Indian Journal of History of Science, 53.3 (2018) 296-301 DOI: 10.16943/ijhs/2018/v53i3/49461

Indigo — The Crop that Created History and then Itself Became History

Rajendra Prasad*

(Received 25 February 2018; revised 21 June 2018)

Abstract

Indigo, the blue dye, was extracted from plants in ancient times, some 5000-6000 years ago (3000-4000 BCE), both in the Old (Asia, Africa and Europe) and New (Americas) Worlds. It got its name Indigo, because it reached Europe from Indus Valley, India and later from other parts of India by the Portuguese and other European sailors. It was commercially encouraged and traded by the British, firstly by the cultivation of indigo plant and production of the dye in South Carolina, USA in mid18th century, which was then a British colony. However, this stopped after the British colonies in USA gained their freedom after American Revolutionary War (1775-1783). It was then that British East India Company (BEIC) started its production in Bengal and part of the current Bihar states of India and continued it until the second decade of 20th century. The managers of BEIC forced the farmers to grow indigo in place of food crops by attracting them with loans on virtually non-repayable conditions. This caused considerable tyranny and torture of farmers and finally led to the *Nīl Vīdroha* (Nīl Revolt) of 1857, and forced the British Government to appoint a Commission of Enquiry, which confirmed the atrocities caused by the British East India Company. The British Government closed the East India Company and took command of the country's rule in 1858. There was a second Nīl Revolt (*Satyāgraha*, the name given to this non-violent revolt) in Champaran, Bihar launched by the Father of the Nation Mahatma Gandhi in 1917.Thus, indigo crop has been associated with and created quite a bit of history. Faced by high prices charged by the British traders for indigo dye, German chemists had already started their search for making synthetic indigo and Adolf Baeyer succeeded in synthesizing it in 1882. This was followed by research by other German chemists, namely, Johannes Pfleger and Karl Heumann in the first decade of 20th century. The synthetic dye was much cheaper and blew the final blow to the natural plant produced indigo dye and indigo crop became a part of history. Now most of the indigo dye used world-over is made synthetically. Nevertheless, in recent years some interest has arisen in natural indigo dye due to growing demand for organic clothes and natural dyes.

Key words: Indican, Indigotin, Indoxyl, Knotweed, Natural indigo, *Nīl* revolt, Woad, Synthetic indigo.

1. Introduction

Indigo is a dye produced and used in the largest amounts in the world and about 20 thousand tons are produced annually (Steingruber, 2004). Its demand increased after the invention of jeans by Jacob Davis and Levi Strauss in 1873 in USA. Bulk of indigo is used for the production of denim cloth for blue jeans; a pair of blue jean trousers requires about 3–12 g of indigo. The indigo dye is in high demand. Blue is the national colour of France and also of their jerseys for games. Light blue '*Azure*' is also the national colour of Italy. Blue is the colour of the official uniform of the cricket team of India and soccer team of Japan. In Egypt, blue colour was traditionally associated with royalty, luxury and wealth (Farusi, 2012). Among the Druze (Syria,

* Ex ICAR National Professor, Indian Agricultural Research Institute, New Delhi, Mailing Address: 6695 Meghan Rose Way, East Amherst, NY14051, USA, Email: rajuma36@gmail.com

Lebanon) blue is the colour worn by the most respectable sheikhs (Russell, 2014). However, there is also the other side. For example, in Yezidis (Northern Iraq), it is forbidden to wear blue and in Mandeans (Southern Iraq) the blue colour is associated with the evil Ruha (Russell, 2014). Small amounts of indigo dye are used for dyeing wool and silk. It is also used as a food colorant, and is listed in the United States as FD&C Blue No. 2 Aluminum Lake (Drugs.Com via internet). For all these reasons indigo has become *numero uno* dye in the world.

A plant producing a blue pigment from India, *Indicon/Indicum* was known as early as 500 BCE (Roy, 1977). Indigo got its name because of its origin in the Indus Valley, discovered some 5,000 years ago (or circa 3000 BCE), where it was called *nīlā*, meaning dark blue and by the 7th Century BCE, people started using the plant for producing the blue dye (Kriger and Connah, 2006).The Portuguese and Greeks were the first to transport this dye from India to Europe and they had the monopoly in its trade until the British got interested in this commodity; it also fitted well with British cotton industry and trade (Prasad, 2018). The Greek term for this dye translated to "Indian dye", which was adopted to Latin as *indicum* and then via Portuguese it got the modern word *indigo*. The Arabs called the dye "*a-nil*" meaning "the blue". The fabric dyed with indigo dating to 6,000 years ago (or circa 4000 BCE) was also discovered in 2009 at Huaca Prieta, Peru (Splitstoser, 2016). The dye was also known to ancient civilizations in Mesopotamia, Egypt, Britain, Iran, and in some countries of western Africa including Senegal, Cameroon and Nigeria. However, India was the earliest major center for its production and processing in 19th and early 20th century (Kriger and Connah, 2006).

2. Indigo Dye Producing Plant Species

Historically, a number of plant species provided the blue dye 'indigo' including *nīla* (*Indigofera species* in family *Leguminoseae*) in Southeast Asia, knotweed (*Polygonum tinctorum* in family *Polygonaceae*) in Asia before the arrival of *nīla, Strobilanthes cusia* in family *Acanthaceae* in Japan and Taiwan*,* and woad or glastum (*Isatis tinctoria* in the family *Brassicaceae*) in Europe. Known *Indigofera* species include: *I. tinctoria* or *I. sumatrana* in the South and Southeast Asia; *I. coccinia*, *I. decora*, *I. tinctoria* and *I. amblyantha* in China; *I. Carolinians* and *I. Lespotsepala* in the South Carolina, USA and *I. suffruticosa* (*añil*) in the Central and South America. *I. tinctoria* was domesticated in India (Kriger and Connah, 2006).

2.1 Indigo Cultivation

2.1.1 India

Indigo was cultivated and used for dying during the Indus Valley Civilization, which is about 5300-2500 years ago (or circa 3300-1300 BCE) (Gupta, 1996). Indigo dye was in use during Maurya empire circa 322-125 BCE (Kumar, 2008). It was also quite popular during Mughal period (16th to 18th century) (Nadri, 2009). When British Naval Force landed on the west coast of the Indian mainland in 1916 under the command of Nicholas Downtown, the most sought after commodity was Indigo. It was produced in Northern Gangetic plains, in Sindh (Sarkhej), in the Deccan region and along the east coast (Gaatha, 2013). Nadri (2009) also mentions Sarkhej in his writings. However, large scale indigo planting in Bengal dates back to 1777 with the expansion of British East India Company's power in Bengal. It was then that indigo planting became more and more commercially profitable because of the demand for blue dye in Europe. Indigo plantation was introduced in large parts of Burdwan, Bankura, Birbhum and Murshidabad districts in Bengal and later in Champaran and Kheda districts of Bihar (Kumar, 2012). The demand for indigo in the 19th century is indicated

by the fact that in 1897, the area under indigo was 7,000 km^2 producing 19,000 tons of indigo, mostly in India. The port of Calcutta exported about 4000 tons of indigo in a year (Gaatha, 2013). It was also closely linked to the cotton production and trade in India by the East India Company (Prasad, 2018). The number of British indigo planters gradually increased and they left no stones unturned to make money. They mercilessly pursued the peasants to plant indigo instead of food crops. They provided loans, called *dadon* at a very high interest rate. Once a farmer took such a loan, he remained in debt for the whole of his life and not only this, it was passed on to his children. This led to a non-violent revolt by the farmers growing indigo. The 'Indigo revolt (*Nīl Vidroha*) was a peasant movement and subsequent uprising of indigo farmers against the indigo planters that arose in large parts of the districts of Burdwan, Bankura, Birbhum, North 24 Parganas in and Jessore (presently in Bangladesh) in Bengal in 1857 (Thapar, 1966; Majumdar, 2011) and the play *Nīl Darpan* by Dinabandhu Mitra is based on the slavery and forced cultivation of indigo (Project Gutenberg- Free books). The British Government closed the East India Company and took command of the country's rule in 1858 and appointed an "Indigo Commission" in 1860 (Bhattacharya, 1977). E. W. L. Tower of the Commission noted that "not a chest of Indigo reached England without being stained with human blood". It was a major triumph of the peasants to incite such emotion in the Europeans' minds. Thus the revolt was a success. This was followed by another 'Indigo revolt' during 1914-1916 in Champaran and Kheda districts of Bihar and Gujrat respectively, which was immortalized a little later by a *Satyāgraha* (the name given to non-violent revolt) launched by the Father of the Nation Mahatma Gandhi in 1917 in Champaran (Gandhi, 1925; Brown, 1972). It was about this time that the production of indigo from plants was taken over by its synthetic production and indigo plantations in India gradually disappeared.

2.1.2 Other Asian countries

Indigo is grown in almost all south Asian countries including Myanmar, Thailand and Indonesia. Indigo has a long history in China daring back to Qin and Han dynasties (221BCE to 220 CE) (Anonymous, 2015a). In China, it is mostly grown in southern parts of the country. In Japan it was introduced from India and there are records that it was grown in 6th and 7th century, when its use was restricted to Nobles and Samurai. However by 17th century it became available to common people (Anonymous, 2015b). In Japan it is mostly grown in Tokushima prefecture in Shi Ko Ku, the smallest of the four main islands of Japan.

2.1.3 United States of America

Farmers in South Carolina, which was then a British colony, experimented with indigo production as early as the 1670s, but it could not compete with other commodities, which were easier to produce and more profitable. Indigo was re-introduced in the 1740s during King George's War (1739-1748), which cut off Britain's supply of indigo from the French West Indies. Eliza Lucas Pinckney is credited for the re-introduction of indigo cultivation in South Carolina (Coon, 1976). "In 1747, 138,300 pounds of dye, worth £16,803 Sterling, were exported to England and it increased to 1,122,200 pounds, valued at £242,395 Sterling in 1775" (Jelatis, 2016). The American Revolutionary War (1775-1783) disrupted indigo production in USA (Jeremy, 2001), although the production appeared to recover after the war, as 907,258 pounds of dye were exported in 1787. However, indigo exports from USA declined sharply in the 1790s (Jelatis, 2016). England then turned to India to meet its indigo demand.

3. Extraction of Dye from the Plants

Extraction of indigo dye from the plants is a laborious process and takes a lot of time and energy. For details of the process used by Britishers in India reference may be made to

Macdonald (1900).The precursor to indigo is indican, a colorless, water-soluble derivative of the amino acid tryptophan. Indican is obtained from the processing of the plant's leaves, which contain about 0.2–0.8% of this compound. About 200 kg of leaves were required to produce 1 kg indigo dye (Gaatha, 2013).When the *nīl* plant leaves are fermented in water, Indican hydrolyzes to release indoxyl. Oxidation by exposure to air converts indoxyl to indigotin or indigo, which is made up of two units of indoxyl. The precipitate from the fermented leaf solution is then mixed with a strong base such as lye (strong solution of caustic soda), pressed into cakes, dried, and powdered. The powder is then mixed with various other substances to produce different shades of blue and purple. The process of indigo dye extraction can be summed up as under (Chanayath et al., 2002):

Indican (in plant) $\xrightarrow{\text{(Fermentation)}}$ Indoxyl $\xrightarrow{\text{(Oxidation)}}$ Indigotin or Indigo

4. Chemical Synthesis of Indigo

Having no direct linkages with India and frustrated by the British high prices, German chemists were forced to produce indigo synthetically. Adolf Baeyer (Johann Friedrich Wilhelm Adolf von Baeyer), Professor of Chemistry at the University of Munich is credited for its first laboratory synthesis using aldol condensation of o-nitrobenzaldehyde with acetone, followed by cyclization and oxidative dimerization to indigo in 1882 (Baeyer and Drewsen, 1882). He also worked out its chemical formula and structure ($C_{16}H_{10}N_2O$ or 2, 2'-Bis (2, 3-dihydro-3- oxoindolyliden Von Baeyer, 1883) (Fig. 1). For this and other works in organic chemistry Adolf Baeyer received Nobel Prize in Chemistry in 1905.

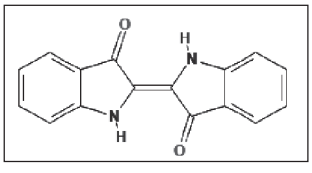

Fig. 1. Indigotin or indigo ($C_{16}H_{10}N_2O$ or 2, 2'-Bis (2, 3-dihydro-3- oxoindolyliden) (Von Baeyer, 1883)

However, it was not possible to manufacture indigo using Baeyer-Drewsen process at the industrial level. Johannes Pfleger, who was the Head Chemist at Deutsce Gold-und Silber Scheideanstalt (Deguudsa AG) at Frankfurt am Main developed and patented in1901 a process involving trearting *N*-phenylglycine with a molten mixture of sodium hydroxide, potassium hydroxide, and sodamide, resulting in the production of indoxyl, which was subsequently oxidized in air to form indigo. Variations of this method are still in use today for manufacturing indigo. For his work, Pfleger received a Doctorate from the Technical University in Munich in 1911 and another Doctorate from the University of Frankfurt in 1923. In 1931, he was made an Honorary Citizen by the Agricultural University in Berlin for his contributions in the area of pest control. An alternative and also a viable route to indigo is credited to Karl Heumann in 1897, who worked at BASF (Badische-Aniline-und Soda Fabric) at Ludwigschafen. It involved converting naphthaline to phthalic anhydride using mercury (II) sulphate as a catalyst and then producing indigo (Findlay, 2013).

The effect of the production of synthetic indigo can be judged from the fact that in 1897, 19,000 tons (very close to the current production 20,000 tons) of indigo were produced from plant sources, while by 1914 it dropped to a mere 1,000 tons and further declined later. At present almost all indigo dye is produced synthetically, although in recent years there is some growing interest and demand for natural dyes (Stevens, 2015; Yusuf et al, 2017), because it is believed that natural indigo has antibacterial, antifungal, deodorizing , skin disease or eczema preventing and insect repelling properties (McGinne,2013;Anonymous, 2015b). For those interested in natural indigo, it is still grown in some parts of India (Singh, 2001), Japan (Anonymous, 2015b), Myanmar (Anonymous,

2016), Cambodia (Sawako, 2007), Vietnam (Leone Fabre, 2014) and Philippines (Leano Jr., 2014).

5. Conclusion

Indigo, once produced from *Indigofera tinctoria* and some and other plant species after a lot of human drudgery in farm fields and indigo extracting vats and related infra structures is now mostly produced synthetically. The indigo crop is virtually extinct as a major commercial crop, although it is still grown in some countries on a small scale. Indigo as a commercial crop is now a history.

Bibliography

Anonymous. Beauty of blue and white: traditional Chinese indigo dyed cloth. *Chinese Daily*, 19 November (2015a).

Anonymous. The indigo blue of Sakon Nakhon (Myanmar) (2016). (www.Vietnamstay.com/news/the-indigo).

Anonymous. Aizone, the mystical Japan blue. *Japan Monthly Web Magazine* April (2016b).

Baeyer, A. Ueber die Verbindungen der Indigogruppe [On the compounds of the indigo group], *Berichte der Deutschen chemischen Gesellschaft zu Berlin* 16 (1883): 2188-2204

Baeyer, A and Drewsen V. Darstellung von Indigblau aus Orthonitrobenzaldehyd *[Preparation of blue indigo from o-nitrobenzaldehyde]*. *Berichte der deutschen chemischen Gesellschaft* 15 (1882) 2856–2864.

Bhattacharya, S. The Indigo Revolt of Bengal. *Social Scientist* 5 (60) (1977):14

Brown, J M. Gandhi's Rise to Power, Indian Politics 1915-1922; In *Indian Politics* 1915-1922, Cambridge University Press, New Delhi, 1972.

Chanayath, N; Lhieochaiphant, S and Phutrakul, S. Pigment extraction techniques from the leaves of *Indigofera tinctoria* Linn and *Baphicacanthus cusia* Brem and chemical structure analysis of their major components. *Cheng Mai University Journal* 1(2) (2002):149-160

Coon, D L. Eliza Lucas Pinckney and the Reintroduction of Indigo Culture in South Carolina, *Journal of Southern History* 42 (1976): 61-76.

Farusi, G. Indigo: recreating Pharaoh's dye. *Science School* 24(21/08/2012)14-19.(via internet)

Findlay, B. Discovered by mistake: A practical synthesis of indigo. *Chemtips* 24 May, (2013) (via internet)

Gaatha, The story of indigo. (06 May 2013). (via internet)

Gupta, S P. *The Indus-Saraswati Civilization: Origin, Problems and Issues*, Pratibha Prakashan, Delhi, 1996.

Gandhi, M K. My Experiments with Truth, Navajivan Publishers, Ahmedabad, 1925.

Jelatis, V. Indigo. In *South Carolina Encyclopedia,* University of South Carolina, Institute for Southern Studies (2016). [http://www.scencyclopedia.org/sce/entries/indigo/]

Jeremy, B. *War for America: The Fight for Independence, 1775–1783*, Sutton Publishing, Gloucestershire, UK., 2001, p. 296.

Kriger, C E. and Connah, G. *Cloth in West African History*. Rowman Altamira Press, Lanham. MD, USA, 2006.

Kumar, P. *Indigo Plantations and Science in Colonial India*, Cambridge University Press, New York, USA, 2012.

Kumar, R. *Encyclopaedia of Untouchables: Ancient, Medieval and Modern*, Kalpaz Publications, Delhi, 2008.

Leano Jr, J.L. *Philippine Natural Dyes for Textiles*. Philippine Textile Research Institute, Ortigas Center, Mandaluyog, Phlippines, 2014.

Leone Fabre, Indigo dying in the Homg people. Bai da Co-Sapa, Lao Cai Province, Vietnam, 2014

Macdonald, M N. Indigo planting in India, *Pearsons Magazine* 10(1900): 387-392.

Majumdar, R.C. *History of Bengal*, BR Publishing Corporation, New Delhi, 2011.

McGinn, E. Natural vs synthetic indigo dyes. *Source-ethicalfashionforum.com* 28 May, 2013.

Nadri, G A. The Political Economy of Indigo in India.1580-1930.: A Global Perspective. BRIL, Lieden, Netherlands, 2009.

Prasad, R., Some Historical Aspects of Indian Cotton and Cotton Textile Trade. Asian Agri-History, 22.3 (2018): 178-186.

Roy, M. Dyes in ancient and medieval India. Lecture delivered at Summer School of History of Science, Indian National Science Academy, New Delhi, Vol. 13 No.2 (1977).

Russell, G. *Heir to Forgotten Kingdoms*, Basic Books, New York, 2014, p.69.

Sawako. *Cambodian natural indigo dying*, Institute for Khmer Traditional Textiles, Siem Reap, Cambodia, 2007.

Singh, R V. The revival of indigo, *Down to Earth* 10 April (2001).

Splitstoser, J C; Dillehay, T D; Wouters, J. and Claro, A. Early pre-Hispanic use of indigo blue in Peru. *Science Advances* 2 (90) (2016). [doi:10.1126/sciadv.1501623]

Steingruber, E., Indigo and Indigo Colorants. In *Ullmann's Encyclopedia of Industrial Chemistry*, Wiley-VCH, Weinheim, Germany, 2004.

Stevens, K. Natural dying's future may get brighter with science, *Los Angeles Times* 09 June, 2015.

Thapar, R. *A History of India*, Penguin Publication, New York, 1966.

Yusuf, M; Shabbir, M and Mohammed, F. Natural colorants: historical, processing and sustainable prospects. *Natural Products and Bioprospecting* 7.1 (2017):123-145.