-mobilizing bacteria (KSB) (Etesami et al., 2017). Such variability reflects differences in metabolic activity, organic acid production, and stress tolerance mechanisms. Recent studies further support that KSB exhibit diverse mechanisms for potassium release and adaptation to environmental stress, enhancing nutrient availability and plant growth (Table:02) (Nawaz et al., 2023; Zhao et al., 2022; Sood et al., 2023).

3.2 Colony Morphology and Gram Staining Characteristics

A total of twenty bacterial isolates (CHK-01 to KAK-20) were obtained and characterized based on their colony morphology, growth on Aleksandrow agar medium, and Gram staining. The morphological observations revealed that the majority of isolates exhibited small, round-shaped colonies with flat elevation, smooth texture, and moist consistency. A few isolates, such as MUK-04, KOK-05, SAK-09, and SAK-10, showed relatively larger colony sizes, while SAK-09, SAK-10, and MUK-12 displayed irregular colony shapes. Pigmentation analysis indicated that most isolates produced white colonies, whereas a few isolates (KOK-05 and MUK-07) exhibited yellow pigmentation.

All isolates demonstrated positive growth on Aleksandrow agar medium, indicating their potential ability to solubilize potassium from insoluble mineral sources. Furthermore, Gram staining results revealed that all isolates were Gram-positive bacteria, suggesting their affiliation with spore-forming genera such as *Bacillus* and *Paenibacillus*. These genera are widely recognized for their ability to survive under harsh environmental conditions, produce organic acids, and enhance mineral solubilization efficiency (Meena et al., 2016; Basak&Biswas, 2010).

The predominance of Gram-positive, rod-shaped, and spore-forming bacteria among potassium-solubilizing isolates has been consistently reported in earlier studies, highlighting their ecological adaptability and effectiveness in nutrient cycling (Sharma et al., 2013). Recent studies further support that *Bacillus* and related genera exhibit efficient potassium mobilization through mechanisms such as acidolysis, chelation, and polysaccharide production, which enhance nutrient availability and plant growth under diverse environmental conditions (Nawaz et al., 2023; Zhao et al., 2022). Additionally, the ability

of these isolates to grow on selective media and exhibit consistent morphological traits indicates their suitability for further biochemical and molecular characterization as potential biofertilizer candidates (Table:02) (Sood et al., 2023; Damathia et al., 2025; Gao et al., 2025)

3.3 Effect of Temperature on Potassium Mobilization

Temperature significantly influenced potassium mobilization efficiency of bacterial isolates. At 20 °C, most isolates exhibited moderate but stable solubilization activity, suggesting their adaptability to lower temperature conditions commonly observed in soil environments. The ability to maintain mobilization activity under cooler conditions indicates ecological fitness and supports their potential application across diverse climatic regions (Fig:03) (Meena et al., 2016; Sood et al., 2023).

At 50 °C, which represents optimal growth conditions for most soil bacteria, potassium mobilization activity increased from Day 1 to Day 2, followed by a slight decline on Day 3. This trend indicates that maximum solubilization occurs during the exponential growth phase, when metabolic activity and organic acid production are highest (Etesami et al., 2017; Nawaz et al., 2023). Among the isolates, Isolate 20 demonstrated the highest mobilization values, followed by isolates 16, 19, 2, and 14, indicating superior metabolic efficiency and potassium solubilization capability.

At 50 °C, several isolates maintained or showed gradual increases in potassium mobilization over time, indicating thermal tolerance and metabolic stability under elevated temperature conditions. Isolate 5 exhibited the highest and most consistent activity, followed by isolates 16, 10, 14, and 15. These findings suggest that certain isolates possess thermotolerant characteristics, enhancing their suitability for biofertilizer application under high-temperature conditions (Sharma et al., 2013; Zhao et al., 2022).

The ability of isolates to solubilize potassium across a wide temperature range highlights their adaptability and effectiveness under varying environmental conditions. Such traits are particularly important for the development of robust biofertilizer formulations capable of functioning under climatic stress and fluctuating soil temperatures (Basak&Biswas, 2010; Gao et al., 2025).

3.4 Effect of Salinity on Potassium Mobilization

Salt concentration significantly influenced potassium mobilization efficiency. At 1% NaCl concentration, all isolates maintained measurable mobilization activity, indicating their salt tolerance and functional stability. Isolates 5 and 19 exhibited the highest and most consistent activity, suggesting strong physiological adaptability and efficient potassium solubilization under saline conditions. Similar findings have been reported where potassium-solubilizing bacteria (KSB), particularly *Bacillus* spp., demonstrated effective nutrient mobilization under mild saline stress due to their adaptive metabolic mechanisms (Basak&Biswas, 2010; Zhao et al., 2022).

At 2.5% NaCl concentration, most isolates continued to exhibit stable mobilization activity, although variations were observed among strains. Isolates 2, 19, and 20 showed consistently higher mobilization values, while isolates 18 and 20 demonstrated peak activity during the exponential growth phase. This suggests enhanced metabolic adaptation and increased production of organic acids under moderate salinity stress. Such responses are consistent with earlier and recent reports indicating that KSB enhance potassium availability through acidification, chelation, and biofilm formation under stress conditions (Fig:05) (Meena et al., 2016; Nawaz et al., 2023; Sood et al., 2023).

At 5% NaCl concentration, potassium mobilization activity was retained in several isolates, although some isolates showed delayed or reduced activity, indicating the activation of stress adaptation mechanisms. Isolates 8, 14, 18, and 20 demonstrated comparatively higher activity, highlighting their strong salt tolerance and functional resilience. The ability of these isolates to maintain potassium solubilization under high salinity aligns with findings that stress-tolerant genera such as *Bacillus* and *Paenibacillus* possess efficient ion regulation, osmoprotection, and enzyme stability mechanisms (Fig:06) (Etesami et al., 2017; Gao et al., 2025; Damathia et al., 2025).

Overall, the results confirm that the selected isolates possess significant salt tolerance and potassium-mobilizing potential under varying saline conditions, supporting their potential application in saline and semi-saline agricultural soils for sustainable crop production (Fig:04) (Sharma et al., 2013; Nawaz et al., 2023).

3.5 Effect of pH on Potassium Mobilization

The effect of pH on potassium mobilization was evaluated under acidic (pH 5), neutral (pH 7), and alkaline (pH 9) conditions. At pH 5, considerable variation in mobilization activity was observed among the isolates. Several isolates exhibited gradual increases in activity over time, indicating their adaptation to acidic environments. Notably, isolates 15, 18, 17, and 16 demonstrated superior mobilization efficiency, suggesting their potential to function effectively under acidic stress conditions. These findings are consistent with previous reports indicating that certain potassium-solubilizing bacteria possess adaptive mechanisms, such as organic acid production and proton extrusion, enabling survival and activity in low pH environments (Fig:07) (Zhao et al., 2022; Nawaz et al., 2023).

At neutral pH (pH 7), which closely represents typical soil conditions, maximum potassium mobilization was observed in several isolates, particularly isolates 2, 3, 4, 6, and 20. Neutral pH provided optimal conditions for bacterial growth and metabolic activity, resulting in enhanced potassium solubilization. This observation aligns with recent studies reporting that potassium-solubilizing bacteria exhibit peak enzymatic activity and nutrient release under near-neutral conditions, thereby improving potassium availability to plants (Sood et al., 2023; Gao et al., 2025).

At alkaline pH (pH 9), only a subset of isolates maintained effective mobilization activity, indicating selective tolerance to alkaline stress. Isolates 2, 3, 4, 6, 8, 11, 12, 13, and 19 exhibited consistent solubilization activity, while others showed reduced or no activity. The ability of these isolates to function under alkaline conditions highlights their adaptability and potential for application in alkaline soils. Similar findings have been reported in recent studies, where stress-tolerant potassium-solubilizing bacteria demonstrated sustained activity through mechanisms such as exopolysaccharide production and ion regulation under alkaline conditions (Fig:08) (Damathia et al., 2025).

Overall, these findings confirm that pH is a critical factor influencing potassium solubilization, with neutral and slightly alkaline conditions favoring maximum activity in tolerant isolates. The observed variability among isolates suggests the importance of selecting efficient and stress-tolerant strains for biofertilizer development and sustainable agricultural applications (Nawaz et al., 2023; Gao et al., 2025).

3.6 Biochemical Characterization of Selected Potash-Mobilizing Isolates

Based on potassium mobilization efficiency under varying environmental conditions, three potent isolates, CHAK-02, KOK-05, and SAK-18, were selected for biochemical characterization. Biochemical analysis revealed that all selected isolates were Gram-positive bacteria, indicating their classification within *Bacillus*-like genera. CHAK-02 exhibited biochemical characteristics consistent with *Bacillus* species, including stress tolerance and mineral solubilization capability. KOK-05 showed positive Voges–Proskauer and catalase reactions, indicating metabolic versatility and efficient organic acid production. SAK-18 demonstrated citrate utilization and carbohydrate fermentation capability, suggesting its adaptability to nutrient-limited and stress environments. The biochemical characteristics of selected isolates suggest their affiliation with *Bacillus* and *Paenibacillus* genera, which are well-known for potassium solubilization, stress tolerance, and plant growth promotion (Nawaz et al., 2023; Zhao et al., 2022). Recent studies further confirm that potassium-solubilizing bacteria enhance nutrient availability, plant growth, and stress tolerance through mechanisms such as organic acid production, chelation, and biofilm formation (Damathia et al., 2025; Gao et al., 2025). These genera are widely used in biofertilizer formulations due to their spore-forming ability, environmental stability, and prolonged shelf life, making them suitable for sustainable agriculture (Table:03) (Sood et al., 2023)

3.7 Overall Performance and Biofertilizer Potential

The present study demonstrates that saline coastal soils harbor diverse and efficient potassium-mobilizing bacteria capable of solubilizing insoluble potassium under varying environmental conditions. Environmental factors such as temperature, salinity, and pH significantly influence potassium mobilization efficiency, with certain isolates exhibiting superior adaptability and consistent performance under stress conditions (Nawaz et al., 2023; Zhao et al., 2022). The ability of selected isolates to maintain potassium solubilization under acidic, neutral, alkaline, and saline conditions highlights their ecological adaptability and functional potential. Such stress-tolerant potassium-mobilizing bacteria play a crucial role in improving potassium availability, enhancing soil fertility, and promoting sustainable agricultural productivity through mechanisms such as organic acid production and mineral weathering (Sood et al., 2023; Damathia et al., 2025).

The superior performance of isolates CHAK-02, KOK-05, and SAK-18 suggests their strong potential for application as biofertilizer candidates, particularly in saline and alkaline soils where nutrient availability is limited. Similar findings have been reported in recent studies demonstrating that *Bacillus* and *Paenibacillus* species improve plant growth and nutrient uptake under abiotic stress conditions (Table:03) (Gao et al., 2025; Nawaz et al., 2023). However, further molecular identification using advanced techniques such as 16S rRNA sequencing, along with field-level evaluation, is recommended to validate their effectiveness and consistency under natural agricultural conditions.

4 Conclusion:

The present investigation successfully demonstrated the occurrence, diversity, and functional potential of indigenous potash-mobilizing bacteria (KMB) isolated from salt-affected coastal soils of Gir Somnath district, Gujarat. The isolation of twenty morphologically distinct bacterial strains from non-rhizospheric saline soils confirms that coastal environments harbor metabolically active and ecologically significant

microbial communities capable of contributing to soil nutrient cycling. Morphological and Gram staining analyses revealed the predominance of Gram-positive bacteria, indicating the likely presence of stress-tolerant genera such as *Bacillus* and *Paenibacillus*, which are widely recognized for their mineral solubilization efficiency and suitability for biofertilizer development.

Functional screening confirmed that all isolates exhibited potassium-mobilizing ability, highlighting their important role in improving potassium availability in saline soils. The solubilization efficiency was significantly influenced by environmental factors such as temperature, salinity, and pH. Several isolates demonstrated optimal activity at 37 °C, while maintaining considerable activity across a wide temperature range (20–50 °C), indicating strong thermal adaptability. Similarly, most isolates exhibited stable potassium mobilization under varying salinity levels (1–5% NaCl) and across a broad pH range (5–9), reflecting their physiological adaptability and ecological resilience under stress conditions.

Among the isolates, CHAK-02, KOK-05, and SAK-18 were identified as the most efficient and stress-tolerant strains based on their consistent performance under combined environmental stress conditions. Biochemical characterization further supported their classification within agriculturally important genera known for plant growth-promoting properties, mineral solubilization, and environmental persistence.

Overall, the selected potash-mobilizing bacterial isolates possess essential characteristics required for biofertilizer development, including efficient potassium solubilization, stress tolerance, metabolic stability, and Gram-positive spore-forming ability. These attributes enhance their potential for survival, storage, and field application. The utilization of such indigenous bacterial strains offers a promising and sustainable approach for improving potassium availability, enhancing soil fertility, and reducing dependency on chemical fertilizers in saline and coastal agricultural ecosystems. However, further molecular identification and field-level evaluation is recommended to validate their effectiveness and practical applicability under natural crop production conditions.

5 References:

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Table: 01KSB with identification code

Strain No.	Identification Code
1	CHK01
2	CHAK02
3	KJK03
4	MUK04
5	KOK05
6	KJK06
7	MUK
8	CHK
9	SAK
10	SAK
11	KOK
12	MUK
13	KAK
14	MUK
15	SAK15
16	
17	
18	SAK18
19	MUK19
20	KAK20

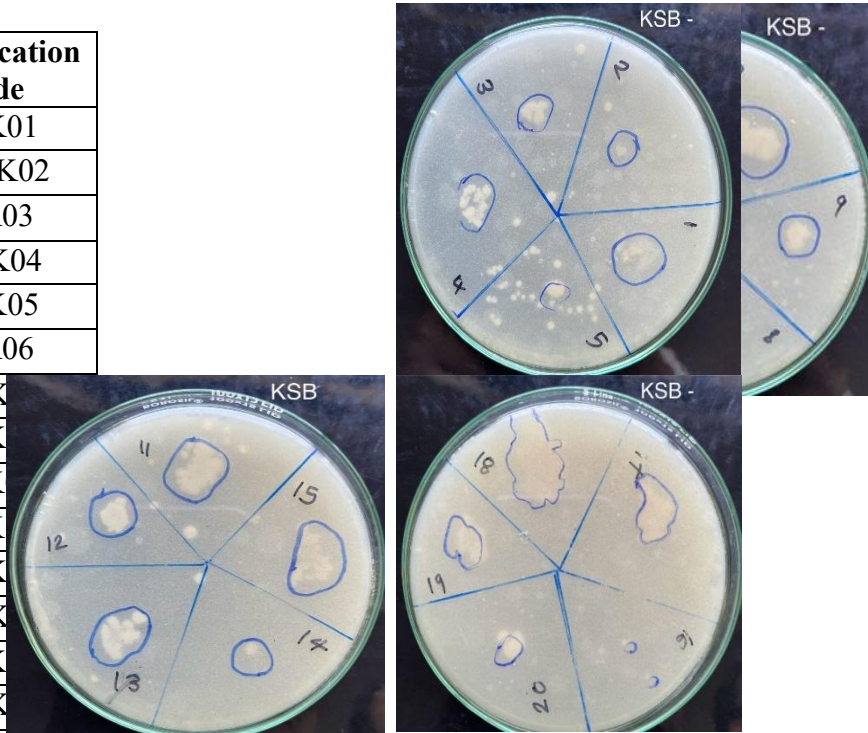


Fig: 02 KSB isolates from soil samples (1% Salt concentration)

Colony Number	Colony Shape	Shape	Elevation	Texture	Consistency	Pigmentation	Growth on Alekasandrow Agar Media	Gram Staining
CHK-01	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
CHAK-02	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
KJK-03	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
MUK-04	Large	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
KOK-05	Large	Round	Flat	Smooth	Moist	Yellow	Yes	Gram+ve
KJK-06	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
MUK-07	Small	Round	Flat	Smooth	Moist	Yellow	Yes	Gram+ve
CHK-08	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
SAK-09	Large	Irregular	Flat	Smooth	Moist	White	Yes	Gram+ve
SAK-10	Large	Irregular	Flat	Smooth	Moist	White	Yes	Gram+ve
KOK-11	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
MUK-12	Small	Irregular	Flat	Smooth	Moist	White	Yes	Gram+ve
KJK-13	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
MUK-14	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
SAK-15	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
CHK-16	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
CHK-17	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
SAK-18	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
MUK-19	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve
KAK-20	Small	Round	Flat	Smooth	Moist	White	Yes	Gram+ve

Table No.02: Colonies Morphology and Gram staining

Table No. 03: Biochemical Test Analysis of Potent KSB Isolates

ISOLATE	Indole	MR	VP	Citrate	Motility test	TSI Agar	Catalase	Oxidase	carbohydrate fermentation test		Gram reaction
									Glucose	Lactose	
CHAK 2	-	-	-	-	-	-	-	-	-	-	+
KOK 5	-	-	P+	-	-	-	-	+	-	+	+
SAK18	+	-	+	+	-	-	-	+	-	+	+
KAK 20	+	-	-	+	-	-	-	+	-	+	+

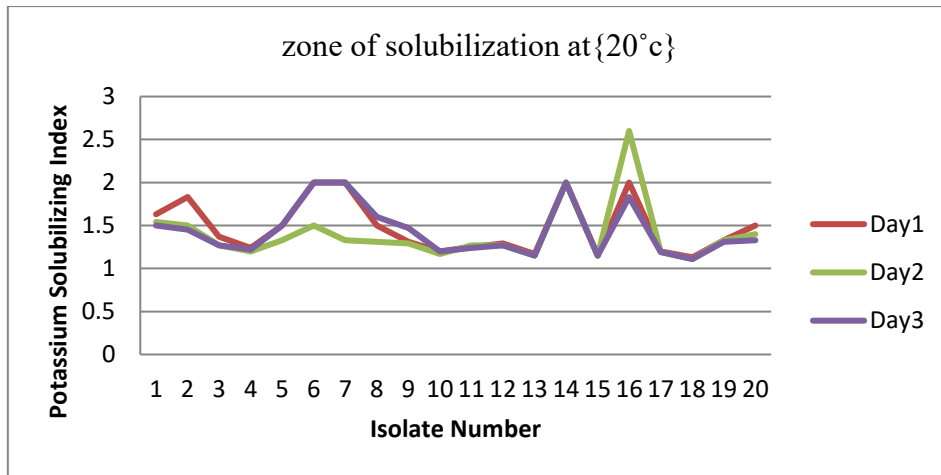


Fig:03 Effect of Temperature on KSB isolates (20°c)

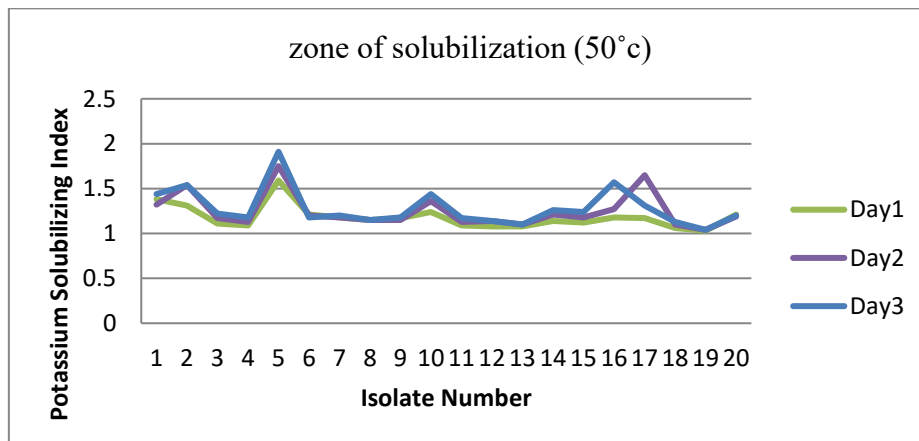


Fig:04 Effect of Temperature on KSB isolates (50°c)

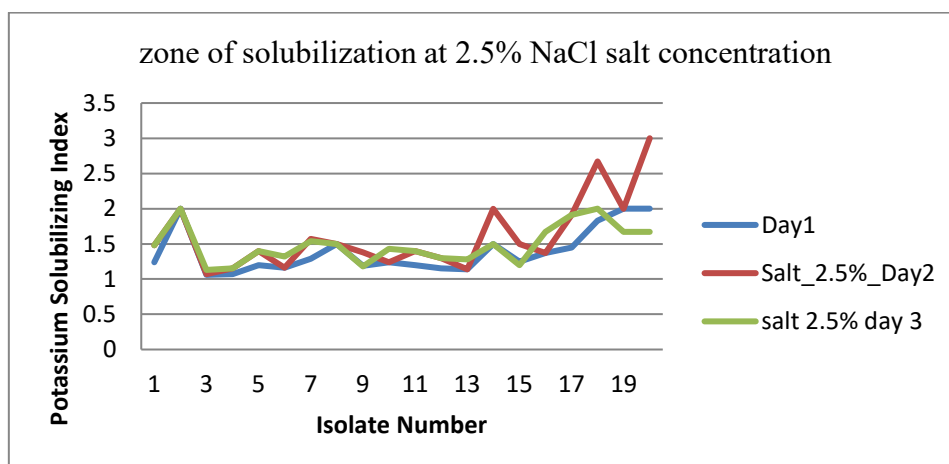


Fig:05 Effect of Salt concentration on KSB isolates (2.5% salt concentration)

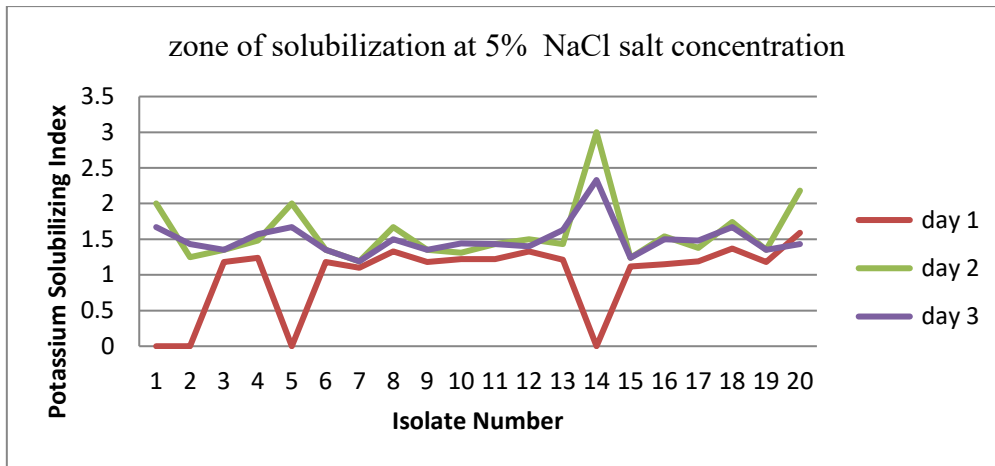


Fig:06 Effect of Salt concentration on KSB isolates (5% salt concentration)

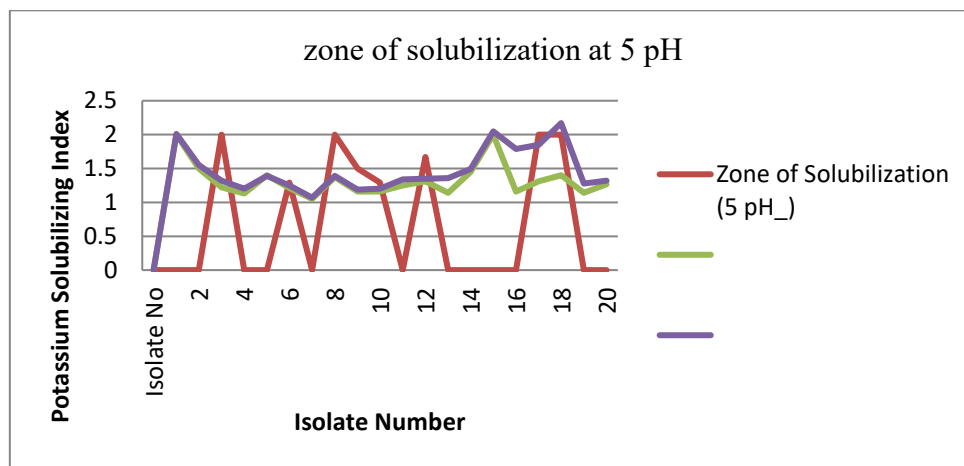


Fig:07 Effect of pH concentration on KSB isolates (5 pH)

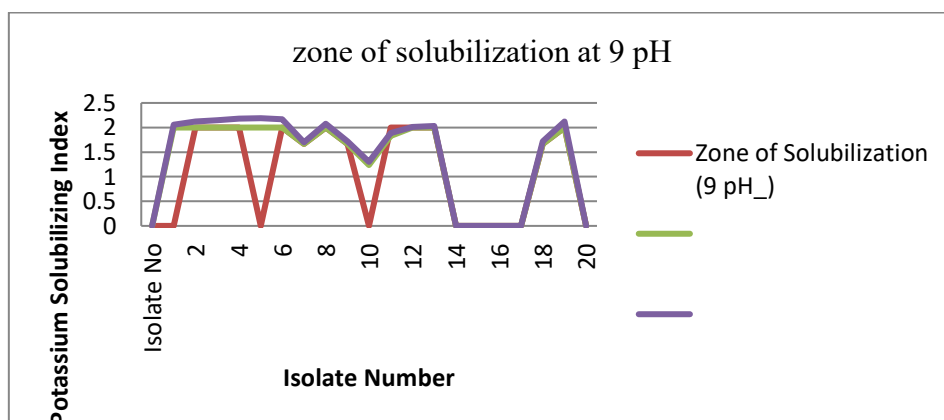


Fig:08 Effect of pH concentration on KSB isolates (9 pH)