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Review Article

Review of Bioactive Antifungal Properties of novel lectin C-25 in Cicer arietinum

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Abstract
Isolation of lectin protein C-25 from Cicer arietinum showed antifungal properties against various Candida species. Leguminous plants especially food legumes produce variety of structurally different proteins for self-defence and lectins are one of them. Amongst one of the many anti-nutritional components in chickpea, lectin a carbohydrate-binding protein, has shown prominent antifungal activity. Lectins are commonly used as antimicrobial and pesticide components but additionally proven to be significant antifungal agents against specific human pathogens like Candida krusei, Candida parapsilosis and Candida tropicalis. This study highlights the benefits of chickpea lectin with respect to the potential for pharmacological perspectives and antimicrobial resistance.

Keywords: Novel lectin C-25, Antifungal activity, Antimicrobial resistance, Nutraceutical

Introduction
Legumes are increasingly being regarded as beneficial food ingredients. In fact, they are recommended as staple food by major health organisations. Cicer arietinum (chickpea) is one of the most commonly consumed legumes especially in the Mediterranean area. In 2017, India produced 67% of the world total for chickpeas [1]. It contains 75% fibres and low-fat protein. The chickpea is an annual legume of the family Fabaceae, subfamily Faboideae [2,3]. Anti nutritional components of chickpea like phytic acid, lectins, sterols, saponins, dietary fibres, resistant starch, oligosaccharides, unsaturated fatty acids, amylase inhibitors and certain bioactive compounds such as carotenoids and isoflavones have shown the capability of lowering the clinical complications associated with various human diseases.

Proteins of seed legumes are usually classified in two main groups: globulins or salt soluble proteins and albumins or water soluble proteins. Globulins represent~70% of legume seed proteins. Most of the albumin proteins have some physiological function while some such as protease inhibitors or lectins, are implicated in defensive mechanisms.

Plant lectins are a very heterogeneous group of glycoproteins classified on the basis of a single common property, namely their ability to specifically recognize and bind carbohydrate ligands.

Lectins are a structurally diverse class of proteins of non-immune origin that bind carbohydrates in a reversible fashion and do not exhibit enzymatic activity towards their ligands. The legume lectin family has been studied for several decades using biochemical and biophysical techniques, and is considered a model system for protein-carbohydrate interactions. These dimeric or tetrameric proteins are found in the seeds and in the vegetative tissues of most leguminous plants.

The Leguminosae family has the largest group of well-characterized legume lectins, which are interesting due to a variety of carbohydrate specificity and greater availability in nature. In general, a wide range of biological applications has been attributed to plant lectins, such as mediators of inflammatory and immune response; antiviral, antibacterial, antifungal, and anti-helminthic agents, healing effect, drug delivery, histochemical markers, biosensing of diseases, and antitumoral activities.

Plant lectins investigated for antifungal potential, mainly against phytopathogenic species, have most reported antifungal effects binding to hyphae, causing inhibition of growth and prevention of spore germination. Fungi that are human and animal pathogens have been found to be affected by antifungal lectins.

The monomers of these lectins exhibit high levels of sequential and structural identity. and so this review can be visualised as an effective means for application in research biology including computational biology. The study was designed to highlight the importance of C-25 as a possible nutraceutical due to antimicrobial resistance.

C-25 Sequence

>tr|R9TPI6|R9TPI6_CICAR Lectin protein C-25 OS=Cicer arietinum OX=3827 GN=LOC101505722 PE=2 SV=1

MTKTGYINAAFRSSRNNEAYLFINDKYVLLDYAPGTSNDKVLYG-PSLVRDGYKSLAKTIFGTYGIDCSFDTEYNEAFIFYENLCARIDY-APHSDKDKIISGPKKIADMFPFFKGTVFENGIDAAFRSTK-GKEVYLFKEDKYARIDYGTNRLVQNIKYISDGFPCLRGTIFEYGMD-SAFASHKTNEAYLFKGEYYARINFTPGSTNDIMGGVKKTLDYWPSL-RGIIPLE

Review of Research Literature

B. Liu et al (2010) and Lei and Chang (2009) stated that lectins are proteins or glycoproteins of a ubiquitous distribution in nature, which have at least one carbohydrate or derivative binding site without catalytic function or immunological characteristics. They have the unique ability to recognize and bind reversibly to specific carbohydrate ligands without any chemical modification which distinguishes lectins from other carbohydrate binding proteins and enzymes and makes them invaluable tools in biomedical and glycoconjugate research. In plant, lectin plays an important role in the defence against harmful fungi, insects and bacteria. Several lectins have been found to possess anticancer properties in human case studies, where they are used as therapeutic agents binding to the cancer cell membrane or their receptors causing cytotoxicity, apoptosis, and inhibition of tumour growth [4,5].

The resistance of microorganisms to antimicrobial agents has been a challenge to treat animal and human infections, and for environmental control. Lectins are natural proteins and some are potent antimicrobials through binding to carbohydrates on microbial surfaces. Oligomerization state of lectins can influence their biological activity and maximum binding capacity; the association among lectin polypeptide chains can alter the carbohydrate-lectin binding dissociation rate constants. Antimicrobial mechanisms of lectins include the pore formation ability, followed by changes in the cell permeability and latter, indicates interactions with the bacterial cell wall components [6].

According to Suresh Kumar et al (2014) the emergence of epidemic fungal pathogenic resistance to current antifungal drugs has increased the interest in developing alternative antibiotics from natural sources. Cicer arietinum is well known for its medicinal properties. An antifungal protein, C-25, was isolated from Cicer arietinum and purified by gel filtration. C25 protein was tested using agar diffusion method against human pathogenic fungi of ATCC strains and against clinical isolates of Candida krusei, Candida tropicalis, and Candida parapsilosis, and MIC values determined were varied from 1.56 to 12.5μg/mL. The SEM study demonstrated that C-25 induces the bleb-like surface changes, irregular cell surface, and cell wall disruption of the fungi at different time intervals. Cytotoxic activity was studied on oral cancer cells and normal cells. It also inhibits the growth of fungal strains which are resistant to fluconazole. It can be concluded that C-25 can be considered as an effective antimycotic agent against human oral cancer cells [7].

Lectins have exhibited antibacterial and antifungal activity against Gram-negative, Gram positive bacteria and fungi, through the interaction with peptidoglycans, polysaccharides, lipopolysaccharides, teichoic and teichuronic acids on bacterial and fungal cell wall [8].

Though the exact mode of action of lectin on fungal growth is not clearly known it was previously observed by SEM that lectin disrupted the cell wall and resulted in leakage of cytoplasm. In the present investigation, C-25 also acts primarily on the cell wall of Candida species, by disrupting the cell wall and distorting the cellular morphologies [9].

Inhibition of fungal growth by the action of lectins, appears to be due to inhibition of spore germination as well as the growth of the mycelium [10-14]. The exact mechanism of action has not yet been elucidated, but there seems to be alteration in the fungal cell wall due to changes in the synthesis of chitin, a deficiency in cell wall deposition. Lectins that bind to chitin showed significant antifungal effect, however, the presence or absence of this change is dependent on the combination of the fungus with the lectin.

They are natural carbohydrate-binding proteins that can mediate the identification of microorganisms through the interaction with complex carbohydrates on microbe surfaces [15]. promoting host-pathogen communications, immune defense activation and cell-to-cell signalling. A growing interest has been developed for the investigation of the lectin role in the interaction between eukaryotic cells and pathogens in infectious disease development and their antimicrobial potential [16]. The antimicrobial roles of lectins include blockade of invasion and infection, inhibition of growth and germination, regulation of microbial cell adhesion and migration.

Several investigations have been carried out worldwide on the antimicrobial activity of natural compounds, including lectins [17]. Nevertheless, studies that address the mechanism of antibacterial or antifungal action are still in a minority [18,19]. The identification of these mechanisms represents an important step for the effective application of new drugs, since it will be useful to establish strategies of drug delivery, increase effectiveness of possible formulations, as well as will predict mechanisms of future and inevitable microbial resistance [20].

Conclusion

This review provides comparative and selective set of papers which include different in vitro, in vivo and in situ techniques that have been used to check the antifungal property of C-25 lectin present in Cicer arietinum. Hence this paper can be used as a helpful pathfinding tool for researchers working in this direction.

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