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COMPARATIVE STUDY AND GCMS ANALYSIS OF PEA PLANT (ARKA ARJUNA), MENTHE (FENUGREEK) AND DOLICHOS LABLAB (ARJUNA PRASIDDHI) AS FOOD CROP AND A RELATIONSHIP OF PGPRS AND PGPH.

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ABSTRACT Intercropping is an important sustainable agricultural practice that involves growing two or more crop species together in the same field to improve productivity, resource utilization, and ecological balance. The present study investigates the phytochemical composition and growth-related metabolites of Pea (Pisum sativum – Arka Arjuna), Fenugreek (Trigonella foenum-graecum) and Dolichos lablab grown individually and under intercropping conditions. Methanolic extracts obtained from seeds and different plant parts were analysed using Gas Chromatography–Mass Spectrometry (GC–MS) to identify bioactive compounds associated with plant growth regulation, nutraceutical value and microbial interactions. The study also highlights the supportive role of Plant Growth Promoting Rhizobacteria (PGPR) and biofertilizers in enhancing phytochemical diversity. GC–MS profiling revealed the presence of several biologically important compounds such as stigmasterol, phytol, α-amyrin, n-hexadecanoic acid and 10E,12Z-octadecadienoic acid. Intercropped plants showed a higher diversity and relative abundance of functional compounds when compared to non-intercropped plants. These findings indicate that intercropping combined with PGPR application is an effective approach to improve crop quality, nutritional value and sustainable agricultural output.

KEYWORDS : Intercropping, Dolichos Lablab, Fenugreek, Pea, PGPR, Biofertilizer, GC–MS, Nutraceuticals

INTRODUCTION

Modern agriculture faces serious challenges such as soil nutrient depletion, increased dependence on chemical fertilizers, pest incidence and climate variability. To address these concerns, sustainable cropping systems that enhance productivity while maintaining soil health are increasingly encouraged. Intercropping is one such system in which two or more crops are grown together during the same growing season. This practice improves land-use efficiency, enhances nutrient cycling and reduces crop vulnerability to pests, diseases and weeds.

The success of intercropping systems is closely associated with soil microorganisms, particularly Plant Growth Promoting Rhizobacteria (PGPR). These beneficial bacteria colonize the rhizosphere and stimulate plant growth by fixing atmospheric nitrogen, solubilizing essential nutrients, producing phytohormones and suppressing plant pathogens. The interaction between crops and PGPR influences not only plant growth but also the synthesis of secondary metabolites that contribute to nutritional and medicinal properties.

Pea (Pisum sativum) is a widely cultivated legume valued for its high protein content and role in biological nitrogen fixation. Fenugreek (Trigonella foenum-graecum) is an important spice and medicinal plant used extensively in traditional systems of medicine. Dolichos lablab is an underutilized but nutritionally rich legume known for its adaptability, protein content and health benefits. Studying the phytochemical composition of these crops under intercropping conditions provides valuable insight into their functional, nutraceutical and agricultural potential. Pea plant: Mature seeds of Pisum sativum cv. "Grapis" were investigated to identify glucosyl conjugates of gibberellins (GAs). Purified and permethylated extracts were analyzed by capillary gas chromatography-mass spectrometry (GC-MS). Based on synthetic standard compounds, GA_{20}-13-O-glucoside (4), GA_{29}-2-O-glucoside (7), and GA_{29}-13-O-glucoside (8) were identified by full-scan spectra. This is the first definitive evidence of the native occurrence of gibberellin-O-glucosides in pea. (G Schinder et al., 1992). Pea and its components can be further developed into more valuable and nutritious products. (Wu DT et al.,2023). Menthe plant: With essential amino acids, iron, ascorbate, folate content. The gas chromatography -mass spectrometry (GC-MS) analysis also Fenugreek (Methi) is an important spice; its dried seeds have wide application in food and beverages as flavoring additive as well as in medicines. The present study was carried out to identify chemical presents in extract them ethanolic seed extract of the plant by phytochemical screening methods and GC-MS analysis. The Phytochemicals studies test shown the presence of carotenoids, polyphenols alkaloids, fatty acids, essential oils, proteins identified the presence of phytochemical components like 2-isocyanato –2- methyl propane (RT:6.555),(5R,6R)-5,6-dihydroxy-5-methyl dihydro-2, 4 (1H,3H) –pyrimidinedione (RT: 6.878), (5R) – 2 – iso propylidine-5-methylcyclohexanone (RT: 12.217).(Shila kant 2013).

From ancient time spices are used to flavor and improve the taste of food recipes. Besides this they are used in cosmetics and medicinal preparation of Indians and Nepali systems such as Ayurveda and Unani. Trigonella foenumgraecum(fenugreek/Methi) has great medicinal value.

The n-hexane extract, Sudan sample of Trigonella foenum-graecum contains oleic acid (9.09%) and butyl phosphonic acid, di(4-octyl) ester (8.72%) as major components, while petroleum ether extract contains O-cymene (27.69%) and Gamma-Terpinene (23.92%) as major components. n-hexane extract contains 9-octadecanamide (Z)-(17.14%) and stearic acid (13.51%), while petroleum ether extract contains D-Limonene (36.46%) and Gammasitosterol(10.95%) as major constituents. The petroleum ether extract of fenugreek seeds from Sudan is rich in Gamma-terpinene and O-cymene, whereas the extract from Saudi Arabia is rich in D-limonene and Gamma-sitosterol. (Hatil Hashim et al., 2024).

Future research should focus on exploring genetic diversity, enhancing nutritional quality, developing sustainable cropping systems and leveraging biotechnological tools to develop climate resilient cultivars with higher production and improved nutrition. Ultimately, increasing awareness of the Dolichos bean benefits can foster wider adoption and support its sustainable use for food, feed and various value-added products across diverse regions (Krishnan Deepana et al., 2024).Dolichos lablab Linn. is a species of bean in the family Fabaceae. Kingdom: Plantae,Subkingdom: Viridiaplantae, Division: Tracheophyta, Subdivision: Spermatophytina Class: Magnoliopsida, Order: Fabales, Family: Fabaceae,Genus: Lablab, Species: Lablab purpureus (Dolichos lablab). To reveal the nutraceutical potential of indigenous plants it is essential to develop quality parameters of standardization. In present study, the dried powder of germinating seeds was extracted in nonpolar solvents, and the extracts were subjected to GC-MS based investigation for phytochemical profiling. GC-MS served as an operative device for concomitant evaluation of phytoconstituents from the seed extracts. This work provides rapid, sensitive & specific detection of various phytoconstituents present in Dolichos bean, which can help in exploring the therapeutic potential of the plant. This work therefore uncovers the phytochemical profile of Dolichos beans emphasizing their nutraceutical properties against important human diseases. The Dolichos bean: a versatile legume with potential to address food security challenges and strategies for improvement (Palekar et al., 2020).(Deepana, etal., 2025)

GC-MS studies on Dolichos lablab (hyacinth bean) have been used to identify a wide range of compounds, including volatile components like hexanal, polyamines such as spermidine and spermine in seeds, and other phytoconstituents like tannins, amyrins, and lupeol in the leaves and extracts. These analyses help in understanding the plant's chemical profile, which has implications for its medicinal and nutritional potential. (Anup kumar sarkar et al., 2024). Taxonomically, Dolichos bean belongs to the family Fabaceae and native to India (Nene, 2006). It is a seed-propagated annual herbaceous plant with active trailing and twining growth patterns, The cultivated dolichos bean is classified into two groups namely vegetable and Pulse type. The vegetable type (Lablab purpureus L. var. typicus) of Dolichos bean is predominantly a perennial twining herb, generally trained on a pendal. It produces flat, longer and more tapering pods with less fibre on pod wall. It is usually cultivated for soft and fleshy whole pods for vegetable purposes, and thus popularly known as pole bean. Pulse type Dolichos bean (Lablab purpureus L. var. lignosus) predominantly a perennial bush, usually cultivated as an annual. It is mainly cultivated for green seeds, and thus, popularly known as field bean (Raghu et al. 2019).

Dolichos beans are commonly grown in arid and semi-arid regions of Asia, Africa and America. It is grown across India, primarily in the states of Karnataka, Andhra Pradesh, Telangana, and the nearby districts of Tamil Nadu and Maharashtra, as well as in the north-eastern hilly terrains. Karnataka alone accounts for nearly 90% of both area and production of Dolichos cultivation in India (Laxmi et al., 2015). It is a popular leguminous vegetable crop spread across the country and is commonly known as hyacinth bean or field bean. It is treated as one of the most nutritious pod vegetables it contains protein, carbohydrates, vitamins, and dietary fibers. The dry seeds are used for a variety of vegetable dishes, while the leaves are utilized to make hay, silage, and green manures (Bose et.al. 1993).

Being indigenous crop, a huge diversity is available in terms of pod colour, pod shape, size and other horticultural traits at biodiversity hotspot regions. It is a climate resilient crop that provides nutritional and financial security to small and marginal farmers in tropical and sub-tropical regions. Being a legume, it can fix 170 kg/ha of atmospheric nitrogen while also producing enough crop residue to add organic matter to the soil (Ullasa et al., 2018). Because of the high protein content, it is regarded as poor man's meat (Joshi and Rahevar, 2015). The crop is known for having a high protein (3.6%) and fibre content (1.8%). Dry seed, on the other hand, has 23.0 to 28.0 per-cent protein and is high in phenol. (1.7- 9.67 mg/100 g), antioxidant (Rai et al., 2014). Seeds have been found to have therapeutic qualities such as diuretic, antispasmodic, anthelmintic, digestive, stomachic, and carminative (Chopra et al., 1986). It has high nutrition value and possesses immense health benefits. The flavonoid 'genistein' found in dolichos bean plays a role in the prevention of cancer (Kobayashi et al., 2002).

Judicious management of major and minor nutrients plays a pivotal role in increasing seed yield and quality of field bean. In addition to the primary nutrients, field bean also requires optimum number of micronutrients such as zinc, boron and molybdenum etc., for improving its vegetative and reproductive characteristics leading to higher seed yield and quality (Singh et al., 2008). Foliar applications can be considered as one of the best methods for micronutrients applications (Ali, 2011). Period of seed-filling is considered as one of the most critical stages affecting crop yield in most of the legume plants. Foliar application of micronutrients at this stage increased number of flowers and pods. Robertson and Longhman (1974) indicated that boron application improved the uptake of P & N and stated that balanced application of micronutrients plays a critical role in determining the effectiveness of seed development in lab lab bean and thereby, better yield of top-quality seeds. Zinc is an essential component of various enzyme activity for energy production, protein synthesis and growth regulation. Besides, it is also helpful in nodulation and nitrogen fixation (Kabi and Poi, 1980).

The plant growth and developmental characters, flowering and quality parametersare generally influenced by several biotic, abiotic, agronomic and management practices besides genetic makeup of every genotype. The improvement in quantitative characterswith respect to different plant growth regulators sprays has been recorded in dolichos bean.The plant growth regulators sprays are known to exert stimulatory effect and have significant influence on plant structure, crop growth, flowering, maturity and pod yield in lablab irrespective of the season (Kumanan et al., 2020). There are many factors that inhibit germination in dolichos bean viz. some phenolic substances, antinutritional factors such as enzymes (trypsin, chymotrypsin, amylase) inhibitors, phytic acid, flatulence factor, oligosaccharides, namely raffinose, stachyose andverbascose which may inhibit the germination (Ramakrishna et al., 2006).

The seed of 3 dolichos bean showed lower per cent of germination in seed testing laboratory and good germination under field condition. Applications of GC-MS studies in Dolichos labla Seeds: Identified polyamines like putrescine, spermidine, and spermine, as well as novel compounds like N-(3-aminopropyl) aminoethanol. Found compounds such as amyrins, lupeol, sitosterols, and tannins in leaves and other extracts. Used GC-MS along with other techniques to analyze a pectin-glucuronoxylan complex, providing detailed information about its structure. Phytochemical profiling of various extracts revealed a rich variety of compounds, which can be used to develop or standardize herbal medicines. Future research should focus on exploring genetic diversity, enhancing nutritional quality, developing sustainable cropping systems and leveraging biotechnological tools to develop climate resilient cultivars with higher production and improved nutrition. Ultimately, increasing awareness of the Dolichos bean benefits can foster wider adoption and support its sustainable use for food, feed and various value-added products across diverse regions (Krishnan Deepana et al., 2024).

Dolichos lablab Linn. is a species of bean in the family Fabaceae. To reveal the nutraceutical potential of indigenous plants it is essential to develop quality parameters of standardization. In present study, the dried powder of germinating seeds was extracted in nonpolar solvents, and the extracts were subjected to GC-MS based investigation for phytochemical profiling. GC-MS served as an operative device for concomitant evaluation of phytoconstituents from the seed extracts. This work provides rapid, sensitive & specific detection of various phytoconstituents present in Dolichos bean, which can help in exploring the therapeutic potential of the plant. This work therefore uncovers the phytochemical profile of Dolichos beans emphasizing their nutraceutical properties against important human diseases. Dolichos lablab Linn. is a species of bean in the family Fabaceae. To reveal the nutraceutical potential of indigenous plants it is essential to develop quality parameters of standardization. In present study, the dried powder of germinating seeds was extracted in nonpolar solvents, and the extracts were subjected to GC-MS based investigation for phytochemical profiling. GC-MS served as an operative device for concomitant evaluation of phytoconstituents from the seed extracts. provides rapid, sensitive & specific detection of various phytoconstituents present in Dolichos bean, which can help in exploring the therapeutic potential of the plant. This work therefore uncovers the phytochemical profile of Dolichos beans emphasizing their nutraceutical properties against important human diseases. Out of fifty-eight volatile compounds detected by gas chromatography-mass spectrometry (GC–MS) analysis, three compounds exhibited interesting biological activities like pheromone activity, sleep-inducing activity, signaling activity, neuroactive and analgesic activity, and one used as component of cosmetic products.

This study utilizes GCMS (gas chromatography mass spectrometry) analysis to compare the phytochemical profiles of Hebbel Avare-3 (HA-3) and its high-yielding M3 generation mutants namely, M8-18, 10 mM and 100 Gy. HA-3 exhibited the presence of 32 phytochemical compounds, while M8-18 contained 44,10 mM revealed 32 and 100 Gy showed 36 phytochemical compounds. The mutants revealed ten abundant novel phytochemicals that were not detected in HA-3, such as 1,3-propanediol, 2-(hydroxymethyl)-2-nitro-, 9,12-octadecanoic acid, 2,3-dihydroxypropyl ester, hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester, stigmasterol, γ-sitosterol, 9,11-octadeca-dienoic acid, methyl ester,(E,E)-,octadecanoic acid, 2,3-dihydroxypropyl ester, γ-tocopherol, 9,12-octadecadienoicacid (Z, Z)-,2,3-dihydroxypropyl ester, octanoic acid, 2-furanylmethyl ester, which have various pharmaceutical, agrochemical and food industry applications. M8-18is rich in 1,3-propanediol, 2-ethyl-2-(hydroxymethyl) (20.60%), 10 mM in stigmasterol (13.40%) and 100 Gy in 1,3-propanediol, 2-(hydroxymethyl)-2-nitro (19.37%). These newly identified compounds in seeds possess antifungal properties, anticancer, antibacterial and anti-inflammatory properties. The enhanced phytochemical profiles of these mutants will aid in developing a superior field bean variety with various applications in pharmaceuticals and for humans. Dolichos lablab, Glycine max and Arachis hypogea. The phytochemical screening and other recommended Parameters for standardizations were performed. Preliminary phytochemical Screening showed the Presence of Steroids, tannins, Proteins, flavonoids, terpenoids, carbohydrate, Protein with help of compound microscope the seeds are thoroughly identified, can be used as rapid inexpensive binomial identification. So these three legume varieties are very important in our daily life. (J S Jaya et al., 2019). Dolichos pachyrhizus rhizomes' ethyl acetate extract underwent phytochemical and GC-MS analysis, which identified the existence of bioactive substances with significant therapeutic effects. Consequently, the existence of these phytochemicals may be partially responsible for the plant's medicinal properties. (Musa et al., 2025).

Methodology

Materials and Methods: Plant materials including seeds, leaves, stems and roots of Pea, Fenugreek and Dolichos lablab were collected from plants grown under controlled intercropping and non-intercropping conditions. The collected samples were thoroughly washed, shade-dried and powdered. Methanolic extraction was carried out using standard extraction procedures.

GCMS Analysis:

GC-MS analysis was performed using a Thermo make GC Trace 1310 interfaced to thermo make MS TSQ 8000 System. Gas Chromatograph interfaced to a Mass Spectrometer (GC/MS) equipped with an TG 5MS silica capillary column (30m×0.25mm ID)×MDF composed of 5% diphenyl/95% dimethyl polysiloxane with 0.25 um Film thickness.For GC/MS detection, an electron ionization system with ionization energy of 70 eV was used. The oven temperature was programmed from 80°cwith a hold of 2 mins and then 200°c at 9°c/min and a hold for 4 min and then to 300°c at 10°c/min and a hold for 5 min. Helium was used as carrier gas at flow 1.5 mL/min. The injector temperature was 250°c, injection size 1.0 uL neat, with splitless mode. Injector temperature was 250°c and ion source temperature was 230°c. The interface and MS ion source were maintained at 300°c and 230°c respectively, Mass spectra were taken at 70ev,a scan interval of 0.2 seconds and fragments from with a mass scan range of 50-550amu.Total GC running time was 35 min (Sania et.al., 2018).The relative percentage amount of each component was calculated by comparing its average peak area to the total areas. Data handling was done using caliber software. The identification of compounds was based on comparison of their mass spectra with those of NIST Libraries. Software adapted to NIST 2014 (2.2.0.0) with AMDIS v.2.72 Version.

Table 1: GCms Compounds with Details

Sl.no	Plant sample	Area%	Height%	Name	importance	Food related application
1	Menthe seeds	18.98	5.29	2-(Isobutoxymethyl)oxirane	Pharmaceutical sciences	nil
2	Dolichos seeds	30.74	12.10	2-(Isobutoxymethyl)oxirane	Pharmaceutical sciences	nil
3	Pea seeds	15.46	19.23	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	Cosmetics and personal care, antioxidant, anti-inflammatory, and anthelmintic activities.	food preservative, and it has been investigated for potential antioxidant and anti-inflammatory properties.
4	Dolichos with menthe stem	44.82	40.28	n-Hexadecanoic acid	Cosmetics and personal care, antioxidant, anti-inflammatory, and anthelmintic activities.	food preservative, and it has been investigated for potential antioxidant and anti-inflammatory properties.
5	Dolichos with menthe Root	23.76	14.80	Brasiliamide A, Me derivative	Anticancer drug	nil
6	Dolichos without menthe stem	34.06	32.19	Tetradecanoic acid	Pharmaceutical application	primarily as a flavor enhancer/adjuvant, defoaming agent, and coating for fresh produce like citrus fruits
7	Dolichos without menthe Root	26.63	27.94	13-Docosenamide, (Z)-	Bioplastic	nil
8	Dolichos with out menthe leaf	32.53	32.09	Phthalic acid, butyl undecyl ester	Microplastics	nil
9	Dolichos with menthe leaf	32.53	32.09	Phthalic acid, butyl undecyl ester	Microplastics	nil

Table 2: Important Components of the Crops and their Application

Sl.no	Menthe seeds	Applicataion
1	10E,12Z-Octadecadienoic acid	Anti-cancer effect, Anti-atherosclerosis, Improve meat quality, Application prospect Currently, a few countries in the world have produced health foods using 10E,12Z-octadecadienoic acid as raw material. 10E,12Z-octadecadienoic acid as the main active ingredient.
2	Dolichos seeds	
	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	Food science: It is a common product of the Maillard reaction, a reaction that occurs during the heating of foods. It can influence the taste, and sometimes the bitterness, of food. Studies are looking at its role in functional foods.
	Stigmasterol	Stigmasterol, a plant phytosterol, has diverse applications in medicine for its anti-inflammatory, antioxidant, anticancer, and neuroprotective properties, aiding in conditions like diabetes, arthritis, and neurological disorders, and serves as a crucial precursor in steroid drug synthesis (like progesterone). In agriculture, it's used as a biostimulant to promote plant growth, root development, and stress resistance. Its biological activities stem from regulating pathways involved in oxidative stress, cell death (apoptosis), and inflammation.
3	Dolichos with menthe stem	
4	4H-Pyran-4-one,2,3-dihydro-3,5-dihydroxy-6-methyl-	Food science: It is a common product of the Maillard reaction, a reaction that occurs during the heating of foods. It can influence the taste, and sometimes the bitterness, of food, role in functional foods.
5	Tetradecanoic acid	Tetradecanoic acid: Constituent of plant waxes: As a carboxylic acid, it is a component of the waxy layers on plant surface that is found in various plant oils and fats, such as coconut and palm oil, and is a building block for plant lipids.
6	n-Hexadecanoic acid	Nutritional component: N-Hexadecanoic acid is present in breast milk, providing a significant portion of its fat content, and is a common dietary intake.

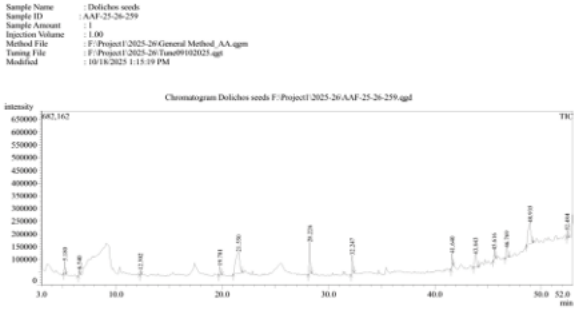
	.alpha.-Amyrin	Alpha-amyrin (α-amyrin) is a natural pentacyclic triterpene with significant pharmacological potential, showing promise in research for applications like anti-inflammatory, anticancer, antimicrobial, neuroprotective, and liver-protective drugs, though it's still in preclinical stages, not yet widespread human use. Key applications explored include treating inflammation (skin, joints), fighting bacterial infections (like MRSA), potentially inhibiting cancer cell growth, managing metabolic issues (diabetes, high lipids), and protecting the liver, often derived from plant resins and studied for its action on signaling pathways. Metabolic Disorders: Helps lower blood glucose and lipids, showing potential for diabetes and hyperlipidemia. It can activate AMPK and PPAR pathways for glucose uptake.

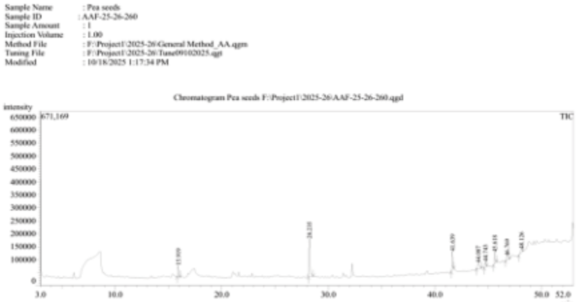
4	Dolichos with menthe Root	
	Alpha.-Amyrin	Alpha-amyrin (α-amyrin) is a natural pentacyclic triterpene with significant pharmacological potential, showing promise in research for applications like anti-inflammatory, anticancer, antimicrobial, neuroprotective, and liver-protective drugs, though it's still in preclinical stages, not yet widespread human use. Key applications explored include treating inflammation (skin, joints), fighting bacterial infections (like MRSA), potentially inhibiting cancer cell growth, managing metabolic issues (diabetes, high lipids), and protecting the liver, often derived from plant resins and studied for its action on signaling pathways.
5	Dolichos with menthe leaf	
	Phytol	Phytol, a plant-derived alcohol from chlorophyll, is used as a fragrance in soaps, cosmetics, and cleaners, and as a key precursor for synthesizing Vitamins E and K. Beyond these, it shows promise in medicine for its anti-inflammatory, antioxidant, antimicrobial, and immune-modulating properties, potentially treating arthritis, infections, and acting as an adjuvant, with research exploring its use in pharmaceuticals and biotech.
	13-Docosenamide, (Z)-	Anti-inflammatory & Analgesic: Reduces inflammation and pain, useful for conditions like skin inflammation or arthritis.

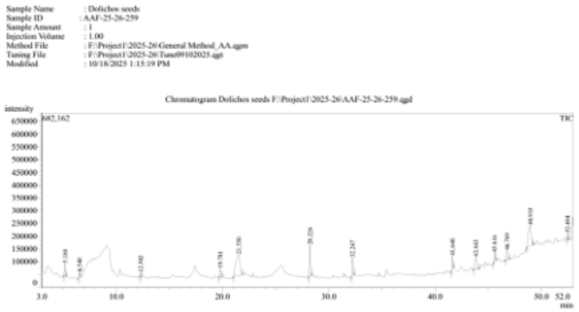
Table 3: Compounds Showing Relationship Between the PGPRs and PGPR

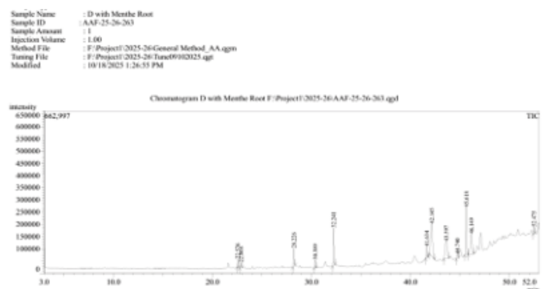
1	Tetradecanoic acid	Fatty acid promoting bacterial growth and biofilm formation
2	2-Pentadecanone, 6,10,14-trimethyl- (Phytone)	Volatile organic compound stimulating PGPR signaling
3	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	Promotes PGPR quorum sensing and biofilm development
4	13-Docosenamide, (Z)-	Enhances microbial adhesion and root colonization
5	Stigmasterol	Enhances plant cell growth, indirectly favors PGPR colonization
6	3-Furanmethanol (possible)	Supports microbial colonization and plant–microbe signaling

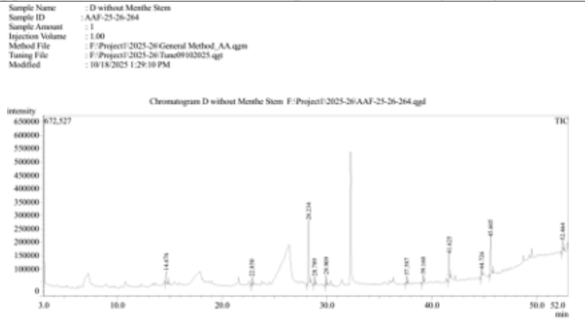
Fid-1-8 GCMS Analysis Representtation

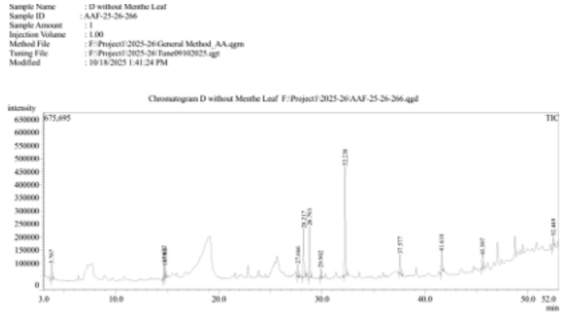


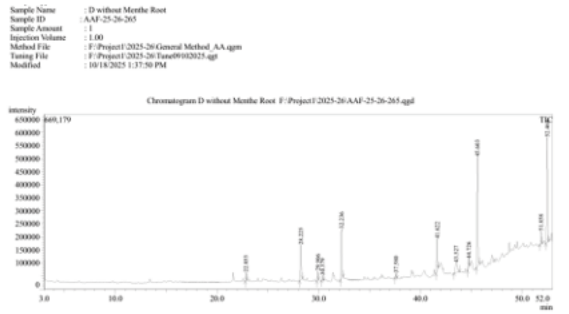


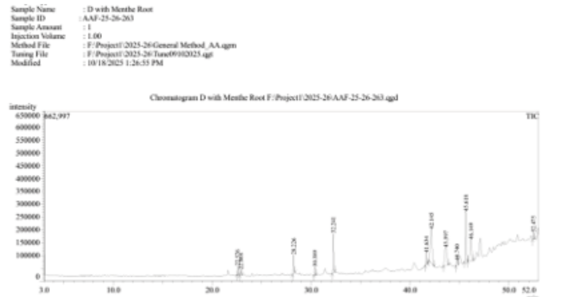












RESULTS

GC–MS analysis revealed a diverse range of bioactive compounds across different plant samples in the normal variety and interbreed variety.

Menthe seeds has shown the following compounds like Pantolactone, Smilagenin, Spirost-5-en-3-ol, acetate, (3.beta.,25R), Octadecanoic acid, Oleic Acid, 10E,12Z-Octadecadienoic acid, Phytol, n-Hexadecanoic acid, Tetradecanoic acid, 6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-o, Benzoic acid, 4-ethoxy-, ethyl ester, Fumaric acid, pent-4-en-2-yl propyl ester, beta.-D-Glucopyranose, 1,6-anhydro-,2-(Isobutoxymethyl)oxirane, 1-Isopropyl-2,2-dimethylpropylideneamine, 5-Hydroxymethylfurfural, 4-Vinylphenol, Pantolactone, 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl.

Dolichos seeds has shown the following compounds like1,2-Cyclopentanedione, Dimethyl trisulfide, 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-(C. Kanzler etal.,2016),1-Isopropyl-2,2-dimethylpropylideneamine, 2-(Isobutoxymethyl) oxirane, Stigmasterol, (25R)-5.alpha.-Spirostan-2.alpha.,3.beta.-diol, gamma.-Sitostenone, 13-Docosenamide, (Z)-, Lupeol, Hexadecanoic acid, 2-hydroxy-1-, n-Hexadecanoic acid,(hydroxymethyl)ethyl ester, Tetradecanoic acid.

Interbreed compounds present in the different parts of the plant has various properties and has been in symbiotic relationship with the PGPRs incomparison with menthe and Dolichos plant grown together in the same pot with maintaining proper condition.

Dolichos with menthe stem has shown the following compounds like Ethanol, 2-phenoxy,4H-Pyran-4-one, 2,3-dihydro-3,5-Ethanol, 2-phenoxy-,dihydroxy-6-methyl-, Propylene Carbonate, (Greer, A.J et al., 2020),Tetradecanoic acid. Stigmasterol, Cholesta-4,6-dien-3-ol, (3.beta.)-. alpha.-Amyrin, 13-Docosenamide, (Z)-, Octadecanoic acid, Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester, 4,8,12,16-Tetramethylheptadecan-4-olide.

Dolichos with menthe Root has shown the following compounds like Lanosta-8,24-dien-3-one, 13-Docosenamide, (Z)-, Stigmasterol, Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester, Brasiliamide A, Me derivative alpha.-Amyrin, Dibutyl phthalate, 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester, Benzoic acid, 4-ethoxy-, ethyl ester, Tetradecanoic acid. 2,4-Di-tert-butylphenol.

Dolichos with menthe leaf has shown the following compounds like 13-Docosenamide, (Z)-, Stigmasterol, Octadecanoic acid, 2-hydroxy-1,3-propanediyl di-ester, 4,8,12,16-Tetramethylheptadecan-4-olide, aHexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester4,8,12,16-Tetramethylheptadecan-4-olide, Phytol, 2-Pentadecanone, 6,10,14-trimethyl-,2-Cyclohexen-1-one, 4-hydroxy-3,5,5-trimethyl-4-(3-oxo-1-buteny, Tetradecanoic acid, , Benzoic acid, 4-ethoxy-, ethyl ester, Ethanol, 2-phenoxy. (Singh, S.K., et al., 2020).Hence the relationship between the PGPRs and PGPR has shown in the form of the secondary metabolites symbiotically.The presence of

CONCLUSION

The present study confirms that intercropping of Dolichos lablab, fenugreek, and pea enhances phytochemical diversity and promotes the accumulation of growth-regulating and bioactive compounds. Total no of compounds found in fenugreek are 19 compounds, Pea has shown 13 compounds, Dolichos Lablab has 12 compounds with different functional compounds.

GC–MS analysis identified key constituents such as stigmasterol (plant growth regulator promoter), 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl (role in functional foods) phytol(precursor for synthesizing Vitamins E and K), α-amyrin(lower blood glucose and lipids), n-hexadecanoic acid (common dietary intake) and 10E,12Z-octadecadienoic acid (role in functional foods,), which contribute to plant growth, nutritional value, and pharmaceutical potential.

The integration of intercropping with PGPRs and biofertilizers represents a sustainable approach to improving crop productivity and biochemical quality. These findings support the adoption of intercropping systems for enhanced agricultural resilience, nutraceutical development, and eco-friendly farming practices. Future line of work is the finding different compounds in the curing various ailments.

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