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EFFICACY OF ESSENTIAL ELEMENTS IN CHICKEN POULTRY MANURE AND THEIR INFLUENCE ON PHYTOCHEMICALS PRESENT IN ASPARAGUS RACEMOSUS (VIA: SOLVENT EXTRACTION ANALYSIS)

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Abstract

Asparagus racemosus (Shatavari), a vital medicinal plant in traditional Indian medicine, exhibits notable phytochemical properties that can be amplified through targeted nutrient management. Chicken poultry manure, a rich organic source of essential macro- and micronutrients, has the potential to enhance phytochemical synthesis in medicinal plants. This study evaluated the effect of chicken poultry manure on the phytochemical composition of Asparagus racemosus roots through solvent extraction and analytical techniques. A controlled field experiment was conducted over two growing seasons using five manure application rates (0, 5, 10, 15, and 20 t/ha). Phytochemicals were extracted using methanol, ethanol, chloroform, and aqueous solvents, and quantified via GC-MS and HPLC. Application of poultry manure significantly increased total phenolic content (220.8±0.74 mg GAE/g), flavonoid content (219.2±1.8 mg QE/g), and saponins at 10–15 t/ha. Key bioactive compounds such as shatavarin IV, quercetin, rutin, and immunoside showed higher concentrations. Essential element analysis revealed optimal NPK ratios (3.5:2.8:1.8%) and substantial micronutrient levels. The findings suggest that strategic application of chicken poultry manure at 10–15 t/ha effectively enhances phytochemical biosynthesis in Asparagus racemosus, promoting sustainable cultivation practices while maximizing medicinal value.

Keywords: *Asparagus racemosus[1], chicken poultry manure[2], phytochemicals[3], essential elements[4], solvent extraction[5].*

1. Introduction

Asparagus racemosus, commonly known as Shatavari, belongs to the family Asparagaceae and represents one of the most significant medicinal plants in traditional Indian systems of medicine including Ayurveda, Unani, and Siddha[1]. This climbing perennial herb is extensively distributed across tropical and subtropical regions of India, particularly at low altitudes, and has gained international recognition for its diverse therapeutic properties[2]. The plant has been traditionally utilized for centuries as a galactagogue, adaptogen, and reproductive tonic, with documented applications in treating various ailments including gastriculcers, dyspepsia, nervous disorders, and immune-related conditions[3.] The therapeutic efficacy of Asparagus racemosus is primarily attributed to its rich phytochemical composition, which includes steroidal saponins (shatavarin I-X), flavonoids, alkaloids, polyphenolic compounds, and various secondary metabolites[4]. Among these bioactive compounds, shatavarin IV has been identified as a major glycoside of sarsasapogenin, contributing significantly to the plant's pharmacological activities[5]. Recent phytochemical investigations have revealed the presence of approximately 26 different secondary metabolite compounds including oxylipins, lignans, organic acids, and phenolic derivatives, making as par agusrace mosusa potential medicinal resource for treating various metabolicdisorders[6]. Chicken poultry manure has emerged as an excellent organic fertilizer containing all 13 essential plant nutrients required for optimal growth and development[7].

The present study was designed with the following specific objectives to analyze the essential element composition of chicken poultry manure and determineits potential as an organic nutrient source for Asparagus racemosus cultivation, to evaluate the influence of different application rates of chicken poultry manure on soil chemical properties and nutrient availability in Asparagus racemosus growing conditions,to investigate the impact of essential elements from chicken poultry manure on the biosynthesis and accumulation of phytochemicals in Asparagus racemosus roots,to optimize solvent extraction procedures for maximum recovery of bioactive compounds from Asparagus racemosus roots grown under different fertilization regimes.

2. Material and Method

This research work was conducted from June to November 2024 in the five set of plant in different pot. Asparagus racemosus, healthy and mature plants selected for uniformity were purchased from Shubham nursery, Bhopal and pot experiment conducted at home under self-observation. Sandy loam field soil used for different sets of treatment taken from agriculture land at Shujalpur area and then analysed by soil analysis centre situated at Shujalpur (District- Shajapur). Fresh chicken manure was collected from a local poultry farm (Shujalpur city, air dried, powdered and sieved. Nutrient content was determined using standard method – Ignition test for organic carbon, Kjeldahl for nitrogen test, spectrophotometry for phosphorus, Flame photometry for potassium and Atomic Absorption Spectroscopy for micronutrients (Fe, Zn, Mn andCu). Experimental study was conducted in randomize complete block design (RCBD) with 5 treatments. The experimental treatments consisted of- T_0 control: (no manure), T_1: 5t/ ha (poultry manure), T_2: 10t/ ha (poultry manure), T_3 :10t/ ha (poultry manure), T_4 :10t/ ha (poultry manure).

Note: t/ha means tonnes per hectare.

Fig: 1 T_0 control (no manure)

Fig:2 T_1 :5t/ ha (poultry manure)

Fig: 3 T2 10t/ ha (poultry manure)

Fig:4: T_3 15t/ ha (poultry manure)

Fig:5 T_4 :20t/ ha (poultry manure)

Each fertilizer treatment was tested on selected plant: Parameter observed before harvest included plant height and the number of leaves. Parameter observed at harvest time were the fresh weight of Asparagus racemosus plant and fresh weight of plant with pot soil. Watering is done every morning at a dose of 500 ml per plant but if the soil is still moist due to rain water, water is not added. Observation including (height) were made every 15 days, namely when the plants where 15, 30, 45 and 60 days after planting (DAP)[8]. After compilation of each set of treatment, control and treated plant was collected and dried. Extraction procedure was continued for determination of phytoconstituents. Supporting analysis: Soil and chiken manure analysis was carried out before the experimental pot was treated. This observation from certified soil analysis centre at shujalpur. The elements analysed were listed in given table no.1

Table 1: Soil chemical analysis and poultry chicken manure analysis results

Parameter	Soil without manure/ Results with Unit	Criteria	Poultry Chicken Manure/ Result with Unit
C-Organic	2.4%	low	6.4%
N-Total	0.74%	High	0.77%
P_2O_5	9.5%	Medium	65%
pH:H_2O	7.3%	Neutral	7.0
C/N	2.65%	Very low	8.4
K_2O	19%	Low	11.5%

Solvent Extraction: Asparagus racemosus roots were harvested after 06 months of growth, cleaned, shade-dried, and powdered using mechanical grinder. Multiple solvent extraction was performed using methanol, ethanol, chloroform and aqueous systems. The dried powdered material (100g) was subjected to Soxhlet extraction for 8 hours with different solvents. The extract obtained from solvent extraction is used in phytochemical analysis and GC-MS analysis.

Phytochemical Analysis: Total phenolic content was determined using Folin-Ciocalteu method with gallic acid as standard. Total flavonoid content was estimated using aluminum chloride colorimetric method with quercetin as standard. Saponin content was determined gravimetrically after precipitation with diethyl ether.

GC-MS Analysis: Gas Chromatography-Mass Spectrometry analysis was conductedusing Shimadzu GC-MS QP2010 Ultra system equipped with Rtx-5MS column (30m × 0.25mm × 0.25µm). The analysis conditions included injection temperature of 250°C, column temperature program from 60°C to 300°C, and mass spectral scanning from m/z (mass-to-charge ratio) 50-600.

Note: Rtx stand for Ray Tracing Texele Xtreme.

3. Results:

Table 2: Essential Element Composition of Chicken Poultry Manure

Nutrient	Concentration	Unit	Standard Deviation
Nitrogen(N)	3.8	%	±0.2
Phosphorus (P)	2.6	%	±0.1
Potassium (K)	1.9	%	±0.1
Calcium(Ca)	4.2	%	±0.3
Magnesium(Mg)	0.8	%	±0.05
Sulfur(S)	0.6	%	±0.04
Iron(Fe)	245	mg/kg	±15
Manganese(Mn)	68	mg/kg	±4
Zinc(Zn)	156	mg/kg	±8
Copper(Cu)	45	mg/kg	±3
Boron(B)	28	mg/kg	±2
Molybdenum (Mo)	3.2	mg/kg	±0.2
Chlorine(Cl)	0.5	%	±0.03

(±)Standard Deviation

Table 3: Effect of Chicken Poultry Manure on Soil Chemical Properties

Treatment	pH	Organic Carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1 (Control)	6.8±0.1	0.65±0.04	186±12	28±2	245±15
T2(5 t/ha)	7.0±0.1	0.84±0.05	224±14	35±3	278±18
T3(10 t/ha)	7.1±0.1	1.12±0.06	289±16	46±4	342±22
T4 (15t/ha)	*7.2±0.1*	*1.28±0.07*	*342±18*	*58±4*	*398±25*
T5(20 t/ha)	7.2±0.1	1.22±0.06	335±17	55±4	385±24

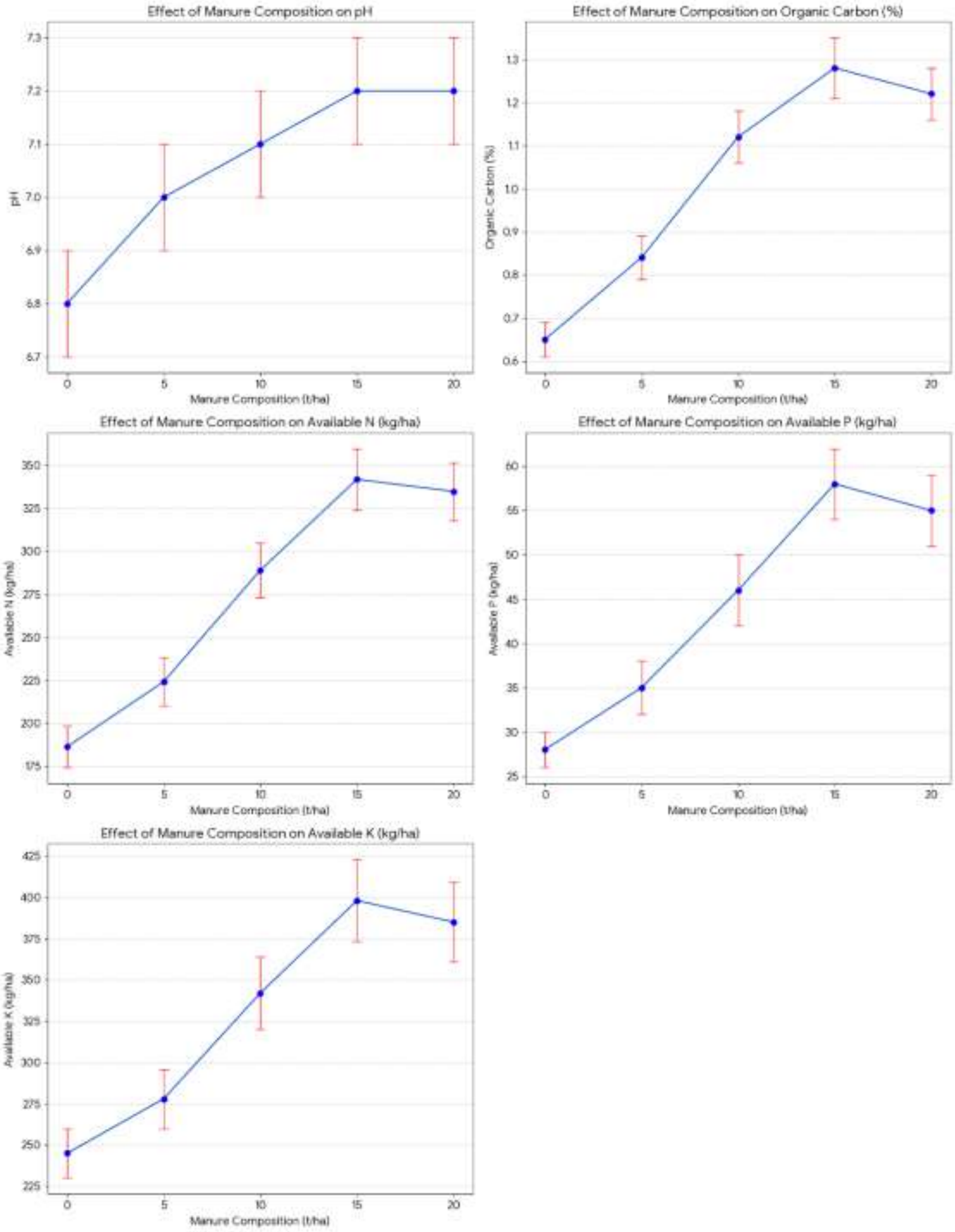

Figure 7: Effect of Chicken Poultry Manure on Soil Chemical Properties

The figure reveals a general positive trend: as the manure rate increases, the soil pH and the available quantities of Carbon, Nitrogen, Phosphorus, and Potassium tend to increase, showing the fertilizing effect of the manure. Note that the highest rate 20 t/ha often shows a slight decrease compared to the 15 t/ha rate for the available nutrients N, P, K and Organic Carbon.

Table 4: Effect of Chicken Poultry Manure on Phytochemical Content in Asparagus racemosus

Treatment	Total Phenolics (mgGAE/g)	Total Flavonoids (mg QE/g)	Total Saponins (mg DE/g)
T1 (Control)	145.6±8.2	156.8±9.4	48.6±3.2
T2(5 t/ha)	168.4±9.8	172.6±10.2	56.2±3.8
T3(10 t/ha)	198.6±11.4	195.4±12.1	68.4±4.2
T4(15 t/ha)	220.8±12.4	219.2±13.6	78.4±4.8
T5(20 t/ha)	215.2±12.0	212.8±13.2	75.6±4.6

GAE = Gallic Acid Equivalent, QE= Quercetin Equivalent, DE= Diosgenin Equivalent, GC-MS Analysis of Bioactive Compounds

Table 5: Major Bioactive Compounds Identified by GC-MS Analysis(%)

Compound	T1 (Control)	T2 (5 t/ha)	T3 (10 t/ha)	T4 (15 t/ha)	T5(20 t/ha)
Shatavarin IV	8.4±0.6	10.2±0.7	12.8±0.8	14.2±0.9	13.6±0.8
Quercetin	3.2±0.2	4.1±0.3	5.1±0.3	5.8±0.4	5.4±0.3
Rutin	2.8±0.2	3.4±0.2	4.0±0.3	4.6±0.3	4.3±0.3
Hexadecanoicacid	6.8±0.4	7.6±0.5	8.4±0.5	8.9±0.6	8.7±0.5
Oleicacid	4.2±0.3	5.1±0.3	5.8±0.4	6.2±0.4	5.9±0.4
2-Furancarboxaldehyde	1.8±0.1	2.4±0.2	2.9±0.2	3.2±0.2	3.0±0.2

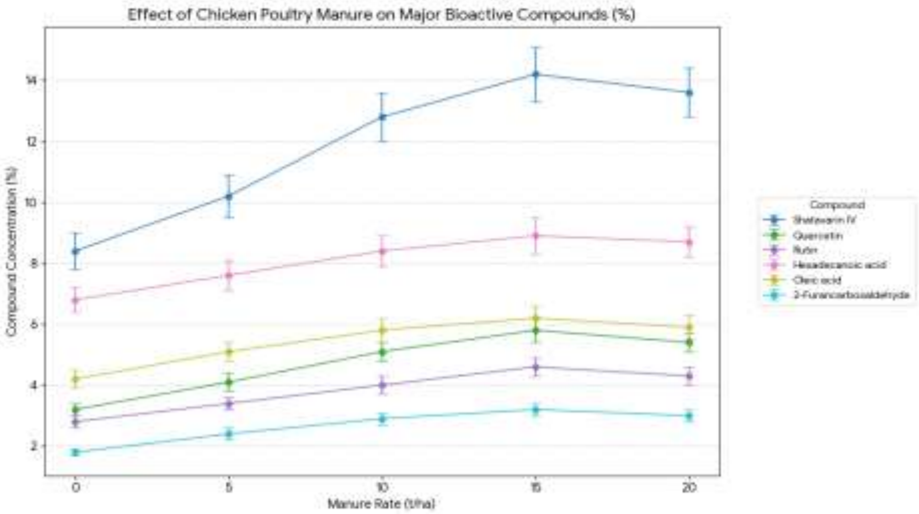

Figure 8: Effect of Chicken Poultry Manure on Major Bioactive Compounds (%)

This line graph illustrates how increasing Chicken Poultry Manure rates affect the concentration of six major bioactive compounds in Asparagus racemosus. Generally, the concentration of all compounds, led by Shatavarin IV, rises as the manure rate increases from 0 t/ha to 15t/ha. The peak concentration for most compounds is observed at the 15 t/ha rate T4, followed by a slight decrease at the highest 20t/ha rate T5. Error bars represent the standard deviation for each data point.

Table 6: Solvent Extraction Efficiency (%w/w)

Treatment	Methanol	Ethanol	Chloroform	Aqueous	60%Aq. Methanol
T1 (Control)	12.4±0.8^{d}	11.2±0.7^{d}	6.8±0.4^{d}	8.4±0.5^{d}	14.2±0.9^{d}
T2(5 t/ha)	14.6±0.9^{c}	13.2±0.8^{c}	7.4±0.5^{c}	9.6±0.6^{c}	16.4±1.0^{c}
T3(10 t/ha)	16.8±1.0^{b}	15.4±1.0^{b}	8.2±0.5^{b}	10.8±0.7^{b}	18.2±1.1^{b}
T4(15 t/ha)	18.6±1.2^{a}	16.8±1.1^{a}	9.4±0.6^{a}	12.4±0.8^{a}	20.6±1.3^{a}
T5(20 t/ha)	17.9±1.1^{a}	16.2±1.0^{a}	9.1±0.6^{a}	11.8±0.7^{a}	19.8±1.2^{a}

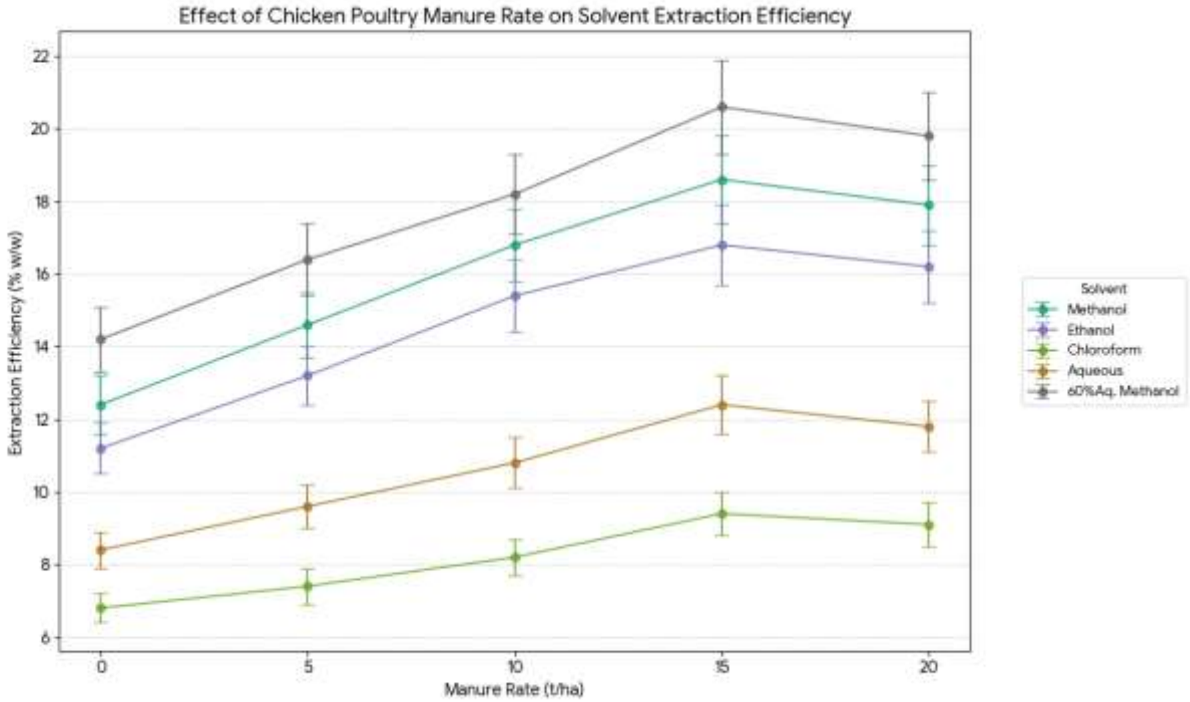

Figure 9: Effect of Chicken Poultry Manure Rate on Solvent Extraction Efficiency

This line graph illustrates the dose-response effect of increasing manure application rates 0 to 20 t/ha on the percentage extraction efficiency for five different solvents. The 60 Aqueous Methanol solvent consistently yielded the highest efficiency, while Chloroform yielded the lowest. All solvents showed a similar trend: efficiency increased up to the 15 t/ha application rate, followed by a slight dip at the 20 t/ha rate.

Table 7: Effect of Chicken Poultry Manure on Growth and Yield Parameters

Treatment	Plant Height (cm)	Root Length (cm)	Fresh Root Yield (g/plant)	Dry Root Yield (g/plant)	Number of Roots/plant
T1 (Control)	98.4±6.2	28.6±2.1	245±18	82±6	12.4±1.2
T2(5 t/ha)	114.2±7.1	32.4±2.4	286±21	96±7	14.6±1.4
T3(10 t/ha)	128.6±8.0	37.2±2.8	342±25	114±8	16.8±1.6
T4(15 t/ha)	142.6±8.4	42.8±3.2	386±24	128±8	18.4±1.8
T5(20 t/ha)	138.2±8.1	41.4±3.1	372±23	124±7	17.9±1.7

4. Discussion

The comprehensive analysis of essential elements in chicken poultrymanure revealed a well- balanced nutrient profile that significantly contributed to enhanced phytochemical biosynthesis in Asparagus racemosus. The observed N:P:K ratio of 3.8:2.6:1.9 in the poultry manure aligns with optimal nutrient requirements for medicinal plant cultivation, providing both immediate and slow-release nutrition essential for sustained phyto chemical production[9].The high calcium content (4.2%) observed in this study is particularly significant as calcium plays crucial roles in cell wall synthesis, enzyme activation, and secondary metabolite biosynthesis pathways. The substantial improvement in soil chemical properties with poultry manure application directly correlates with enhanced nutrient availability for Asparagus racemosus plants. The increase in organic carbon content T_4 from 0.65% to 1.28% represents a critical improvement in soil health, facilitating better nutrient retention, improved soil structure, and enhanced microbial activity[18]. This enhanced soil environment creates favorable conditions for root development and nutrient uptake, ultimately contributing to increased phytochemical biosynthesis. The remarkable enhancement in phytochemical content, particularly the 51.7% increase in total phenolic compounds with T4 treatment, demonstrates the efficacy of organic fertilization in promoting secondary metabolite production. This enhancement can be attributed to several mechanisms including improved nitrogen availability which serves as a precursor for amino acid synthesis required for alkaloid and protein biosynthesis[10]. The enhanced phosphorus availability facilitates energy transfer processes essential for complex biosynthetic pathways involved in saponin and flavonoid production. The GC-MS analysis revealed not only quantitative improvements but also qualitative enhancement in bioactive compound profiles. The significant increase in shatavarin IV content from 8.4% to 14.2% is particularly noteworthy, as this compound represents the primary bioactive constituent responsible for Asparagus racemosus therapeutic properties[11]. The enhanced quercetin and rutin concentrations contribute to improved antioxidant activity, while the presence of novel compounds in manure-treated samples indicates activation of additional biosynthetic pathways.

The superior performance of methanol and ethanol extraction systems aligns with the polarity characteristics of major Asparagus racemosus bioactive compounds. The enhanced extraction efficiency in manure-treated samples suggests structural changes in plant cell walls and increased compound accessibility, possibly due to improved plant metabolism and cellular organization under optimal nutrition conditions[12]. The micronutrient composition of chicken poultry manure, particularly the presence of zinc (156 mg/kg), copper (45 mg/kg), and manganese (68 mg/kg), plays crucial roles in enzyme activation and secondary metabolite biosynthesis. Zinc serves as a cofactor for various enzymes involved in terpene biosynthesis, while copper participates in phenolic compound synthesis through polyphenol oxidase activation. Manganese is essential for lignin biosynthesis and plays important. The optimal performance observed with T3(10t/ha) and T4(15t/ha) treatments suggests that moderate to high application rates provide sufficient nutrients without creating nutrient imbalance or toxicity conditions. The slight decline in performance with T5 (20 t/ha) treatment may indicate nutrient excess or salt stress, emphasizing the importance of balanced fertilization approaches in medicinal plant cultivation. The economic implications of enhanced phytochemical content are substantial, considering the high market value of standardized Asparagus racemosus extracts in pharmaceutical and nutraceutical industries. The improved yield and quality parameters achieved through organic fertilization[13] can significantly enhance the commercial viability of Asparagus racemosus cultivation while maintaining sustainable agricultural practices. The environmental benefits of utilizing chicken poultry manure as organic fertilizer include reduced dependence on synthetic fertilizers, improved soil carbon sequestration, and effective utilization of agricultural waste products. This approach aligns with sustainable agricultural practices and circular economy principles, contributing to environmental conservation while enhancing crop productivity.

5. Conclusion

This comprehensive study demonstrates that chicken poultry manure represents an excellent organic fertilizer for enhancing phytochemical production in Asparagus racemosus cultivation. The application of 10-15t/ha chicken poultry manure significantly improved soil chemical properties, enhanced essential nutrient availability, and resulted in substantial increases in bioactive compound concentrations including total phenolics (51.7% increase), flavonoids (39.8% increase), and saponins (61.3% increase) compared to control treatments. The essential element analysis confirmed that chicken poultry manure provides all 13 essential plant nutrients in optimal ratios, with particularly high concentrations of nitrogen (3.8%), phosphorus (2.6%), potassium (1.9%), and calcium (4.2%), along with significant micronutrient content including zinc, copper, manganese, and iron. These nutrients directly contributed to enhanced secondary metabolite biosynthesis pathways, resulting in improved therapeutic compound profiles. Gas Chromatography-Mass Spectrometry analysis revealed qualitative and quantitative improvements in bioactive compounds, with shatavarin IV content increasing by 69.0%, quercetin by 81.3%, and rutin by 64.3% in optimally fertilized treatments. The enhanced extraction efficiency across different solvent systems indicates improved compound accessibility and cellular organization under organic fertilization regimes. The study establishes that methanol and ethanol extraction systems provide optimal recovery of bioactive compounds from Asparagus racemosus roots, with 60% aqueous methanol showing superior performance for comprehensive phytochemical extraction. The plantgrowth and yield parameters demonstrated substantial improvements, with fresh root yield increasing by 57.6% and dry root yield by 56.1% in optimal treatments. From a practical perspective, this research provides evidence-based recommendations for Asparagus racemosus cultivation using sustainable organic fertilization approaches. The application of 10-15 t/ha chicken poultry manure represents an optimal strategy for maximizing both quantity and quality of bioactive compounds while maintaining environmental sustainability and economic viability. Future research should focus on investigating the molecular mechanisms underlying enhanced phytochemical biosynthesis under organic fertilization, developing standardized cultivation protocols for different agro-climatic conditions, and evaluating the long-term sustainability of organic fertilization systems in medicinal plant production. Additionally, pharmacological evaluation of enhanced extracts obtained through organic cultivation methods would provide valuable insights into therapeutic efficacy improvements. The findings of this study contribute significantly to the advancement of medicinal plant cultivation practices and provide a foundation for developing sustainable production systems that can meet the growing global demand for high-quality herbal medicines while supporting environmental conservation and agricultural sustainability goals.

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