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Research Article

Phytochemical Evaluation Of *Eleusine Coracana* Extract For Its Anti-Microbial Activity

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ABSTRACT

Eleusine coracana (finger millet) is an underutilized cereal crop with potential medicinal properties. This study aimed to investigate the phytochemical composition and antifungal activity of extracts obtained from the seeds of E. coracana using ethanol and aqueous extraction methods. The plant materials were extracted with 100% ethanol and boiling water to obtain crude ethanol and aqueous extracts, respectively. Qualitative phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, and phenolic compounds, with the ethanol extracts containing a more diverse range of phytochemicals. The antifungal activity was evaluated against Candida albicans and Cryptococcouses using agar well diffusion and broth microdilution assays. The ethanol seed extract exhibited the highest antifungal activity, with minimum inhibitory concentrations (MICs) of 0.5 mg/ml against C. albicans and Cryptococcouses, respectively. The observed antifungal activity was attributed to the presence of phenolic compounds and flavonoids, which were more effectively extracted by ethanol compared to the aqueous extraction. These findings highlight the potential of E. coracana as a natural source of antifungal agents and warrant further investigation into the isolation and characterization of the bioactive compounds responsible for the observed activity.

Keywords: *Eleusine coracana*, finger millet, phytochemicals, antifungal activity, ethanol extract, aqueous extract, phenolic compounds, Candida albicans.

1. INTRODUCTION:

Eleusine coracana, commonly known as finger millet or ragi, is a small-grained cereal crop belonging to the Poaceae family. Originating in Africa, finger millet is widely cultivated in various regions of Asia, particularly in India, Nepal, and Ethiopia [Nidhi singh et al., 2015], where it serves as a staple food for millions of people. Besides its nutritional significance, Eleusine coracana has garnered attention for its potential medicinal properties attributed to its rich phytochemical composition. Phytochemicals are bioactive compounds naturally synthesized by plants, known to possess various health-promoting properties, including antimicrobial activity. These compounds, such as alkaloids[Dinesh Chandra et al., 2016], flavonoids, phenolics, and terpenoids, exhibit diverse biological effects and have been extensively studied for their therapeutic potential in combating microbial infections. In recent years, there has been a growing interest in exploring the antimicrobial properties of plant-derived compounds as alternatives to conventional antibiotics. The emergence of antibiotic resistance among pathogenic microorganisms has underscored the urgent need for novel antimicrobial agents to address this global health challenge. Natural products, particularly those derived from medicinal plants like Eleusine coracana, offer a promising avenue for the discovery of new antimicrobial agents.

Several studies have investigated the phytochemical composition of Eleusine coracana and its potential pharmacological activities[S.Shobana et.,al, Pranita Patil et al., 2023]. However, there remains a need for comprehensive research evaluating the antimicrobial efficacy of Eleusine coracana extract against a wide range of microbial pathogens. Understanding the antimicrobial potential of Eleusine coracana could not only contribute to the development of new therapeutic agents but also enhance the utilization of this traditional crop for medicinal purposes. This background sets the stage for the current research endeavor, which aims to conduct a phytochemical evaluation of Eleusine coracana extract and assess its antimicrobial activity against selected microorganisms. By elucidating the bioactive constituents and antimicrobial properties of Eleusine coracana, this study seeks to provide valuable insights into the potential applications of this underutilized crop in the field of natural product-based drug discovery and antimicrobial therapy[Ashwani G. Rane et al., 2023]. Finger millet (Eleusine coracana) has been cultivated for centuries, primarily in semi-arid regions of Africa and Asia, where it thrives in harsh environmental conditions. Traditionally, it has been valued for its resilience to drought, nutritional richness, and versatility in culinary applications. In recent decades, finger millet has attracted renewed interest due to its exceptional nutritional profile, containing high levels of dietary fiber, minerals (such as calcium, iron, and magnesium), vitamins (especially B-complex vitamins), and essential amino acids.

Beyond its nutritional significance, traditional systems of medicine have long recognized the therapeutic potential of finger millet. In various cultures, it has been used to alleviate a range of ailments, including digestive disorders, diabetes, and skin conditions[Pranita Patil et al., 2023]. The medicinal properties of finger millet are often attributed to its phytochemical constituents, which comprise a diverse array of bioactive compounds. Phytochemicals found in finger millet exhibit a wide spectrum of biological activities, including antioxidant, anti-inflammatory, antidiabetic, and antimicrobial effects. Among these, the antimicrobial activity of finger millet extracts has garnered particular attention in recent years[Surya Nath Pandey et al., 2023]. With the rise of antibiotic-resistant bacteria posing a significant public health threat, there is an urgent need to explore alternative antimicrobial agents derived from natural sources. The antimicrobial potential of finger millet may be attributed to various phytochemicals present in its grains, leaves, and other plant parts. These bioactive compounds interact with microbial pathogens through multiple mechanisms, including disruption of cell membranes, inhibition of essential enzymes, and modulation of microbial gene expression. By targeting microbial pathogens through multiple pathways, finger millet-derived phytochemicals may offer a holistic approach to combating infections while minimizing the risk of resistance development [Jayawardana S.A.S et al., 2021].

Despite the growing body of research on the antimicrobial properties of finger millet, there is still much to be explored regarding its specific mechanisms of action, optimal extraction methods, and potential applications in clinical settings. Moreover, given the rich biodiversity of finger millet varieties across different regions, there is a need to investigate the variability in phytochemical composition and antimicrobial activity among different cultivars[Banerjee S. et al., 2012]. Against this backdrop, the present study seeks to contribute to the body of knowledge on finger millet's antimicrobial potential by conducting a comprehensive phytochemical evaluation of Eleusine coracana extract and assessing its efficacy against a panel of clinically relevant microorganisms. By elucidating the bioactive constituents responsible for its antimicrobial activity, this research aims to pave the way for the development of finger millet-based antimicrobial agents with therapeutic applications in healthcare and food preservation [Surya Nath Pandey et al., 2023].

1.1 Phytochemical Composition of *Eleusine Coracana*:

The phytochemical composition of *Eleusine coracana*, commonly known as finger millet or ragi, encompasses a diverse array of bioactive compounds, including but not limited to:

1.1.1 Polyphenols: *Eleusine coracana* is rich in polyphenolic compounds such as flavonoids, phenolic acids, and tannins. These polyphenols contribute to the antioxidant properties of finger millet and exert various health benefits, including anti-inflammatory and anti-carcinogenic effects [Walaa Kamel Mousa et al., 2014].

1.1.2 Alkaloids: Finger millet contains alkaloids, which are nitrogen-containing compounds with diverse biological activities. Certain alkaloids found in *Eleusine coracana* may exhibit antimicrobial, analgesic, or antipyretic properties [Maria clerya Alvino leite et., al 2014].

1.1.3 Triterpenoids: *Eleusine coracana* contains triterpenoid compounds, which are known for their anti-inflammatory, hepatoprotective, and antimicrobial activities. These compounds may contribute to the medicinal properties of finger millet extracts [Naira sulany Olivera desousa et al., 2023].

1.1.4 Saponins: Saponins are glycosides found in finger millet that possess foaming and emulsifying properties. In addition to their role as natural surfactants, saponins have been investigated for their potential health benefits, including cholesterol-lowering effects and anticancer properties[Banerjee S. et al ., 2012].

1.1.5 Phytosterols: Finger millet is a good source of phytosterols, plant-derived compounds with structural similarity to cholesterol. Phytosterols have been shown to lower blood cholesterol levels and may have potential applications in the prevention of cardiovascular diseases [Kumar A et al., 2016].

1.1.6 Essential oils: *Eleusine coracana* contains essential oils composed of volatile aromatic compounds. These essential oils contribute to the characteristic flavor and aroma of finger millet and may possess antimicrobial and insecticidal properties[luitel et al.,].

1.1.7 Vitamins and minerals: Finger millet is a nutrient-rich cereal, containing significant amounts of vitamins (especially B-complex vitamins) and minerals (such as calcium, iron, and magnesium). These micronutrients play essential roles in various physiological processes and contribute to the overall health benefits of consuming finger millet [Luitel et al ., & Bhavya M et al., 2014]

1.2 Antimicrobial Properties of *Eleusine Coracana*:

The antimicrobial properties of phytochemicals, derived from various plant sources including *Eleusine coracana*, have been widely studied and recognized. These bioactive compounds exhibit diverse mechanisms of action against microorganisms, including bacteria, fungi, viruses, and protozoa. Some of the key antimicrobial properties of phytochemicals include:

1.2.1 Direct Microbial Inhibition: Many phytochemicals possess direct antimicrobial activity by disrupting microbial cell membranes, interfering with cell wall synthesis, inhibiting protein synthesis, or disrupting microbial metabolism. For example, flavonoids and alkaloids have been shown to disrupt microbial membranes, leading to leakage of cellular contents and eventual cell death [Tidke et al., 2020].

1.2.2 Antibiofilm Activity: Phytochemicals have been found to inhibit the formation and disrupt the pre-formed biofilms of pathogenic microorganisms. Biofilms are communities of microorganisms attached to surfaces, which are highly resistant to antimicrobial agents and host immune responses. Compounds such as phenolic acids and saponins have been shown to interfere with biofilm formation and enhance the susceptibility of biofilm-associated bacteria to antimicrobial agents[Patrick T. Mekiny et al., 2023].

1.2.3 Antiviral Activity: Certain phytochemicals exhibit antiviral activity by inhibiting viral replication, entry, or release from host cells. For example, flavonoids and tannins have been reported to inhibit the replication of various viruses, including influenza virus, herpes simplex virus, and human immunodeficiency virus (HIV) [Pandey et at., 2023]

1.2.4 Antifungal Activity: Phytochemicals have demonstrated antifungal activity against a wide range of pathogenic fungi, including Candida species and dermatophytes. These compounds may disrupt fungal cell membranes, inhibit fungal enzyme activity, or interfere with fungal cell wall synthesis. Polyphenols, alkaloids, and terpenoids are among the phytochemicals with significant antifungal properties[Patrick T. Mekeny et al ., 2023, Pandey et al., 2023].

1.2.5 Antiparasitic Activity: Some phytochemicals exhibit antiparasitic activity against protozoan parasites such as Plasmodium species (causative agents of malaria) and Trypanosoma species (causative agents of sleeping sickness and Chagas disease). Compounds such as alkaloids, terpenoids, and sesquiterpenes have shown promise as antiparasitic agents through various mechanisms, including inhibition of parasite growth and disruption of parasite metabolism [Bhavya m. et al., 2024].

1.2.6 Synergistic Effects: Phytochemicals may act synergistically with conventional antimicrobial agents, enhancing their efficacy and reducing the risk of resistance development. Combining phytochemicals with antibiotics or antifungal drugs has been shown to potentiate their antimicrobial activity against resistant strains of microorganisms [Chauhan et al., 2018].

1.3 PLANT PROFILE:

figure 1. Plant of Eleusine coracana.

Table no 1: Botanical Classification of Eleusine coracana

S.No	Name	Classification
1	Kingdom	Plantae
2	Phylum	Angiosperms
3	Class	Monocots
4	Order	Poales
5	Family	Poaceae
6	Genus	*Eleusine*
7	Species	e.coracana

Figure 2. Seeds of Ragi.

1.3.1 Physical Characteristics:
1. Finger millet is an annual cereal grass with slender, erect stems that can grow up to 1.5 meters in height.
2. The leaves are long, narrow, and linear, with a prominent midrib [Surya nath pandey et at., 2023].
3. The inflorescence is a terminal panicle, consisting of small spikelets arranged in pairs along the branches.
4. Each spikelet contains several tiny grains, which are typically reddish-brown in color[Maria clerya Alvino Leite et al., 2014].

1.3.2 Habitat and Distribution:
1. Finger millet is native to the African continent, particularly in the eastern and southern regions.
2. It is widely cultivated in warm, tropical and subtropical climates around the world, including parts of Asia and the Americas[Bhavya M et al., 2024].
3. This resilient crop can tolerate a range of environmental conditions, including poor soil fertility, drought, and high temperatures.

1.3.3 Cultivation Requirements:
1. Finger millet is typically grown as a rain-fed crop but can also be cultivated under irrigated conditions.
2. It prefers well-drained sandy loam or loamy soils with good organic matter content.
3. The optimal temperature for growth ranges from 25°C to 30°C, although it can tolerate higher temperatures during the growing season[Chauhan et at., 2018].
4. Finger millet is a C4 photosynthetic plant, making it relatively efficient in utilizing sunlight and water.

1.3.4 Uses:
1. Dietary Staple: Finger millet is a nutritious cereal grain consumed as a staple food in many parts of Africa and Asia. It is rich in carbohydrates, protein, fiber, vitamins, and minerals.
2. Culinary Purposes: The grains can be ground into flour and used to make a variety of traditional dishes, including porridge, flatbreads, cakes, and fermented beverages[Patrick T Mekeny et al., 2023, Partha Sarathi Swain et al., 2023].
3. Nutritional Benefits: Finger millet is known for its high nutritional value, offering health benefits such as improved digestion, enhanced immunity, and management of diabetes and other metabolic disorders.
4. Animal Feed: The straw and leftover biomass from finger millet cultivation are often used as fodder for livestock[Naira Sulany Olivera desousa et al ., 2023].

1.3.5 Ecological Significance:
1. Finger millet is an important crop for smallholder farmers in regions prone to food insecurity and climatic variability.

2. It is valued for its ability to grow in marginal environments and contribute to food security and livelihoods[Kasinanthan Rakkamal et al., 2023].
3. The cultivation of finger millet also promotes soil conservation and biodiversity conservation, as it requires minimal inputs and can be intercropped with other

2. MATERIAL & METHOD:

2.1 Collection of Sample:

The study of anti- fungal activity we have to collect the seeds from the reliable source or local market then authenticated from the scientist and processed appropriately. For extraction we have to take the ragi seeds and put in the hot air oven for 1 hr and then take out from then weigh of the seed then crushed the seeds by motar pistal [Surya Nath pandey et al., 2023].

2.2 Selection of Microorganism:

For this study we were take the two fungus which one are Candita albicans and Cryptococcoses.

2.3 Solvent Extraction:

For solvent extraction we take the soxhlet apparatus After the weigh we have to make the thimble and put in the soxhlet tube with the 500ml ethanol or aqueous and the process will be held upto 25- 28 hr at the 50'C for ethanol and 70'C for aqueous for the extraction process in Soxhelt apparatus. The solvent have to filter and after that the solvent have evaporate at 100 degree Celsius temperature of water bath and solvent become the semisolid[Theivanayagam Maharajan et al., 2023].

The yield % of the sample is for ethanol 3.48% and for aqueous 3.28%. Then we have to check the antimicrobial activity.

Figure 3. *Soxhelt apparatus for Ethanol & Aqueous.*

2.4 Phytochemical Analysis:

Table no 2. Phytochemical test Kasinanthan Rakkammal et al., 2023] .

S.No	Phytochemical	Quantitative Test	Outcome
1	Alkaloid	Hager's Tests	Yellow precipitation present.
2	Flavonoids	Alkaline reagent test	Colourless solution present.
3	Tannins	Braymer Test	Dark blue colour indicates
4	Saponins	Foam Test	Formation of layer of foam indicates.
5	Phenol	Ferric Chloride Test	Deep blue black colour indicates.

2.5 Antimicrobial Activity: The fungus Candida albicans and cryptococcosis which will be used in research, Collect and grow the strain of this fungus in laboratory with the help of suitable and effective nutritional agar medium. Ethanol or Aqueous solvents will be used for the extraction of bio active compounds[Chauhan et al., 2018]. To perform the anti-fungal activity of the millets on the fungus, use anti-microbial methods (Agar dillution method). The highest effect was shown by the ethanolic extract against the fungus.

Figure 4. Zone of Inhibition of Candida Albicans & Cryptococcus.

3. Result & Discussion:

1. **Yield Percentage**: The percentage of the extraction is in Ethanol 3.28% and Aqueous is 3.48%
2. **Phytochemical Analysis:**

The phytochemical analysis of Eleusine coracana extract revealed the presence of various bioactive compounds. Qualitative tests indicated the presence of alkaloids, flavonoids, phenolics, terpenoids, saponins, and tannins. Quantitative analysis further confirmed the abundance of these phytochemical constituents.

Table no 3: Phytochemical result .

Phytochemical	Ethanol	Aqueous
Alkcoloids	+	+
Flavonoids	+	+
Tannins	+	+
Saponins	+	-
Phenol	+	+

3. Antimicrobial Assays:

The antimicrobial activity of Eleusine coracana extract was evaluated against a panel of pathogenic microorganisms, including bacteria and fungi. The agar well diffusion method was employed to assess the inhibitory effects of the extract.

3.1 Fungal Strains:

Candida Albicans. The extract displayed inhibitory effects with a zone diameter of ethanol is 13mm±0.5mm and for Aqueous is 11mm±0.5mm.
Cryptococcus. The extract displayed inhibitory effects with a zone diameter of ethanol is 12mm±0.5mm and for aqueous is 10mm±0.5mm.

3.2 Minimum Inhibitory Concentration:

The minimum inhibitory concentration (MIC) of Eleusine coracana extract was determined for each microbial strain. MIC values were determined by diluting the extracts and assessing the lowest concentration that inhibits visible growth of the microorganism like candita albicans and Cryptococcoses. Like we take the dose for Candita albicans 0.6mg, 0.8mg, 1.0mg, 1.2mg, 1.4mg and MIC concentration are 20%, 40%, 60%, 80%,100%. And Dose for Cryptococcoses is 0.4mg, 0.6mg, 0.8mg, 1.0mg, 1.2mg and MIC concentration is 20%, 40%, 60%, 80%, 100%.

figure 5. MIC of Candida albicans & Cryptococcus.

The zone of diameter is calculated by taking the concentration 1mg/ml against the Candita albicans and Cryptococcoses fungus to check the zone of inhibition.

3.1 Discussion:

The present study explored the antifungal potential of Eleusine coracana (finger millet) extracts obtained through ethanol and aqueous extraction methods, with the aim of identifying effective natural antifungal agents. The phytochemical analysis revealed the presence of various bioactive compounds, including alkaloids, flavonoids, tannins, saponins, and phenolic compounds, which are known to possess significant antimicrobial properties.

Ethanol vs. Aqueous Extraction:

The comparative analysis of ethanol and aqueous extracts demonstrated that ethanol extraction yielded a higher concentration. Particularly phenolic compounds and flavonoids. This finding is consistent with previous studies indicating that ethanol, as a polar solvent, is more effective at extracting a broad spectrum of phytochemicals from plant materials. The ethanol extract of Eleusine coracana exhibited superior antifungal activity against all tested fungal pathogens, including Candida albicans, Cryptococcoses.

Mechanisms of Antifungal Action:

The antifungal activity of *Eleusine coracana* extracts can be attributed to several mechanisms. Phenolic compounds and flavonoids, which are abundant in the ethanol extract, are known to disrupt fungal cell membranes, leading to increased permeability and cell lysis. Additionally, these compounds can inhibit fungal enzymes crucial for metabolic processes and cell wall synthesis, thereby impeding fungal growth and proliferation. The presence of tannins and saponins further enhances the antifungal efficacy by forming complexes with proteins and lipids in fungal cell membranes, causing structural damage and functional impairment.

4. References:

1. Ashwini G.Rane[1*], Jyoti D.Vora [2], Priyanka J, A Review on the Biochemical, Antimicrobial and Organoleptic Studies on the Germination Proile of Finger Millet (Eleusine coracana), International Journal of Food Science, Nutrition and Dietetics (IJFS) ISSN 2326-3350
2. Banerjee S.[1], Sanjay K. R.[2]*, Chethan S.[3] and Malleshi N. G.[1] Finger millet (Eleusine coracana) polyphenols: Investigation of their antioxidant capacity and antimicrobial activity. African Journal of Food Science Vol. 6(13), pp. 362-374, 15 July, 2012
3. Bhavya M, Dinesh Kumar M, Girijesh G K, & Vidya N T. (2024). Morpho-physiological Evaluation of Finger Millet (Eleusine coracana L. Gaertn.) Genotypes for Drought Tolerance. *International Journal of Environment and Climate Change*, *14*(1), 380–392. https://doi.org/10.9734/ijecc/2024/v14i13846
4. Chauhan, E. S. (2018). Effects of processing (germination and popping) on the nutritional and anti-nutritional properties of finger millet (Eleusine coracana). *Current Research in Nutrition and Food Science Journal*, *6*(2), 566-572.
5. Dinesh Chandra[*], Satish Chandra, Pallavi, A.K. Sharma , Review of Finger millet (Eleusine coracana (L.) Gaertn): A power house of health benefiting nutrients, Food Science and Human Wellness 5 (2016).
6. Jayawardana S.A.S.[1], Samarasekera J.K.R.R.[1*], Hettiarachchi G.H.C.M.[2], Gooneratne J.[1], Maharjan R.[3] and Choudhary M.I.[3,4] Antimicrobial Properties of Ethanolic and Methanolic Extracts of Finger millet (Eleusine coracana (L.) Gaertn.) Varieties Cultivated in Sri Lanka International Journal of Multidisciplinary Studies (IJMS) Volume 7, Issue I, 2021.
7. Kasinathan Rakkammal, Theivanayagam Maharajan, R.N. Shriram, P.S. Jeevan Ram, Stanislaus Antony Ceasar & Manikandan Ramesh. (2023) Physiological, biochemical and molecular responses of finger millet (Eleusine coracana) genotypes exposed to short-term drought stress induced by PEG-6000. *South African Journal of Botany* 155, pages 45-59.
8. Kumar A, Metwal M, Kaur S, Gupta AK, Puranik S, Singh S, Singh M, Gupta S, Babu BK, Sood S, Yadav R. Nutraceutical Value of Finger Millet [Eleusine coracana (L.) Gaertn.], and Their Improvement Using Omics Approaches. Front Plant Sci. 2016 Jun 29;7:934. doi: 10.3389/fpls.2016.00934. PMID: 27446162; PMCID: PMC4925701.
9. Luitel, Dol & Siwakoti, Mohan & Jha, Pramod. (2020). Eleusine coracana (L) Gaertn (Finger millet): A Crop With Medicinal Value
10. Maria Clerya Alvino Leite,[1,2] André Parente de Brito Bezerra,[2] Janiere Pereira de Sousa,[2] Felipe Queiroga Sarmento Guerra,[2] and Edeltrudes de Oliveira Lima[2]. Evaluation of Antifungal Activity and

Mechanism of Action of Citral against Candida albicans Hindawi Publishing Corporation Evidence-Based Complementary and Alternative Medicine Volume 2014, Article ID 378280, 9 pages.

11. Nidhi Singh, Meenu G, Anamika Sekhar and Jayanthi Abraham, Evaluation of antimicrobial and anticancer properties of finger millet (*Eleusine coracana*) and pearl millet (*Pennisetum glaucum*) extracts, The Pharma Innovation Journal 2015, ISSN: 2277- 7695**.**
12. Naira Sulany Oliveira de Sousa[1] Juan Diego Ribeiro de Almeida[2] Hagen Frickmann[3],[4],Marcus Vinícius Guimarães Lacerda[5],[6],[7] and João Vicente Braga de Souza[1],[2] Searching for new antifungals for the treatment of cryptococcosis journal of the Brazilian Society of Tropical Medicine Vol.:56 | (e0121-2023) | 2023 .
13. Patrick T. McKeny; Trevor A. Nessel; Patrick M. Zito. Antifungal Antibiotics. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.
14. Pandey, S. N., Mittal, P., & Singh, G. (2023). Phyto-Pharmacological Importance with Nutritional Potential of Eleusine coracana Linn.: A Review. International Journal of Pharmaceutical Investigation, 13(4), 688–697. https://doi.org/10.5530/ijpi.13.4.086
15. Partha Sarathi Swain, B. B. Mohanty & Ashis Kumar Pradhan. (2023) Untangling the factors influencing finger millet production: Evidence from the Indian states. *International Social Science Journal* 73:248, pages 359-372
16. Pranita Patil, Sury Pratap Singh, Pankti Patel, Functional properties and health benefits of finger millet (*Eleusine coracana* L.): A review, The Journal of Phytopharmacology 2023 ISSN 2320-480X.
17. S. Shobana[*], K. Krishnaswamy[*,1], V. Sudha[*], N.G. Malleshi[*], R.M. Anjana[*], L. Palaniappan[†], V. Mohan[*] ,Finger Millet (Ragi, Eleusine coracana L.): A Review of Its Nutritional Properties, Processing, and Plausible Health Benefits, Advances in Food and Nutrition Research, Volume 69 ISSN 1043-4526.
18. Surya Nath Pandey*, Payal Mittal, Gurfateh Singh, Phyto-Pharmacological Importance with Nutritional Potential of *Eleusine coracana* Linn.: A Review, Int. J. Pharm. Investigation, 2023; 13(4):688-697**.**
19. Tidke, S. A. (2020). Nutraceutical Potential of Finger millet (Eleusine Coracana): Review. *Journal of Pathology Research Reviews & Reports. SRC/JPR-113. DOI: https://doi. org/10.47363/JPR/2020 (2)*, *112*, 3.
20. Theivanayagam Maharajan, Thumadath Palayullaparambil Ajeesh Krishna, Kasinathan Rakkammal, Muthusamy Ramakrishnan, Stanislaus Antony Ceasar, Manikandan Ramesh & Savarimuthu Ignacimuthu. (2023) Identification of QTL Associated with Agro-Morphological and Phosphorus Content Traits in Finger Millet under Differential Phosphorus Supply via Linkage Mapping. *Agriculture* 13:2, pages 262.
21. Vagdevi, A., Trupthi, S., Pandey, M., Reddy, N. B., & Singh, M. (2023). Nutritional qualities, processing and health benefits of finger millet (Eleusine coracana L.). *The Pharma. Innov J*, *12*(1), 1291-7.
22. Walaa Kamel Mousa [1,2], Adrian L. Schwan [3] and Manish N. Raizada [1,*]. Characterization of Antifungal Natural Products Isolated from Endophytic Fungi of Finger Millet (*Eleusine coracana*) *Molecules* 2016, *21*, 1171 .