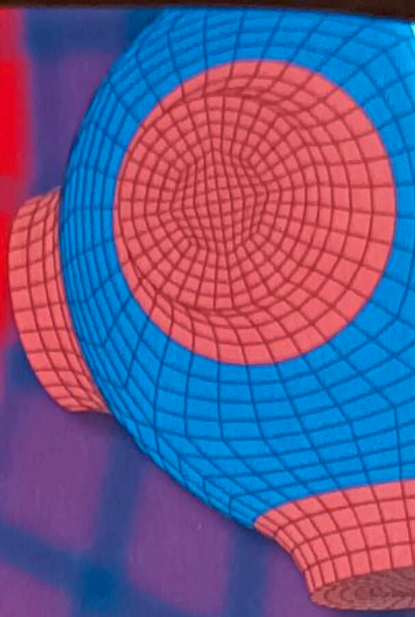
Advanced Structured Materials



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Bioactive Natural Products for Pharmaceutical Applications

Springer

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Contents

17. D Pal & P. Sahu

Chapter 22
Piperine: Sources, Properties, Applications, and Biotechnological Production

Neetu Sachan, Dilipkumar Pal, and Phool Chandra

Abstract From ancient times, phytopharmaceuticals have played an important role in the management of human health. Piperine, an alkaloid with the piperidine nucleus was discovered and isolated by Hans Christian Ørsted, from the fruits of *Piper nigrum*. Piperine forms is slightly water soluble and forms monoclinic needles and possess a strong pungent taste. Piperine contains plentiful established health effects and beneficial therapeutic properties. Cells and enzymes are key elements in biotechnological processes to carry out a wide variety of very specific reactions under judicious conditions to produce piperine and their products. Piperine also serves as bio-enhancers in conjunction with drugs to stimulate drug molecules' activity across different routes by improving the drug's bioavailability across the membrane, raising the drug's effect across conformational interaction, and working as a drug receptor. In recent years, there has been significant interest in the use of piperine to treat many illnesses, its health-beneficial effects, and its work as bio-enhancers. Due to their biological activity, piperine has the potential to be used in health and medicine.

Keywords Piperine · Alkaloid · Piper nigrum · Bio-enhancers · Therapeutics · Phytopharmaceuticals

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22.1 Introduction

Piperine contains numerous pharmacological activities and many health benefits, particularly against chronic conditions such as insulin resistance reduction, anti-inflammatory activity, and correction in hepatic steatosis (Derosa et al. 2016). Piperine was first isolated in 1820 by the Danish chemist Hans Christian Orstedt; it occurs as a yellow crystalline solid (MW = 285.33 g mol^{-1}, m.p. = 128–130 °C) poorly soluble in water and presents weak base properties (Chavarria et al. 2016; Koleva et al. 2012).

22.2 Biosynthesis of Piperine

Piperine is a secondary metabolite biosynthetically derived from L-lysine and a cinnamoyl-CoA precursor. Decarboxylation of L-lysine by lysine decarboxylase (LDC) yields cadaverine, which undergoes oxidative deamination by copper amine oxidase (CuAO,) originating 5- aminopentanal. This compound is rapidly cyclized into Δ^1-piperidine Schiff base and subsequently reduced to form piperidine. In parallel, piperonyl-CoA is generated from a cinnamoyl –CoA precursor; this precursor undergoes chain elongation with malonylCoA in a Claisen-like reaction, generating a keto-ester that is reduced by NADPH and then dehydrated to afford piperonyl-CoA. The piperine unit reacts with piperonyl-CoA affording piperine (Fig. 22.1).

22.3 Extraction Techniques

The extraction of piperine from the plants can be made with different techniques and that are present in Fig. 22.2 (Raman and Gaikar 2002; Rathod 2014).

22.4 Effect on Heart

Piperine produced both positive chronotropic and inotropic responses in the isolated rat atria but not in the ventricular muscles. A tachyphylaxis to piperine occurred rapidly depending on the dose of preincubation. It has been revealed that piperine diminishes the level of substance P in the rat spinal cord, possibly as a result of an extensive discharge of this neuropeptide. In the heart, it has been shown that capsaicin releases CGRP from NANC nerves and the released CGRP shows positive chronotropic and inotropic effects (Franco-Cereceda and Lundberg 1985; Franco-Cereceda et al. 1988; Miyauchi et al. 1987, 1988). Therefore, the lack of