

Propanthial S-oxide synthase: Potential target to develop flavoursome, nonlachrymatory user-friendly onions

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Propanthial S-oxide is the irritating lachrymatory factor, which is released by onions when they are chopped. It was presumed to be a by-product of alliinase reaction which produces 1-propenylsulphenic acid, the precursor of the flavouring metabolite thiosulphinic acid. Imai *et al.*¹ from House Food Corporation, Chiba, Japan have recently reported that propanthial S-oxide, the lachrymatory factor, is also synthesized from 1-propenylsulphenic acid. Thus 1-propenylsulphenic acid, the product of the alliinase reaction, produces not only the flavouring metabolite but also the lachrymatory factor in onions.

The biochemical pathway that produces the flavouring metabolite thiosulphinic acid starts with *trans* 1-propenyl-L-cysteine sulfoxide (PRENCISO). PRENCISO

(*trans*), the naturally-occurring form of PRENCISO in onions, is acted upon by the enzyme alliinase to produce 1-propenylsulphenic acid, pyruvic acid and ammonia (Figure 1). 1-propenylsulphenic acid is very unstable, and is, therefore, immediately converted to thiosulphinic acid, the metabolite responsible for the characteristic flavour of fresh onions^{2,3}. The organoleptic differences between various *Allium* species such as onion, garlic, leek and chive are due to the occurrence of different alliinase substrates: 1-propenyl, 2-propenyl, 1-propyl and methyl L-cysteine sulfoxides, respectively⁴.

Half of the cysteine sulfoxide derivatives have been reported to be tied up as γ -glutamyl peptides. The alliinase enzyme cannot act upon the L-cysteine

sulfoxide precursor until it is freed from the glutamyl peptide. γ -glutamyl peptide transpeptidase enzyme has been reported to liberate cysteine sulfoxide by transferring the glutamyl moiety to another amino acid⁵.

The discovery of the propanthial S-oxide synthase, the enzyme responsible for the synthesis of the lachrymatory factor, was based on a very simple observation that the crude extract of alliinase from onions (*Allium cepa*), when added to PRENCISO, produced the lachrymatory factor, whereas the crude extract of alliinase from garlic (*Allium sativum*) did not. So there must be something in the alliinase preparation from onions (possibly another enzyme), which could be involved in the formation of the lachrymatory factor. By passing the crude onion alliinase preparation through a hydroxyapatite column, Imai *et al.*¹ could completely separate the fraction with lachrymatory factor from the alliinase fraction. Further purification of the lachrymatory factor fraction gave three distinct proteins. Degenerate gene-specific primers, deduced from one of the amino terminal sequences of isolated proteins, were used to obtain its complete cDNA sequence through Rapid Amplification of Complementary DNA Ends (RACE) technique. The full length cDNA consisted of 737 base pairs with a predicted gene product of 169 amino acids, which was named lachrymatory factor synthase. The lachrymatory factor synthase gene was expressed in *Escherichia coli*, and the resulting recombinant protein exhibited the expected lachrymatory factor synthase activity. These observations were in contrast to the previous studies^{5,6} which indicated that alliinase from any source was the only enzyme needed to produce the lachrymatory factor from PRENCISO, and the reaction from the intermediate sulphenic acid to propanthial S-oxide and thiosulphinic acid were presumed to be spontaneous, because sulphenic acid is very unstable and has, therefore, never been isolated. The discovery of the propanthial S-oxide synthase enzyme, also

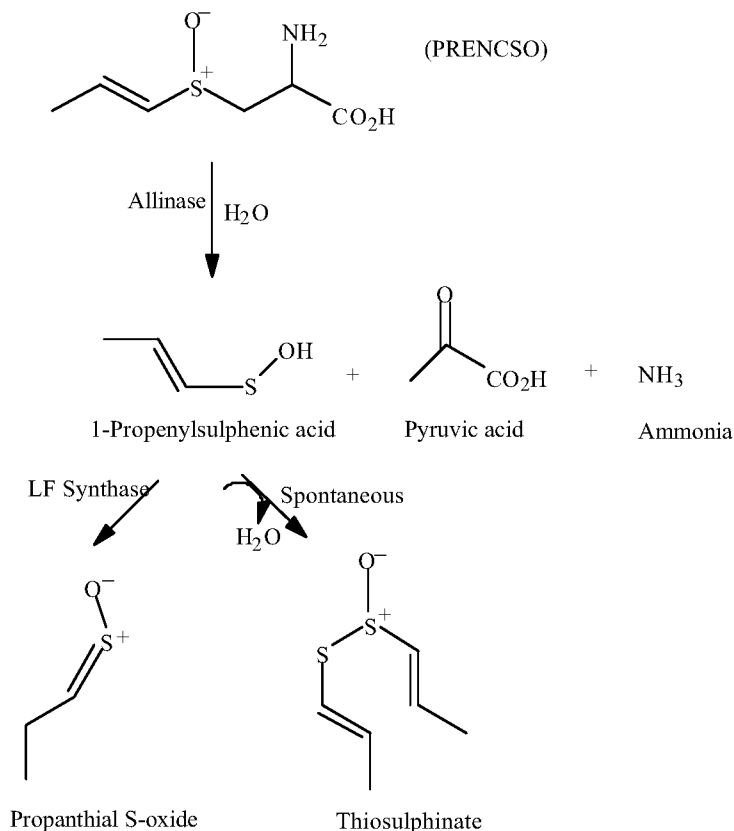


Figure 1. Biosynthesis of lachrymatory factor (LF) propanthial S-oxide.

known as lachrymatory factor synthase, has paved the way to develop non-lachrymatory onions by suppressing the lachrymatory factor synthase gene without affecting the production of thiosulphinates, the flavouring metabolite of onions. Since no new gene will be added from outside, it is believed that the genetically engineered onions with the silenced lachrymatory factor synthase gene will be readily accepted by the consumers. Though non-lachrymatory onions could also be produced by down regulating alliinase enzyme it would be at the expense of the characteristic onion flavour. Thus the discovery of the

lachrymatory factor synthase enzyme has opened up a new vista to develop non-lachrymatory onion with its characteristic flavour, which would give no cause for tears.

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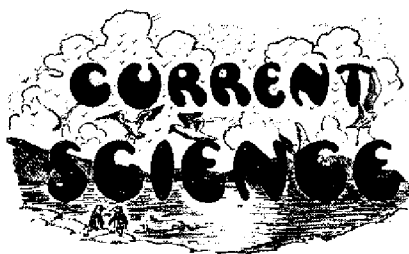
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FROM THE ARCHIVES



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Fuel research in India

The establishment of a Board of Scientific and Industrial Research for India and the appointment by it of a Fuel Research Committee has brought more prominently to the fore the question of the establishment of a Fuel Research Department or Station in India. It is too early to say whether we may confidently look forward to the establishment of a separate Department but we may reasonably hope that a start will at least be made on organized research. In this matter of fuel research India lags behind nearly all other important countries of the world and particularly behind her chief competitor in the field of fuel, namely South Africa. The establishment in that country of a Fuel Research Institute by utilizing the accumulated funds of the formerly-existing Coal Grading Board should be of special interest to those concerned in this very important matter. The Committee that has been formed in India will presumably have to consider what schemes should be rec-

ommended for adoption by the existing workers or should form the basis of the work to be undertaken in the early stages by any Fuel Research Department that may be established....

Finally, the writer would appeal to enthusiastic scientists and quasi-scientists throughout India not to fall into the harmful error of over-stating the case for the development of India's mineral (and other) resources and their dependent industries by the results of scientific research. There is, in his opinion, a regrettable tendency just at present to paint attractive pictures of the wonderful benefits awaiting the country if only research is sponsored, encouraged and financed, a tendency to assure the uninitiated that technical success in scientific research will automatically be followed by wholesale industrial development. The coal by-product question is a case in point. Much loose talk has been allowed to find a place in the press in recent months regarding the storehouse of beautiful dyes, wonderful disease-curing drugs and valuable synthetic resins locked up in a lump of coal. Following upon these articles there have been appeals, mostly genuine and in the best of good faith, to finance this and that research, in many instances such advocated researches being, upon investigation, little more than a repetition or extension of work already excellently and for the most part exhaustively done in other countries and requiring little more than intelligent application by commercial and industrial interests. Such

popular writing is an undesirable type of 'appealing to the gallery'.

In too many instances, it is to be feared, have glowing accounts of the promise given by this and that research been followed by disappointing silence as to the results. The consequence has been to put into the hands of those who have been over-persuaded additional arguments against the encouragement of pure and applied research.

Such a statement is not to be taken as a wholesale stricture on the initiation of research. On the contrary, research should be encouraged and financed to the utmost capacity of the country and the writer himself has, ever since his arrival in the country, pressed most strongly for a sympathetic attitude on the part of government towards research. But we should be honest in this matter and truthfully say that pure research should be encouraged irrespective of any kind of guarantee of profit arising from the results. Research is the life-blood of the scientist and of the educationist and a country that persistently starves its research workers is doomed to remain in the background scientifically, educationally and industrially.

But let us be modest and dignified in our claims as scientists, restrained in our self-praise at scientific gatherings and in the press, cautious (outwardly at least) in our optimism, guarding against rushing into print with the ill-digested results of research work, and honestly, quietly and sincerely persistent in effort.

Charles Forrester