KRISHNASWAMI VENKATARAMAN

(1901-1981)

Elected Fellow 1939

FAMILY BACKGROUND

KRISHNASWAMI VENKATARAMAN (fondly called KV), the second of the three distinguished sons of PS Krishnaswami, was born at Madras on June 7, 1901, in a family where scholarship was greatly valued. His father, though a civil engineer by profession was also a Sanskrit scholar, and after retirement translated Valmiki Ramayana into Tamil. His elder brother, K Swaminathan was professor of English at Madras University. After retirement he became Chief Editor of the Collected Works of Mahatma Gandhi, in which capacity he continued till the ripe age of 96 when he passed away in March 1994. The younger brother, KS Sanjiwi was Professor of Medicine in Presidency Medical College, Madras, and specialised in tuberculosis. Apart from his professional work he founded the Voluntary Health Service in Madras and, at 91, though in poor health, was still involved in Health Delivery Services in the villages. Thus, the desire and ability to work on self-imposed tasks and scholarly pursuits was a family trait which KV carried in no small measure. KV was married quite young (at 19) to Shakunthala (then 14). They were a most devoted and complimenting couple. While KV looked after the scientific affairs of his colleagues and students, Mrs Venkataraman looked after the welfare of KV, his students and staff. They had one daughter, Dharma, who recently retired as Professor of Economics from Delhi School of Economics, was married to Lavraj Kumar, a graduate in Chemistry from Oxford, who joined the Indian Management Service and retired as Secretary to the Government of India. KV passed away on May 12, 1981 at New Delhi and was survived by his wife and daughter; Mrs Venkataraman did not long survive him.

University Education and Professional Career

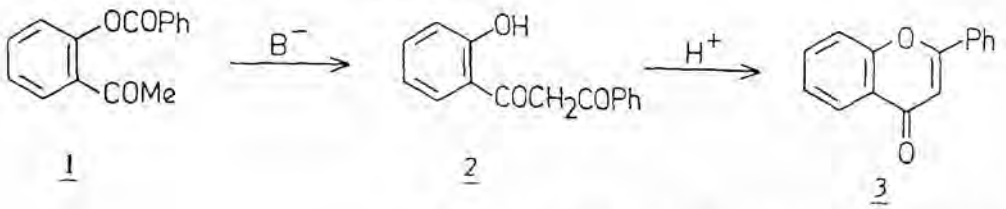
KV recived his college and university education in Madras and he obtained his MA in Chemistry from Madras University in 1923. Prof BB Dey was his teacher and had a big influence in shaping the future of the young KV. He secured a Madras Government scholarship and proceeded to Manchester for higher studies. After taking his MSc (Tech) degree in Colour Chemistry at the University of Manchester, he obtained PhD degree doing research under the supervision of Sir Robert Robinson. He later received the DSc degree from the same University. KV returned to India in 1927 and worked for sometime as a Research Fellow at the Indian Institute of Science, Bangalore. His first appointment was as Lecturer in Chemistry at Foreman Christian College, Lahore, Punjab, where he worked from 1928-1934. Although the facilities for research there were very meagre, the outstanding work done by KV during this period established his reputation as a scientist of great promise. And then there was no looking back. In 1934 he joined the University of Bombay as Reader in dyeing and printing in the newly created University Department of Chemical Technology (UDCT) (housed at that time in the Royal Institute of Science, besides the University Campus in Fort), with Dr RB Foster as the first Professor and Head. In 1938 KV was appoinnted as Prof and Head, UDCT. Dr Foster left in 1938 when KV was appointed as Professor and Head of UDCT, and resigned as Director and Mody Professor of Chemical Technology when the UDCT moved to its present campus in 1943. KV stayed at UDCT till 1957 and was Director for 19 years. During his tenure as the Director of UDCT in its formative years KV laid great emphasis on research and encouraged other departmental heads to have independent research projects. He blended admirably pure/basic science and technology with emphasis on applied/industrial problems both in the teaching/training programmes as also in research projects. This brought UDCT close to industry right from its early years. He introduced couses in several areas of chemical technology. He invited renowned scientists from all over the world for visits and lectures which maintained a scientifically surcharged atmosphere. He also established a tradition for every student to give a talk on his PhD research work before the thesis was submitted, and face questions from collegues and faculty members. This was like a practical lesson in the art of lecturing. I still remember after the talk I gave 'KV remarked' "It was a very good talk but you went like the Frontier Mail (the fastest & longest train journey in prepartition India)". I have tried to modulate the speed and content of my lectures ever since. KV thus set the tone, direction and research traditions and UDCT quickly emerged as a highly prestigious institution for education and research in chemical technology in the country, a position which it has maintained ever since. In 1957, KV was appointed as the first Indian Director of the National Chemical laboratory, Pune. During his tenure NCL became a major centre of research on natural products and synthetic organic chemistry. He retired from NCL in 1966 but continued to have an active research group there, first under a PL-480 scheme on wood phenolics from 1966-77, and as Emeritus Scientist thereafter. He passed away on May 12, 1981 after a brief illness, in the Ganga Ram Nursing Home in New Delhi.

Scientific Contribution to Organic Chemistry

KV started his research career at FC College, Lahore, in 1929, with studies on the chemistry of oxygen heterocycles, a field in which he continued to take active interest till almost the end of his life. Very soon a series of publications started appearing in the newly started journals, *"Current Seicnce, Proceedings of the Indian Academy of Science in India* and the *Journal of Chemical Society"* (UK), which brought to him and Indian Chemistry international recognition. The originality which he showed then was maintained for over 50 years.

One of the most important contributions during this period was the demonstration that o-benzoyloxyacetophenones (1) undergo a base-catalysed internal Claisen condensation of an ester and a ketone to form o-hydroxydibenzoylmethanes (2), which undergo facile acid-catalysed cyclisation to flavones (3). This reaction, which came to be knnown as the Baker-Venkataraman transformation, has been extensively used in the synthesis of flavounes and chromones.

Baker-Venkataraman Transformation



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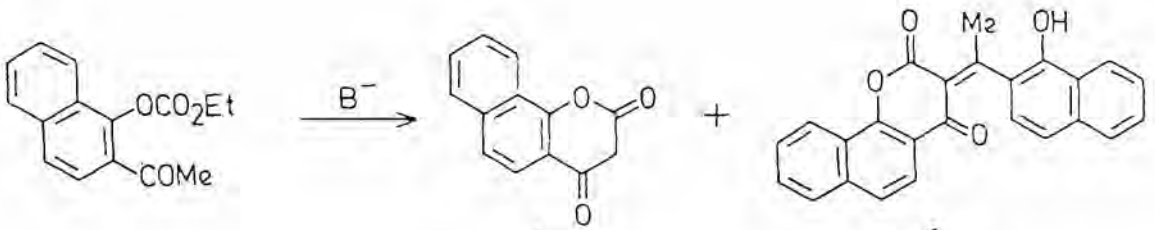
Mahal H S, Venkataramn K; Current Science: 1933: 2; 214

Baker W; J. Chem. Soc.; 1933; 1381



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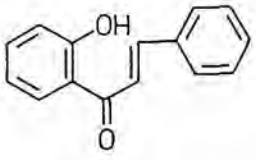
Anand N; Venkataraman K; Proc. Ind. Acad. Sci.: 1948, 28A; 160

Pandey, Prakash, Dikshit, Kapil, Anand and Venkataraman Ind. J. Chem.; 1987; 26B: 1067

It was shown later by KV that the diketone 2 could be prepared in one step from o-hydroxyacetophenone by heating the latter with acid chloride and K_2CO_3 in acetone and that longer treatment, especially of substituted ketones, could lead directly to flavones. A variation of this reaction discovered much later in which I was also associated with KV was a new synthesis of 4-hydroxycoumarins (5) from o-hydroxyacetophenones through o-ethoxycarbonyloxyacetophenones (4). A side product formed in this reaction, isolated in 1947, but whose structure (6) was reported in 1987 would perhaps be the last of KV's research papers.

Following this, KV published a useful method for the oxidative conversion of o-hydroxychalcones (7) to flavones (8a) and flavonols (8B) using SeO_2 or alkaline hydrogen peroxide, respectively.



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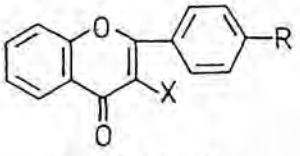
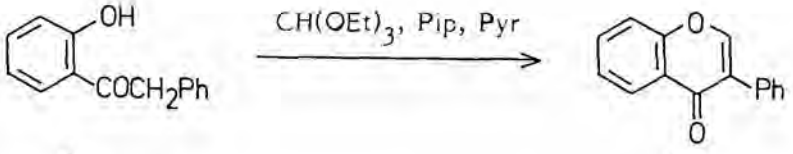


8a R,X = H

b R,X = OH

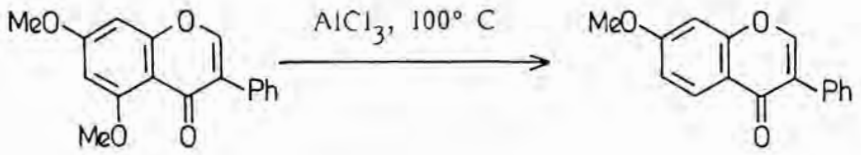
Another significant contribution of this period was the modification of the synthesis of isoflavones (10) from o-hydroxydesoxybenzoins (9) under very mild conditions and with high yields; the ring closure was effected in very good yield using ethyl orthoformate in pyridine in the presence of piperidine as catalyst, which obviated the need to protect the hydroxyl groups. This continues to be a very common method used for the synthesis of isoflavones.



9 10

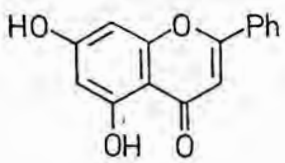
KV demonstrated the selective demethylation of the 5-methoxy group in flavones and isoflavones and 3-methoxy group in flavones by Lewis acids under mild conditions. Extensive use has been made of this procedure for synthesising partially methylated polyhydroxyflavones, flavonols and isoflavones. The procedure of introducting a hydroxy group in suitably substituted oxygen heterocyclics through nitration or azo coupling, followed by reduction and Sandmeyer hydrolysis of the amino compound to the hydroxy compound was employed extensively by KV. For the synthesis of partially methylated polyhydroxy-flavones, isoflavones and xanthones; some of the more important natural

products synthesized through this strategy include gentisin and rhamnazin; in the synthesis of the former I was associated.



11 12

KV was quick in appreciating the potentiality of emerging developments in organic chemistry and in applying them to his research problems. Once the hydrogenolytic removal of sulfur from organic compounds by Raney nickel was established, he applied this technique very ingeniously for the removal of nuclear hydroxyl groups in flavones by hydrogenolysis of the tosylate, e.g. in the synthesis of 5-hydroxyflavone (14b) from 5, 7-dihydroxyflavone (13), through the 7-0 tosylate (14a). He developed this reaction as a general method for the reduction of quinones (15) to the corresponding hydrocarbons (17), by hydrogenolysis of their leucosulfonic esters (16), followed by dehydrogenation. He and his associates extensively used this reaction for the determination of the structures of complex synthetic dyes.



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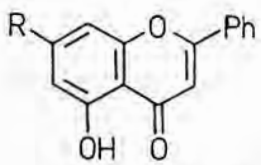
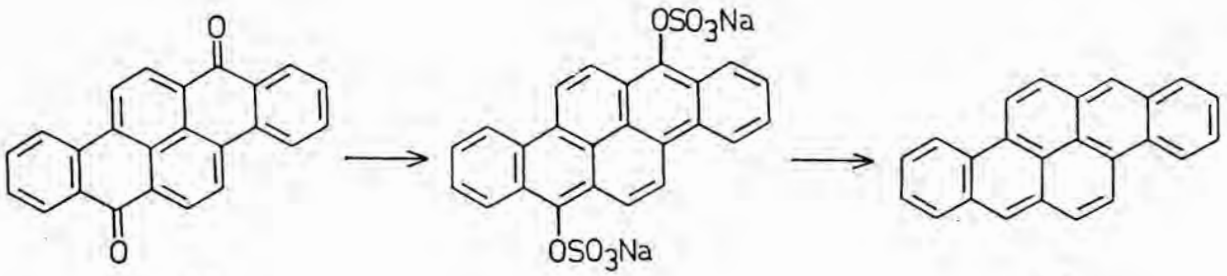


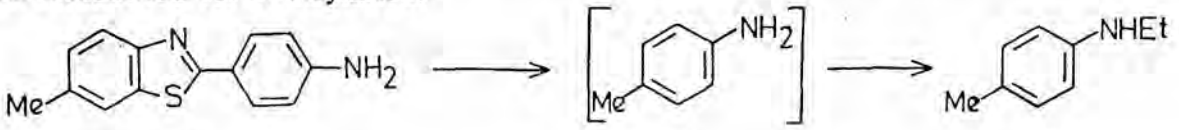
14a R = OTs
b R = H



15 16 17

During the Raney nickel desulfurisation of a commercial dye dehydro-p-toluidine (18) in ethanol, KV obtained an excellent yield of N-ethyl-P-toluidine (18) in ethanol. KV obtained an excellent yield of N-ethyl-P-toluidine (19) which was explained as being due to the scission of the N-C bond to form p-toluidine, which then undergoes N-ethylation

by ethanol, due to the oxidative-reductive action of Raney nickel. This method is now well established for N-alkylation.



18 19 20

KV made equally significant contributions in the field of isolation and structural elucidation of naturally occurring flavones, isoflavones and naphthaquinones, and in many cases derived chemotaxonomic correlations. From the heartwood of *Artocarpus heterophyllus* he and his associates isolated artocarpanone and eight flavones (Chart 11), all characterised by the B-resorcylic acid orientation of the hydroxyl groups in the B-ring, and established the taxonomic relationship between Artocarpus and the Morus species by isolation and structure elucidation of similar flavones from *M. alba*.

Chemical constituents of Artocarpus hetorophyllus

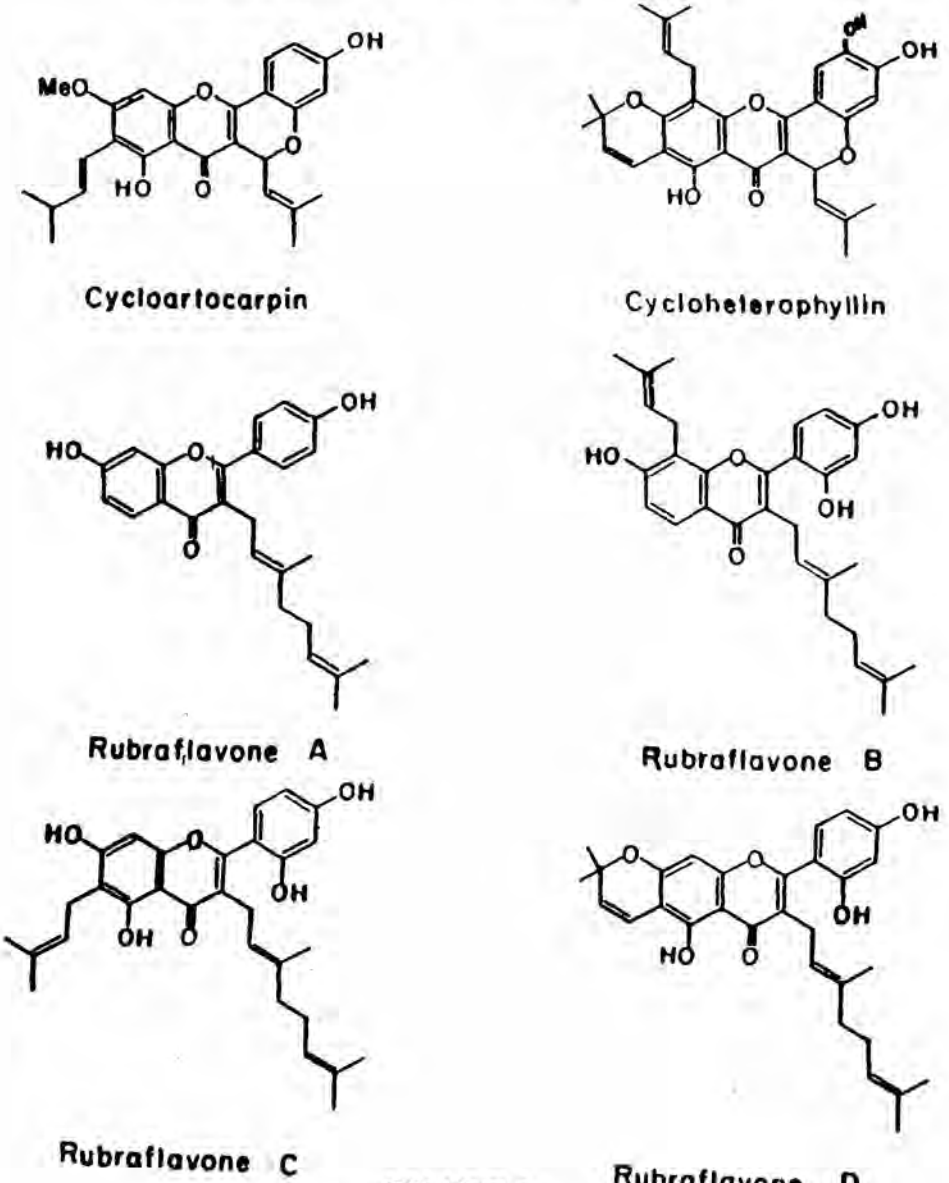


CHART 1

Another important contribution was in the area of lac pigments, some of which were shown to contain nitrogen which fact had been overlooked till then. Structures were assigned to all the laccaic acids based on degradation experiments and spectroscopic studies. His interest in the chemistry of laccaic acid led KV to the investigation of other anthraquinonoid insect pigments and proposed revised structures for kermasic acid and ceroalbolinic acid.

Lac and Insect Pigments

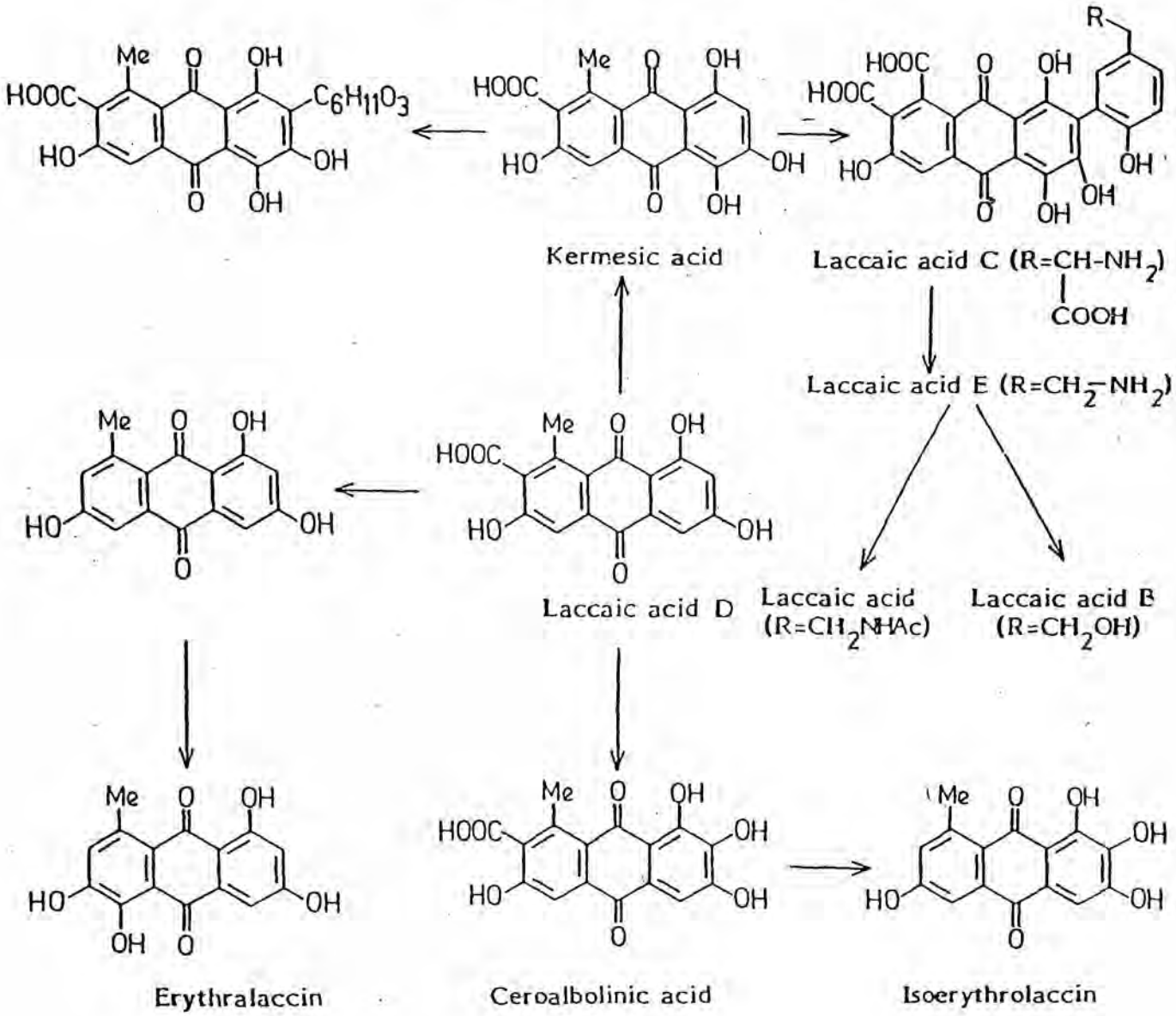


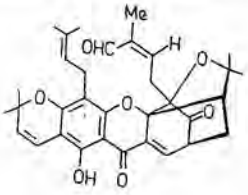
CHART 2

KV never considered himself too old to learn new subjects and right up to the last had a childlike curiosity for new knowledge. When spectroscopy and particularly NMR spectroscopy came to be established as a powerful tool in organic chemistry for structure

determination, he applied the techniques extensively for structure determination, for example for establishing the pattern of substitution in flavones and isoflavones. The Bawa Kartar Singh Memorial Lecture, which he delivered at Punjab University in 1964 was devoted to application of spectroscopic methods to determination of the structure of phenolic pigments. Indian physicists have been well known for their contribution to X-ray crystallography. KV was amongst the first organic chemists to collaborate with X-ray crystallographers to solve problems of organic structures; in collaboration with Ramachandran and Kartha a correct structure was assigned to morellin based on X-ray crystallography.

Dyestuff Technology : Although there had been some research on dyestuff chemistry in India, the first systematic work in this area was started with the establishment of Course in 'Technology of Intermediates and Dyes' at UDCT in 1943 supported by CSIR, upgraded later, a Dept. of Dyestuff Technology on the initiative of KV. This department soon became the leading school of dyestuff research in the country. This brought dyestuff chemistry into both academic and technologic mainstreams. KV's interest in dyestuff chemistry was wide ranging and included synthesis of dyes, structure and substantivity relationship, structure of complex vat dyes, synthesis of surface-active agents and of textile auxilliaries. KV published a series of papers in this area from 1937 onwards in the *J. Soc. Dyers and Colorists,* which attracted both national and international attention. After the second world war KV was invited to visit the war ravaged IG Farben industries and report on the status of the German dyestuff industry which gave him firsthand detailed knowledge of the multinational dyestuff industry. KV prepared a report (the Pai-Venkataraman report) for the setting up of an intermediates and dystuff industry in India. Anticipating that the Indian dyestuff industry would require R & D back-up and trained technologists in allied areas to man the industry, KV established at UDCT research groups in areas such as textile technology and strengthened the groups in chemical technology thus completing all the links in the chain of dyestuff technology. KV was a great champion of technological self-reliance and always opposed import of technology where domestic know-how of equal merit was available. He was one of the first Indian Scientists to establish close working links between academia and industry. In fact, some of his students established the Indian Dyestuff Industries Ltd., and several other smaller units, which was the beginning of the dyestuff industry in India. He is thus rightly considered as the father of dyestuff research as well as of the Indian dyestuff industry. Another important contribution of KV to dyestuff chemistry is the monumental books he wrote in this area; he first wrote *Chemistry of Synthetic Dyes* published in 1952 as a set of two volumes by Academic Press. During 1971-78 six more volumes (Vol. III-VIII) covering the progress made after 1952 were edited by him with international multi-authorship. These volumes were soon translated into Russian and other languages and have also been reprinted. These eight volumes along with *The Analytical Chemistry of Synthetic*

Dyes edited by KV (Wiley Interscience, 1978) continue to be standard reference books for dyestuff chemists.



Morellin

As a Teacher

KV was an exceptionally good teacher. He was a master of the art of expression both in his lectures and in his writings. His lectures were most informative and uptodate, and presentation lucid and clear. He was never in a hurry to publish, but whatever he published had to be in perfect order and meticulously written. His research papers and his books are an example to be emulated by all those who aspire to achieve precision and thoroughness in their publications.

KV laid great emphasis on research and was an inspiring research guide. He would discuss research problems with his students at great length and did not mind answering any questions. He would visit his students almost daily and was always available to them. The only sore point with his research students was the long time most of them took to get their PhD degree. A common joke in the Lab. was that KV's students got their degree posthumously. KV wanted every thesis to be great. KV supervised about 85 students for their PhD degree and include distinguished scientists such as Drs. BD Tilak, BS Joshi and AV Rama Rao, who have carried on the KV legacy.

He encouraged his students to write the first draft of a research paper, and then corrected it. KV always had his students as the senior author. Writing a paper with KV was a practical lesson in the art of elegant and lucid writing. When I wrote my first paper, I worked on it for days and gave it to KV, and I thought it was in perfact shape. I felt so crestfallen when I got it back. Not a single line was withoout some correction or punctuation or expression. Soon I got over the shock and realised how much he had improved the paper. KV was very punctilious about spellings and pronunciation of names; the first time I spelled his name as Venkatraman, he was quick in pointing out that he was Venkataraman, and gave me a brief talk on the importance of names. The respect for names and punctuation has been with me ever since.

Honours and Awards

KV received them in plenty; these included Honorary DSc of Mendeleev Institute of Chemical Technology, Moscow; Elected Fellow of the USSR Academy of Sciences, Moscow; Elected Fellow of the Polish Academy of Sciences, Warsaw; Hon. Membership of the Society of Dyers and Colourists, UK; President of the Indian Chemical Society; Fellow of the Indian National Science Academy, National Academy of Sciences and Indian Academy of Sciences; Vice-President Indian National Science Academy; recipient

of TR Seshadri 70th Birthday Commemoration Medal of INSA; PC Ray Medal of the Indian Chemical Society; delivered the Bawa Kartar Singh Memorial Lecture of Punjab University in 1964, and member of the Editorial Boards of Tetrahedron, Tetrahedron Letters and Indian Journal Chemistry till his passing away. He was honoured by the President of India with the Padma Bhushan in 1961. KV is amongst the very few Indian chemists having a reaction after his name: Baker-Venkataraman Transformation. KV had one regret, that he was not elected Fellow of the Royal Society.

As A Person

KV was a highly cultivated and cultured human being. He never talked ill of others and had no rancour. He was by nature charitable, polite and considerate. He very seldom lost temper or talked harshly, and the harshest words I heard from him were: "How could you do this, it is not fair"! He was sharp witted and had a delightful sense of humour – he could both enjoy a joke and also cut a joke.

KV had a penchant for hard work and led a very disciplined life, a habit which he continued till almost the end of his life. Come what may, he would be in his office by 9 AM and leave at 7 PM. Nothing could make him change his normal routine. Even on holidays and after retirement he would be in his office working on his books or manuscripts; and this in spite of his indifferent health (he suffered from chronic asthma). His relaxation was reading PG Woodhouse and Agatha Christie or occasionally playing a game of bridge.

KV was very meticulous, precise and organised both in his scientific work and also in directing administration and would look into the minutest details. A very fair person, he belonged to no group of the scientific community. KV did not like to serve on government committees and preferred to be left undisturbed to pursue his teaching and research work. Getting money by means which would divert attention from academic life was an anathema to KV. He believed (and practised) that a University teacher should be happy with his emoluments, howsoever little. Thus, paid consultation to industry was a taboo with him and he discouraged it.

As a great teacher, an inspiring research guide and as a cultivated person, KV set before his students and colleagues high standards and lofty ideals.

Personal Association

I first met Dr. Venkataraman in 1945 when I joined him as a research student. My first impression of him was of a gracious, gentle and sharp person with an intense involvement in his work, which got strengthened as I got to know him more. I left his laboratory

in 1948 for Cambridge after finishing my PhD thesis. To have Dr Venkataraman as a research superviser and mentor at that formative period of my research career was most fortuitous. I kept in close touch with him even after leaving his laboratory. The last I met him was in the Ganga Ram Nursing Home just a few days before he passed away, and he was still his gracious self, planning what he would do after coming out of the Nursing Home. I feel deeply privileged to write this Memoir and pay my humble tribute to an outstanding scientist, a good human being, and my teacher.

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Lucknow.

Bibliography

1. 1924. Notes on bixin. *J. Indian Inst. Sci. 7*, 225.
2. 1926. (With J HUEBNER) The behaviour of different starches towards dyestuffs and iodine. Part I. *J. Soc. Dyers Colorists*. **42**, 116.
3. – (With J HUEBNER) The behaviour of different starches towards dyestuffs and iodine. Part II. *J. Soc. Dyers Colorists*. **42**, 327.
4. – (With SIR ROBERT ROBINSON) A Synthesis of acacetin and certain other derivatives of flavone. *J. Chem. Soc.* **129**, 2344.
5. 1929. (With SIR ROBERT ROBINSON) A synthesis of morin and of 5,7,2,4 -tetrahydroxyflavone. *J. Chem. Soc.* **135**, 61.
6. – Synthetical experiments in the chromone group. Part I. A new synthesis of 7,8,-dihydroxy-2-methylchromone and 7,8-dihydroxy flavone. *J. Chem. Soc.* 2219.
7. 1930. A new synthesis of dicinnamoylmethane. *J. Indian Chem. Soc.* **7**, 157.
8. 1931. (With IC BADHWAR, W. BAKER AND B.K. MENON) The condensation of formylpheny lacetonitriles with phenols. Part I *J. Chem. Soc.* **139**, 1541.
9. – (With AS BHULLAR) Synthetical experiments in the chromone group Part II. 1,4-Naphthapyrones. *J. Chem. Soc.* **139**, 1165.
10. – (With KC GULATI) Synthetical experiments in the chromone group. Part III. Diflavones. *J. Chem. Soc.* 2376.
11. – (With BK MENON) Synthetical experiments in the chromone group. Part IV. 1,4-Naphthapyrones. *J. Chem. Soc.* 2591.
12. 1932. (With US CHEEMA) Synthetical experiments in the chromone group. Part V. Chromones derived from 2-pheny lacetyl-1-naphthol and 2-phenylpropionyl-1-naphthol. *J. Chem. Soc.* **141**, 918.
13. – (With US CHEEMA AND KC GULATI) Synthetical experiments in the chromone group. Part VI. 2-Styrylchromones. *J. Chem. Soc.* 925.
14. – (With IC BADHWAR) The condensation of -formylphenylacetonitriles with phenols. Part II. *J. Chem. Soc.* 2420.
15. – (With IC BADHWAR AND KS KANG) Sythetical experiments in the chromone group. Part VII. A synthesis of 7,8,4-trihydroxy-7,8,3,4-tetrahydroxy-, and 7,8,3,4,5-, 5,7,3,4,5- and 3,7,3,4-5-pentahydroxyflavones. *J. Chem. Soc.* 1107.

16. 1933. (With KC GULATI) The dye of acacia wood. *J. Chem. Soc.* **137**, 53.
17. – (With KC GULATI AND SR SETH).Antiseptics and anthelminthics. Part I. 1-Alkyl-2-naphthols *J. Prakt. Chem.* **137**, 47 (1933).
18. (With HS MAHAL) Some 4-styrylcoumarins. *J. Chem. Soc.* **143**, 616.
19. – (With GK BHARADWAJ) The action of aluminium chloride on polymethoxyflavones. *Curr. Sci.* (India) **2**, 50.
20. – (With TC CHANDHA) Synthetical experiments in the chromone group. Part VIII. Derivatives of o-hydroxy-, 2,5-dihydroxy-and 2,4,5-trihydroxyacetophenone. *J. Chem. Soc.* **143**, 1073.
21. – (With KC GULATI) The colouring matter of Khapli wheat. *Curr. Sci.* (India) **1**, 238.
22. – (With KC GULATI) Synthetical experiments in the chromone group. Part IX. A synthesis of 5,7,4-trihydroxy-3,5-dimethoxyflavone, believed to be identical with trioin. *J. Chem. Soc.* 942.
23. – (With KC GULATI) A synthesis of Tricin. *J. Chem. Soc.* 1644.
24. – (With TC CHADHA AND HS MAHAL) Synthetical experiments in the chromone group. Part X. Coumarin and Chromone formation *J. Chem. Soc.* **143**, 1450.
25. – (With HS MAHAL) A synthesis of flavones at room temperature. *Curr. Sci.* (India) **2**, 214.
26. – The Synthesis of chromones. *J. Indian Chem. Soc.* Sir P.C. Ray Commemoration Volume, **27**.
27. 1934. (IC BADHWAR) Gallacetophenone. *Org. Syntheses* **14**, 40.
28. – (With PC JOSHI) Synthetical experiments in the chromone group. Part XI. Synthesis of isoflavone *J. Chem. Soc.* **145**, 513.
29. – (With HS MAHAL AND HS RAI) Synthetical experiments in the chromone group. Part XII. A synthesis of 7-hydroxyisoflavone and of -and-naphthaisoflavone. *J. Chem. Soc.* 1120.
30. – (With KC GULATI AND SR SETH) Synthetical experiments in the chromone group. Part XIII. Hydroxy-2-styrylchromones. *J. Chem. Soc.* 1765.
31. – (With HS MAHAL) Synthetical experiments in the chromone group. Part XIV The action of sodamide on 1-acyloxy-2-acetonaphthones. *J. Chem. Soc.* 1767.
32. – (With HS MAHAL AND HS RAI) Synthetical experiments in the chromone group. Part XV. A synthesis of formononetin, daidzein and pseudobaptigenin. *J. Chem. Soc.* 1769.
33. – (With AN RATNAGIRISWARAN AND KB SEHRA) The anthelminthic consitituent of the leaves of Calycopteris floribunda. *Biochem. J.* **28**, 1964.
34. 1935. (With HS MAHAL AND HS RAI) Synthetical experiments in the chromone group. Part XVI. Chalkones and flavanones and their oxidation to flavones by means of selenium dioxide. *J. Chem. Soc.* 866.
35. – (With DC BHALLA AND HS MAHA) Synthetical experiments in the chromone group. Part XVII. Further observations on the action of sodamide on 0-acyloxyacetophenones. *J. Chem. Soc.* 868.
36. – (With KC GULATI AND SR SETH) Phloracetophenone. *Org. Synthesis* **15**, 70.
37. – (With W KARRER) Identity of calycopterin and thapsin. *Nature* **135**, 878.
38. 1936. (With DR DHINGRA AND HL UPPAL) Antiseptics and anthelminthics. Part II. A synthesis of 6-benzyl-7-hydroxyflavone and 6-n-hexyl-7-hydroxyflavone. *Proc. Indian Acad. Sci.* **3A**, 206.
39. – (With KC GULATI) Synthetical experiments in the chromone group. Part XVIII. Demethylation with aluminium chloride *J. Chem. Soc.* 267.
40. – (With HS MAHAL) Synthetical experiments in the chromone group. Part XIX. A synthesis of genkwanin. *J. Chem. Soc.* 569.
41. – (With DR DHINGRA AND IS UPPAL) Wetting agents in textile processing. Part I. *J.Sor Dyers Colorists* **53**, 91.
42. 1938. (With HS MAHAL) The coupling of 6-hydroxyflavone with diazo salts. *Curr. Sci.* (India) **6**, 450.
43. – (With RB FORSTER AND PR MEHTA) Studies in the Naphtol AS series. Part I. Fastness to kier boiling. *J. Soc. Dyers Colorists*, **1**, 36.
44. – (With RB FORSTER AND SR RAMACHANDRAN) Studies in the Naphtol AS series Part II. Fastness to rubbing. *J. Soc. Dyers Colorists* **6**, 216.

45. – (With RB FORSTER AND SM KAJI) The distinction between oxycellulose and hydrocellulose. *J. Chem. Soc.* Ind. & News Ed. **1**, 36.
46. – (With NC MITRA) A volumetric estimation of moisture with particular reference to cotton. *J. Chem. Soc.* Ind. (London) **57**, 306.
47. – (With RB FORSTER AND SM KAJI) A rapid method for the estimation of reducing power in cotton. *J. Chem. Soc.* Ind. (London) **57**, 310.
48. – (With SR RAMACHANDRAN) The seed husk of Plantago ovata in printing and finishing *J.Soc. Dyers Colorists*. **54**, 462.
49. – (With RB FORSTER AND IS UPPAL) Wetting agents in textile processing. Part II. A modified herbing apparatus. *J. Soc. Dyers Colorists*. **54**, 465.
50. – (With IS UPPAL) The sulphonation of monomethylaniline. *J. Chem. Soc.* Ind. (London) **57**, 410.
51. – (With SR RAMACHANDRAN AND IS UPPAL) Wetting agents in textile processing Part III. Calcium soap dispersing power. *J. Soc. Dyers Colorists.* **54**, 513.
52. – (With SR RAMACHANDRAN) Cutch Part 1. Modified shades by coupling with diazo salts. *J. Soc. Dyers Colorists.* **54**, 513.
53. 1939. (With IS UPPAL) Wetting agents in textile processing. Part IV derivatives of arylamine sulphonic acids. *J. Soc. Dyers Colorists.* **55**, 125.
54. – (With FF DARBAR AND SR RAMACHANDRAN) Trisodium phosphate as a textile auxiliary. Part I. Properties as a kier-boiling assistant *J. Indian Chem. Soc.* Ind. & News Ed. **2**, 81.
55. – Synthetical experiments in the flavone and isoflavone groups. *Proc. Nat. Inst. Sci.* India **5**, 253.
56. – The chemistry of detergents. *Curr. Sci.* (India) **8**, 281.
57. – (With RC GANDHI) Anacardic acid and its derivatives as textile auxiliary agents. *Curr. Sci.* (India) **8**, 367.
58. 1940. (With SM KAJI) The mechanism of degradation of cellulose. *Curr. Sci.* (India) **9**, 66.
59. – (With RV BHAT AND RB FORSTER) Studies in the Naphtol AS Series. Part IV. Synthetical experiments. I. *J. Soc. Dyers Colorists.* **56**, 166.
60. – (With GV SHIROLKAR AND IS UPPAL) The sulphonation of monoethylalniline *J. Indian Chem. Soc.* **17**, 443.
61. – (With GV SHIROLKAR) Wetting agents in textile processing. Part VI. Some properties of soaps. *J. Soc. Dyers Colorists.* **56**, 503.
62. 1941. (With BK VAIDYA) Recent applications of colloid chemistry to textile problems. *Bhatnagar Commemoration Volume*, p.49.
63. – (With GV SHIROLKAR) Wetting agents in textile processing. Part VII. Carboxyamides. *J. Soc. Dyers Colorists.* **57**, 41.
64. – (With GV SHIROLKAR) Wetting agents in textile processing. Part VIII. Purification and analysis of commercial wetting agents. *J. Indian Chem. Soc.* Ind. & News Ed. **4**,61.
65. – (With NAZIR AHMAD AND MU PARMAR) The chemical processing of Indian cotton materials. Part I. The effect of kier-boiling and bleaching on the cuprammonium fluidity and strength of yarn spun from four good quality Indian cottons. *J. Indian Chem. Soc.*, Ind. & News Ed. **4**, 93.
66. – (With RC SHAH AND VV VIRKAR) The constitution of calycopterin, the yellow coluring matter of the leaves of Calycopteris floribunda. *J. Indian Chem. Soc.* **19**, 135.
67. – (With RC GANDHI) Mildew in cotton Part I. The routine examination of textile antiseptics. *J. Indian Chem. Soc.* Ind. & News Ed. **5**, 85.
68. – (With RB FORSTER AND RC GANDHI) Mildew in cotton. Part II. Estimation of salicylanilide in textiles. *J. Indian Chem. Soc.*, Ind. & News Ed. **5**, 85.
69. – (With RC GANDHI) Mildew in cotton. Part III. Synthetical experiments in antiseptics for textiles: Derivatives of cashewnut shell oil *J. Indian Chem. Soc.*, Ind. & News Ed. **5**, 89.
70. – (With RV BHAT) Studies in the Naphtol AS series. Part V. Synthetical experiments, II. *J. Sooc. Dyers Colorists*, **58**, 155.

71. – (With NF DESAI) 1-Benzeneazo-2-naphthol as a food colour. *J. Indian Chem. Soc.*, Ind. & News Ed. **5**, 165.
72. – (With RV BHAT AND SR RAMACHANDRAN) Studies in the Naphtol AS series. Part VI. Synthetical experiments, III. Synthesis of "naphthols" with paraffin chains. *J. Soc. Dyers Colorists. 58*, 203.
73. – (With RV BHAT AND MISS KD GAVANKAR) Studies in the Naphtol AS series. Part VII. Synthetical experiments, IV. 2-Hydroxy-3-naphthoyl derivatives of aminoanthraquinones *J. Indian Chem. Soc.* Ind. & News. Ed. **5**, 171.
74. 1943. (With RB FORSTER AND KG KUDVA) Fatness tests and standards for coloured cements. *J. Indian Chem. Soc.,* Ind. & News. Ed. **6**, 119.
75. – Identity of puddumetin and genkwanin *Sci.* (Calcutta) **6**, 45.
76. 1944. (With ED DARUWALA AND BD TILAK) Wetting agents in textile processing. Part IX. Lauryl-p-toluidide-2-sodium sulphonate. *J.Indian Chem. Soc.*, Ind. & News Ed. **6**, 24.
77. – (With BD TILAK) Surface-active compounds. Part X. Derivatives of alkoxyanilides. *J. Sci. Ind. Research* (India) **3**, 193.
78. – (With BD TILAK) Surface-active compounds. Part XI. Derivatives of C-alkylanilines. *J. Sci. Ind. Research* (India) **3**, 290.
79. – (With MB DESAI AND BK VAIDYA) The use of emulsified organic solvents in Kier-boiling. *J. Indian Shem. Soc.* Ind. & News Ed. **7**, 140.
80. – (With RJ MOUALIM) Studies in the naphtol AS series. Part VIII. Constitution of naphtol AS-S and Brenthol BA. *J. Sci Ind. Research* (India) **3**, 447.
81. 1945. Some aspects of synthetic dyes. *Presidential Address, Chemistry Section 32nd Indian Science Congress*. 1945.
82. – (With TS GORE AND TB PANSE) Citrinin. *Nature* **157**, 333.
83. – Demethylation of 3-methoxyflavones with aluminium chloride. *Curr. Sci.* (India) **15**, 105.
84. – (With NAZIR AHMAD AND MU PARMAR) The chemical processing of Indian Cotton materials. Part II. The influence of different concentrations of caustic soda on the quality of kier-boiled and bleached yarns spun from Indian cottons. *J. Indian Chem. Soc.*, **Ind. & News Ed. 9** 1.
85. – (With NF DESAI AND A SREENIVASAN) Susceptibility of tamarind seed powder to mildew in cotton. *J. Sci Ind. Research* (India) **5**, 44.
86. – (With RN LYER) Synthetical experiments in the chromone group. Part XX. A new sythesis of 5,6-dihydroxyflavone. *Proc. Indian Acad. Sci.* **23A**, 278.
87. 1947. (With N ANAND) Synthetical experiments in the chromone group. part XXI. Synthesis of gentisin the colouring matter of gentian root. *Proc. Indian Acad. Sci.* **25A**, 438.
88. – (With SV SUNTHANKAR) Anthraquinone series. Part I. 1-Aminoanthraquinone-2-aldazine. *Proc. Indian Acad. Sci.* **25A**, 467.
89. – (With N ANAND) Synthetical experiments in the chromone group. Part XXII. Nitroflavones as intermediates for the synthesis of hydroxy-and hydroxymethoxyflavones. *Proc. Indian Acad. Sci.*, **26A**, 279.
90. 1948. (With SK MUNSHI AND BD TILAK) Sulphanilamides. Part I. Salts with sulphonic acids. *Proc. Indian Acad. Sci.* **27**, 265.
91. – (With SK MUNSHI AND BD TILAK) Ammonium salts of sulphanilamides and sulphonic acids. *Nature*. 161, 55.92.
92. – (With KR SHAH AND BD TILAK) Sulphur dyes and sulphurized vat dyes. Part I. Constitution of Hydron Blue. *Proc. Indian Acad, Sci.* **28A**, 111.
93. – (With KH SHAH AND BD TILAK) Raney nickel reductions. Part I. *Proc. Indian Acad. Sci.* **28A**, 142, (1948).
94. – (With SG BEDEKAR AND BD TILAK) Anthraquinone series. Part II. Halogenated aminoanthraquinones and indanthrones. *Proc. Indian Acad. Sci.*, **28A**, 236. (1948)
95. – (With ML KHORANA AND DK MOTIWALA) Anthelminthics. Part III. Anthelminthic activity of Calycopteris floribunda. *Proc. Indian Acad. Sci.* **27A**, 121.
96. – (With N ANAND) A new synthesis of 4-hydroxycoumarins. *Proc. Indian Acad. Sci.*, **28A**, 151.

97. – (With N ANAND) 6,7-Benzocoumaranone. *Proc. Indian Acad. Sci.*, **28A**, 160.
98. – (With N ANAND AND DM PATEL) Azoic dyes. Part IX. The behaviour of -benzoyl-2-acetyl-1-naphthol towards diazonium salts. *Proc. Indian Acad. Sci.* **28A**, 545.
99. – (With TS GORE AND TB PANSE) The constitution of citrinin. *J. Am.Chem. Soc.* **70**, 2287.
100. 1949. (With DS BHATE AND TB PANSE) Potential antitubercular compounds. part I. 3,3-Dihydroxyazobenzene-4, 4-dicarboxylic acid and 4-aminosalicylic acid. *Proc. Indian Acad. Sci.* **29A**, 196.
101. – (With N ANAND AND RN IYER) Synthetical experiments in the chromone group. Part XXIII. A new synthesis of rhamnazin and a synthesis of 3,4-dihydroxy-7-methoxyflavone. *Proc. Indian Acad. Sci.*, **29A**, 203.
102. – (With GS GOORE AND TB PANSE) Citrinin. part I. *Proc. Indian Acad. Sci.*, **29A**, 289.
103. – (With KH SHAQH AND BD TILAK) Sulphur dyes and sulphurized vat dyes. part II. Constitution of Cibanone Yellow R. *Proc. Indian Acad. Sci.*, **30A**, 1.
104. – (With VR SATHE) A new reaction for the synthesis of chromones and isoflavones. *Curr. Sci.* (India) **18**, 373.
105. 1950 (With MA GOVINDA RAU) Dipole moments of resonance structures and the ultraviolet absorption maxima of anthracene. *Curr. Sci.* (India) **19**, 9.
106. – (With TS GORE AND RV TALAVDEKAR) A new partial synthesis of citrinin. *Curr. Sci.* (India) **19**, 20.
107. – (With TS GORE) Chromatographic separation of dyes. *Curr. Sci.* (India) **19**, 149.
108. – (With PN PANDIT AND BD TILAK) Anthraquinone and anthrone series. Part III. Constitution of dinitrodibezanthrone and some derivatives of 3,3-dibenzanthronyl. *Proc. Indian Acad. Sci.*, **32A**, 29.
109. – (With PN PANDIT AND BD TILAK) Anthraquinone and anthrone series. Part V. Constitution of a benzanthrone-quinoline and of cyananthrene. *Proc. Indian Acad. Sci.*, **32A**, 39.
110. – (With BS JOSHI AND BD TILAK) Anthraquinone and anthrone series Part VI. 6-and B-benzamidopyrimidanthrones. *Proc. Indian Acad. Sci.*, **32A**, 201.
111. – (With SV SUNTHANKAR) Anthraquinone and anthrone series. Part VI. 6-and B-benzamidopyrimidanthrones. *Proc. Indian Acad. Sci.*, **32A**, 240.
112. – (With BS JOSHI AND BD TILAK) Anthraquinone and anthrone series. Part VII. A synthesis of islandicin. *Proc. Indian Acad. Sci.*, **32B**, 348.
113. – (With GN KAO AND BD TILAK) Raney nickel reductions. Part II. Thioindigo, 6,6-diethioxythioindigo and thioindoxyl. *Proc. Indian Acad. Sci.* **32A**, 162.
114. – (With RV TALAVDEKAR) Azoic dyes. Part X. Brominated naphthols. *Proc. Indian Acad. Sci.*, **32A**, 292.
115. – (With DS BHATE AND TB PANSE) Potential antitubercular compounds. Part II. 3,5-Di-iodo-4-aminosalicylic acid, 4-amino-O-acetylsalicylic acid and other derivatives of 4-aminosalicylic acit. *Proc. Indian Acad. Sci.*, **32A**, 357.
116. 1949. (With RN LYER AND KH SHAH) A synthesis of prunetin. *Curr. Sci.* (Inndia) **18**, 404.
117. 1957. (With RN LYER AND KH SHAH) Synthetical experiments in the chromone group. Part XXIV. A synthesis of prunetin. *Proc. Indian Acad. Sci.*, **33A**, 1116.
118. – (With RN LYER AND KH SHAH) Synthesis of santal. *Proc. Indian Acad. Sci.*, **33A**, 2228.
119. – (With NR RAO AND KH SHAH) Chromatographic separation of vat dyes. *Curr. Sci.* (India) **20**, 66.
120. – (With MS PAVGI, VC SANE AND A SREENIVASAN) Sulphanilamides. Part II. In vitro synergism with anionic surface-active compounds. *Proc. Indian Acad. Sci.*, **33A**, 56.
121. – (With BS JOSHI AND BD TILAK) Anthraquinone and anthrone series. Part VIII. 4-Halognoalizarins and their derivatives. *Proc. Indian Acad. Sci.*, **34A**, 304.
122. – (With NR RAO AND KH SHAH) Anthraquinone and anthrone series. part IX. Chromatographic adsorption of aminoanthraquinones on alumina. *Proc. Indian Acad. Sci.*, **34A**, 355.
123. – (With SV SUNTHANKAR AND BD TILAK) Nitrophenyl alkyl sulphides, sulphoxides and sulphones. *Curr Sci.* (India) **20**, 155.

124. – (With TS GORE) Chelationn in azophenols in relation to chromatographic adsorbability on alumina. *Proc. Inndian Acad. Sci.*, **34A**, 368.

125. – The Chemistry of Synthetic Dyes Vols. I and II, p.1442. Academic Press, New York 1952 (translated into Russian and Chinese). Vol.I reprinted 1961.

126. 1952. (With PN PANDIT AND BD TILAK) Anthraquinone and anthrone series. Part X. Some derivatives of benzanthrone and dibenzanthrone. *Proc. Indian Acad. Sci.*, **35A**, 159.

127. – (With V RAMANATHAN) A new method for the preparation of resorcyclic acid (2,6-dihydroxybenzoic acid). *Curr Sci.* (India) **21**, 283 (1952).

128. – (With SS KARMARKAR AND KH SHAH) Synthetical experiments in the chromone group. Part XXVI. Synthesis of 5,7,2-trihydroxyisoflavone, 5,7,2-trihydroxy-8-methylisoflavone and 5-hydroxyisoflavone *Proc. Indian Acad. Sci.*, **36A**, 552.

129. 1953. Constitutional problems concerning vat dyes. *Lectures delivered as the Cooch-Behar Professor at the Indian Association for the Cultivation of Science*. Calcutta, in March 1953.

130. – Quinoline dyes. In Encyclopedia of Chemical Technology Vol. II, pp.402-410, R.E. Kirk and D.F. Othmer. *Interscience Encyclopedia* Inc., New York., 1953.

132. – (With SS KARMAKAR AND KH SHAH) Synthetical experiments in the chromone group. Part XXVIII. Synthesis of 6-hydroxy-5-7 dimethoxyisoflavone and 5,6,7-trihydroxyisoflavone. *Proc. Indian Acad. Sci.*, **37A**, 660.

133. – (With V RAMANATHAN) Synthetical experiments in the chromone group. Part XXIX. A method for the reductionn of 5,7- dihydroxyflavones to 5-hydroxyflavones. *Proc. Indian Acad. Sci.*, **38A**, 40.

134. – (V RAMANATHAN AND BD TILAK) Raney nickel reductions. Part III. Reduction of anthraquinone and its derivatives. *Proc. Indian Acad. Sci.*, **38A**, 161.

135. – (With GN KAO AND BD TILAK) Raney nickel reductions. Part IV. Thioindigo dyes thionaphthenes and thioafluorenes. *Proc. Indian Acad. Sci.*, **38A**, 244.

136. – (With MR PADHYE AND NR RAO) Anthraquinone and anthrone series. Part XI. Steric hindrance in dibenzanthronyls and dibenzanthrones, *Proc. Indian Acad. Sci.*, **38A**, 307.

137. – (With MR PADHYE AND NR RAO) The effect of substitution on the light absorption of naphthalene. *Proc. Indian Acad. Sci.*, **38A**, 297.

138. – (With PN PANDIT AND BD TILAK) Anthraquinone and anthrone series. Part XII. The benzanthrone condensation on 2-chloroanthraquinone. *Proc. Indian Acad. Sci.*, **38A**, 355.

139. – (With SS MALHOTRA AND BD TILAK) Anthraquinone and anthrone series. Part XIII. Synthesis of 5-substituted benzanthrones. *Proc. Indian Acad. Sci.*, **38A**, 361.

140 – (With BS JOSHI AND N PRAKASH) Anthraquinone and anthrone series. Part XIV. 10Amino-3-chloranthraquinone. *Proc. Indian Acad. Sci.*, **38A**, 474.

141. – (With SV SUNTHANKAR AND BD TILAK) Chloramphenico Series. Part I. p-Nitrophenyl alkyl sulphides sulphoxides and sulphones. *Proc. Indian Acad. Sci.*, **38A**, 23.

142. 1954 (With BS JOSHI AND N PRAKASH) Anthraquinone and anthrone series Part XV. A synthesis of 1,3,5-trihydroxyanthraquinone, *J. Sci. Ind. Research* (India), **13B**, 246.

143. – Colouring matters. Rev. *Textile Progr.* **6**, 295.

144. – (With V RAMANATHAN) Synthesis experiments in the chromone group. Part XXX. A synthesis of 3,5,8,3,4-pentahydroxyflavone and its non-identity with ponderosin. *Proc. Indian Acad. Sci.*, **39A**, 90.

145. – (With V RAMANATHAN) 3,5-Dimethoxyflavone. *J. Sci. Ind. Research* (India), **13B**, 818.

146. – (With MR PADHYE AND NR RAO) Anthraquinone and anthrone series Part XVI. The absorption spectra of leuco derivatives of anthraquinones, 1-and 2-aminoanthraquinones and certain acylamidoanthraquinones in alkaline solution. *J. Sci. Ind. Research* (India) **13b**, 759.

147. – (With N PARKASH) Anthraquinone and anthrone series,Part XVII. A synthesis of 1,37-trihydroxyanthraquinone and a new synthesis of 1,3,8-trihydroxyanthraquinone. *J. Sci. Ind. Research* (India) **13B**, 759.

148. – (With BS JOSHI AND N PARKASH) A synthesis of lucidin. *Curr. Sci.* (India), **23**, 330.

149. 1955. (With BS JOSHI AND N PARKASH) Anthraquinone and anthrone series. Part XVIII. A synthesis of lucidin. *J. Sci. Ind. Research* (India) **14B**, 87.

150. – (With R MANI) The preparation of phenolic ketones, and chalkones by means of boron trifluoride. *Curr. Sci.* (India) **23**, 220.

151. – Direct cotton dyes. *Curr. Sci.* (India) **23**, 402.

152. 1955. Colouring matters Rev. *Textile Progr* **7**, 330.

153. – (With SS KARMARKAR AND KH SHAH) Synthetical experiments in the chromone group. Part XXXI. A synthesis of muningin. *Proc. Indian Acad Sci.* **41A**, 192.

154. – (With NV BRINGI AND KH SHAH) The colouring matters of Garcinia morella part I*J. Sci. Ind. Research* (India) **14B**, 135.

155. – (With BS JOSHI AND N PARKASH) Anthraquinone and anthrone series. Part XIX. Degradation of anthraquinone-acridones. *J. Sci. Ind. Research* (India) **14B**, 325.

156. – (With NB DESAI AND V RAMANATHAN) Raney nickel reductions. Part V. A general method for the reduction of quinones to the corresponding hydrocarbon derivatives. *J. Sci. Ind. Research* (India) **14B**, 330.

157. – (With GN KAO AND BD TILAK) Taney nickel reductions. Part VI. Alkylation of amines with alcohols in the presence of Raney nickel. *J. Sci. Ind. Research* (India) **14B**, 624.

158. – (With EF KURTH AND V RAMANATHAN) The colouring matters of Ponderosa pine bark. *Curr Sci.* (India) **24**, 157.

159. 1955. (With DS BAPAT) Potential antitubercular compounds. Part III. 7-Aminoflavone *Proc. Indian Acad. Sci.* **42A**, 336.

160. 1956. (With NV BRINGI, KG DAVE, SS KARMARKAR, EF KURTH AND R MANI) Some naturally occurring -pyrone derivatives. *Sci. Proc. Roy.* Dlublin Soc. **27**, 93.

161. – (With EF KURTH AND V RAMANATHAN) The colouring matters of Ponderosa pine bark. Part I. *J. Sci. Ind. Research* (India) **15B**, 139.

162. – (With KG DAVE) The colouring matters of the wood of Artocarpus integrifolia. Part I. Artocarpin. *J. Sci. Ind. Research* (India) **15B**, 183.

163. – (With NV BRINGI AND MR PANDHYE) The colouring matters of Garcinia morella. Part II. Infrared and ultraviolet absooption spectra of morellin and its reduction products. *J. Sci. Ind. Research* (India) **15B**, 128.

164. – (With NB DESAI AND V RAMANATHAN) Raney nickel reductions, part VII. A synthesis of 1-azenaphthacene. *J. Sci. Ind. Research* (India) **15B**, 279.

165. – (With NR AYYANAGAR) Anthraquinone and anthrone series. part XX. A simple synthesis of lucidin and munjistin. *J. Sci. Ind. Research* (India) **15B**, 359.

166. – (With R MANI AND V RAMANATHAN) The colouring matters of Ponderosa pin bark. Part II. A synthesis of pinoquercetin and pinomyricetin. *J. Sci. Ind. Research* (India)**15B**, 490.

167. – (With SA KAGAL AND SS KARMARKAR) Synthetical experiments in the chromone group. Part XXXII. A synthesis of tectorigenin. *Proc. Indian Acad. Sci.* **44**, 36.

168. – (With TS GORE AND MK UNNI) Direct Cotton dyes. Part I. Chromatographic purification and crystallization of Congo Red,d benzopurpurin and Chrysophenine. *J. Sci. Ind. Research* (India) **15B**, 618.

169. 1957. Raney nickel reductions. *J. Madras Univ. Centenary Volume* **B27**.

170. – Naturally Occurring Anthraquinone Derivatives. *Festschrift Arthur Stoll*. PP. 360-375.

171. – (With MISS MD BHAVSAR AND BD TILAK) Anthraquinone and anthrone series part XXI. 2-Bromomethylanthraquinones and their derivatives *J. Sci. Ind. Research* (India) **16B**, 392.

172. 1938. Some applications of Raney nickel to synthetical and constitutional problems. *P.C. Ray Memorial Lecture. J. Indian Chem. Soc.* **35**, 2

173. – (With BD TILAK AND MK UNNI) Anthraquinone and anthrone series. Part XXII. 3,4,9,10-Dibenzopyrene and pentaphene from Indanthrene Scarlet 4G and Mayvat Brilliant Red AF. *Tetrahedron* **3**, 62.

174. 1959. (With NR AYYANGAR AND BS JOSHI) Anthraquinone and anthrone series. Part XXIII. The non-identity of 1,3,8-trihydroxy-2-hydroxymethylanthraquinone with versicolorin and a synthesis of damnacanthol and damnacanthal. *Tetrahedron* **6**, 331.

175. – (With NB DESAI) Raney nickel reductions. Part VIII. A synthesis of 1,2-benzanthracene and its 3-methyl and 4-methyl derivatives. *Tetrahedron* **5**, 305.

176. – (With KG DAVE, BS JOSHI AND AV PATWARDHAN) The constitution of erythrolaccin. *Tetrahedron Letters* **6**, 22.

177. – Flavones and Isoflavones. L. Zechmeister, *Progr. in Chem. Org. nat. Prods.* **17**, 1-69.

178. 1962. Methods for Determining the Structure of Flavonoids. In T. A. Geissman, *The Chemistry of the Flavonoid Compounds* opp. 71-107. Pergamon Press, Oxford (1962).

179. 1960. New methods for the synthesis of naturally occurring anthraquinones. *Presidential Address.J. Indian Chem. Soc.* **37**, 247.

180. – (With DS BAPAT, BC SUBBA RAO AND MK UNNI) The action of diborane and of sodium. borohydride boron trifluoride etherate on anthraquinones : A new synthesis of aloe-emodin and citreorosein and a general method for the reduction of anthraquinones to anthracene derivatives. *Tetrahedron Letters* **5**, 15.

181. – (With MK UNNI) Anthraquinone and anthrone series part XXIV. Chromatography of vat dyes on alumina at high temperatures. *J. Sci. Ind. Research* (India) **19B**, 355.

182. – (With SS MALHOTRA AND MK UNNI) Anthraquinone and anthrone series. Part XXV. The constitution of nitrated dibenzanthroone. *J. Sci. Ind. Research* (India) **19**, 382.

183. – (With KG DAVE AND SA TELANG) The colouring matters of the wood of Artocarpus integrifolia. Part II. Artocarpetin a new flavone, and artocarpanone, a new flavone. *J. Sci. Ind. Research* (India) **19B**, 470.

184. – (With BS JOSHI, R SRINIVASAN AND RV TALAVDEKAR) Derivatives of 1,3,5-triazine. part I. Condensation of 0-hydroxybenzanilides with cyanuric chloride and fission of the triazine ring. *Tetrahedron* **11**, 133.

185. – (With P MADHAVAN NAIR AND R SRINIVASAN) Condensation of 2,4-dinitrochlorobenzene with o-hydroxyarylamides. *Tetrahedron* **11**, 140.

186. – (With MISS S KANTHAMANI AND C NARAYANAN) Isolation of stachydrine and rutin from the fruits of Capparis moonil. *J. Sci. Ind. Research* (India) **19B**, 409.

187. 1961. Constitutional problems concerning anthraquinonoid vat dyes. Presidential Address. *J. Indian Chem. Soc.* **38**, 197.

188. – (With KG DAVE AND R MANI) The colouring matters of the wood of Artocarpus integrifolia. Part III. Constitution of artocarpin and synthesis of tetrahydroartocarpin dimethyl ether. *J. Sci. Ind. Research* (India) **20B**, 112.

189. – Recent progress in synthetic dyes. *J. Indian Chem. Soc.* (Ray Birthday Centenary Vol.) **38**, 452.

190. 1962. (With KG DAVE AND SA TELANG) Flavonoid pigments of the heartwood of Artocarpus integrifolia. *Tetrahedron Letters*. **1**, 9.

191. – Some reactions of 2,4-dinitrochlorobenzene and cyanuric chloride. *Summer School Org. Chem.*, Shilklong, India **25**, 97.

192. – Methods for determining the structure of flavonoid compounds. *Chem. Flavonoid Compounds* **70**.

193. 1963. (With G KARTHA, GN RAMACHANDRAN, HB BHAT, PM NAIR AND VKV RAGHAVAN). The Constitution of morellin. *Tetrahedron Lett.* 459.

194. 1964. Recent progress in the Chemistry of synthetic dyes. *Yuki Gosei Kagaku Kyokai Shi*, **22**, 401.

195. 1966. Spectroscopic methods of structure determination. Applications to natural phenolic pigments, *J. Sci. Ind. Res.* **25**, 97.

196. 1968. Reactive dyes. *Colourage* **15**, 69.

197. 1976. Recent work on some natural phenolic pigments. *Recent Dev. Chem. Nat. Carbon Compd.* **7**, 39.

198. 1977. Anthraquinone vat dyes. *Khimiya Sintetich*. Krastitelei, **112**.199.

199. 1979. Cyanuric chloride, a useful reagent for converting carboxylic acids into chlorides, esters, amides and peptides. *Tetrahedron Lett*. 3037.

200. 1980. Cyanuric chloride a useful reagent for macrocyclic lactonization. *Tetrahedron Lett.* **21**, 1893.

201. 1987. (With CB PANDEY, OM PRAKASH, DK DIKSHIT, RS KAPIL AND NITYA ANAND) 2-(1-Hydroxynaphthalen-2"-yl)-2-(2, 4-dioxo-3, 4-dihydro-2H-naptho[1,2-b]-pyran-3-yl) ethylidene: minor product formed during cyclisation of 2-Acetyl-1-naphthyl methyl carbonate with base. *Ind. J. Chem.* Vol. **26B**, 1067.