Journal of Biochemistry and Cell Biology

Biochemistry and Microbial Activity of Tryptophan and Nicotine

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Abstract

L-tryptophan is the only protein amino acid (AA) with an indole ring; through biotransformation in live creatures, it either helps to retain this chemical group in cells and tissues or breaks it down by producing a variety of bioactive chemicals in both scenarios. Studies on the biology of Trp emphasise the pleiotropic impact of its tiny derivatives on homeostasis mechanisms. In addition to protein turnover, the production of the neurotransmitter and hormone serotonin (5-HT), the pineal gland hormone melatonin (MLT), and the trace amine tryptamine is covered by the pathways of Trp indole derivatives in humans. Instead, the "kynurenine shunt," which results in cell-response adapters such L-kynurenine, kynurenic, and quinolinic acids, or the coenzyme nicotinamide adenine dinucleotide (NAD+), is defned by the breakdown of the Trp indole ring. One of the most promising approaches to cleaning up polluted surroundings with powerful, very efective bacteria is bioremediation. The very poisonous heterocpi
nicotine and other tobacco alkaloids can be broken down by microbes using particular enzymes and metabolic pathways. These nicotinophilic bacteria use nicotine as their only supply of carbon, nitrogen, and energy following the metabolic conversion. The demethylation pathway in fungi, the pyridine pathway in Gram-positive bacteria, the pyrrolidine pathway, and variants of the pyridine and pyrrolidine pathways in Gram-negative bacteria are just a few of the identifed nicotine breakdown pathways. In this review, we covered the biotechnological uses of nicotine intermediate metabolites as well as the enzymes and microorganisms that break down nicotine.

Keywords: Nicotine; Bioremediation; Pleiotropic

IntroductionIL-Typ11(t)-6ophan IL-Tnp) ia of12(n;4(e)of12(n th)-6(h)(e)o20 L)9(-)19(mn)4(e alcid)(a o(AA)6(ds) h)-6(h)(a

(7.0%), and the USA (4.6%). Following China and the United States in terms of global tobacco consumption is India (275 million users). Every year, 3,00,274 tonnes of nicotine waste are expected to be produced by the tobacco industry. e majority of the alkaloid content of commercial tobacco, Nicotiana tabacum, is typically made up of nicotine. Tobacco goods like cigarettes, cigars, chewing tobacco, and snu were all made using all or part of the tobacco leaf as the raw material. It was estimated that smoking contributed to 4.9 million deaths in the year 2000 [8]. It is anticipated that there would be more than 9 million fatalities annually by the year 2020. e industry produced solid and liquid tobacco wastes with high levels of nicotine due to the rising use of tobacco products.

e tobacco companies create waste that contains 18 g of nicotine on average per kg of dry weight [9]. ese non-recyclable powdered tobacco wastes have been labelled as toxic release inventory (TRI) compounds by the Environmental Protection Agency (EPA). According to European Union Regulations (EUR), something is considered "toxic and harmful" when the amount of nicotine surpasses 0.05%(w/w)[10].

Chemical Structure of Living Organism [11]

e chemical structure of the 20 L-AAs' -R groups has been chosen by Earth's molecular evolution as the one best suited for the production of proteins. L-Trp is the sole AA in proteins derived from indole, a bicyclic ring formed by a benzene and a pyrrole group, connected to the -carbon by a -CH2-group. Trp has one of the highest levels of hydrophobic properties among all protein AAs thanks to the indole ring's presence in its chemical structure. One of these AAs, L-Trp, has been "retained" as a component of proteins in living creatures, likely because it has the simplest structure of all potential indole AAs. Although other AAs could potentially be made starting from indole, only L-Trp has done so. rough the action of the enzyme chorismate mutase, prephenate is produced from chorismate, which then enters a 3-branch pathway to produce Tyr and Phe. Anthranilate synthase recognises chorismate and transfers an amino group from the AA glutamine to it, producing anthranilate and pyruvate; anthranilate is then converted into Trp via 5 additional enzymatic steps. e biosynthesis of Trp in bacteria shares genes and chemical reactions with plants or fungi. However, this metabolic pathway is followed by various regulatory mechanisms in bacteria, plants, and fungi. e Trp operon, one of the most well-studied models of prokaryotic gene expression regulation, regulates the production of Trp in bacteria. Depending on the intracellular concentrations of this AA, the Trp operon is either activated or repressed.

their periphery [14]. e nicotine's pyridine ring was targeted during breakdown by bacteria like Arthrobacter sp. (Gram-positive), which followed the pyridine pathway. A er attacking the pyrrolidine ring, the Gram-negative bacterium Pseudomonas sp. followed the pyrrolidine route.

Applications of Nicotine

e employment of microorganisms to catalyse the conversion of one metabolite into another is known as biotransformation or biocatalysis. Enzymes, cellular extracts, or entire microbial cells all participated in the catalysis of these compounds. e synthesis of bulk chemicals for the industry's usage in creating pharmaceutical, food, and agrochemical compounds uses the promising technology of biotransformation. e biocatalytic generation of functionalized pyridines from renewable sources uses nicotine as a starting ingredient. To turn harmful nicotine into useful molecules like HSP and DHP, the simplest and friendliest methods of biotransformation approach were employed. e development of anticancer, antimalarial, and analgesic drugs as well as the therapy of Parkinson's disease, hypertension, and central nervous system problems all makes use of nicotine's biotransformation intermediates [15].

Discussion

rough a multitude of molecular e ectors, L-tryptophan biochemistry is at the centre of the converging nutritional, neuroendocrine, and immunological pathways. As mentioned in the preceding paragraphs, each of these pathways is likely responsible for important, complex, and severe diseases and syndromes. e understanding of Trp metabolism and its implications for clinical research and medical genetics has been enhanced thanks to developments in applied biochemistry and molecular biology technology. New perspectives are actually starting to take shape; in particular, it becomes more and more obvious that illnesses with ambiguous aetiological pathophysiology require multidisciplinary and multifactorial approaches. is would make it possible to categorise patients with the same condition into groups that have similar but separate symptoms or treatment-related reactions connected with certain biochemical patterns. For instance, further evidence would be provided by the discovery of biochemical clusters within neuropsychiatric disorders or other complicated diseases. In order to create the insecticide imidacloprid, which is used to treat Parkinson's disease, 2,5- or 3,5-disubstituted pyridines are catabolized from 6HLN and HSP. SIB-1508Y is one of these biologically active metabolites. 2,5-DHP, a signi cant nicotine intermediate metabolite, can serve as the starting point for the chemical production of aminolevulinic acid, a universal precursor. is precursor is used to make cancer- ghting medications, herbicides, plant growth regulators, and porphyrins like heme and chlorophyll.

Conclusion

Tryptophan, an essential amino acid (AA), di ers chemically from all other protein AAs in that it is associated to stress/environmental adaptive response. Tryptophan derivatiia(a)9startrola3(s)5(6(s(b)-8.9(o)oder)imi)-4ve cs urophyll.