On the villainous saltpetre in pre-independent India

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William Shakespeare qualifies saltpetre with the term 'villanous' in *Henry IV* (Act I, Scene 3, 1598, note 1), because of its then known relevance in gunpowder manufacture:

'This villanous salt-petre should be digg'd
Out of the bowels of the harmless earth,
Which many a good tall fellow had destroy'd
So cowardly; and but for these vile guns,
He would himself have been a soldier.'

This note explores how much of saltpetre was known in India and how it was used in the last few centuries.

Saltpetre (potassium nitrate; KNO_3) has been known as a raw material for gunpowder in various parts of the world since the 13th century. Incidentally, it was also used as a 'food preservative' and fertilizer in crop husbandry. Today saltpetre is one of the top 100 chemical compounds of the world[1]. An undated Internet article[2] explains its ability to chill water, wine and other beverages, a practice followed in 16th century Europe. The same article also refers to its use in the 13th century Greco–Arab medicine (*Ioninan*, *Unani-Tib* in India) by alluding to remarks of *Ibn-abī-Uşaybi'a*, an Arab alchemist, that saltpetre could turn water into snow (also see ref. 3, p. 301) and includes a photograph of the metal flask with a narrow, elongated neck and a bulbous bottom used in the 18th century India, which could be manually spun to maximize chilling (note 2). Obviously, the demand for saltpetre was increasing in India at this time. In 1663, Edward Wood from a factory of the East India Company located at Balasore (note 3) wrote to John Pack describing the dearness of saltpetre: that he had never paid more than 2/6d (2 shillings and 6 pence) for a bushel (note 4) of saltpetre before[4].

Saltpetre occurs naturally as a product of complex geochemical reactions mediated by nitrifying bacteria[5], which convert nitrogenous biological waste into NO_2 and NO_3 (note 5). Although saltpetre is essentially KNO_3, it can include traces of $NaNO_3$ and $CaCO_3$ when freshly extracted[6]. A neat description of extraction of saltpetre in pre-modern India is available in Biswas[7] (p. 427):

'The saltpetre-yielding Indian soil usually had deep beds of granules of carbonate of lime [$CaCO_3$], a source of potash from feldspar or wood-ash thrown on surface drains, bearing discharge of nitrogenous refuse such as food-waste and human or animal urine. The ancient saltpetre-hunter would look for the white veil-like patch of crystalline formation bear surface drains of human or animal habitations. He would scoop these surface earth samples and lixiviate in boiling water in earthen vessels. Subsequently, the filtered solution would be evaporated up to a point, and then cooled to yield the first crop of crystals chiefly of potassium nitrate. The mother liquor on further evaporation yielded calcium and sodium nitrate and chloride. Whereas potassium nitrate is not deliquescent, and this dry material separated from the rest has been widely used as a constituent of gun powder, the entire material including the hygroscopic residue. When dissolved, cools water and was widely used for preparing cold drinks.'

The Chinese made gunpowder using saltpetre for the first time, in the 13th century[8]. This capability of gunpowder production using saltpetre entered India in the later decades of the 14th century. Random references point out that the *Vijayanagarã* kings, from the time of *Krišnadévarãyã*, used guns and gunpowder. The Deccan *Sûltãn*-s – their contemporaries – possessed guns and cannons. For example, to defend *Penukônda* and *Adôni*, *Çennappa Nãyakã*, a general in the *Vijayanagara* army, used heavy guns against Adil Shah's army in 1567 (ref. 9), which reinforces their knowledge of gunpowder making and gun casting. Jean de Thévenot[10] (p. 105; note 6), while recording his journey in India in the 1660s, mentions:

'At *Poliacate* [*Pulicat*, *c*. 50 km north of Madras city] they refine Salt-Petre which they bring from *Bengala* [Bengal], and make the Gunpowder, with which they furnish their other factories; they refine Salt-Petre that they send to *Europe* in *Batavia.*'

A brief note outlining the extraction and purification of saltpetre in India, translating information from Jean de Thevénot (1665), is available in the first volume of the *Philosophical Transactions* (of London)[11]. A short description on saltpetre manufacture and by-products can be found in Dunnicliff and Prasad[12]; extensive notes are available in Watts[13].

The term 'śorakã' (Sanskrit) existed referring to saltpetre in India in the 10th–11th centuries (ref. 5, p. 215). Battles in India were so frequent in the 16th century that the available saltpetre was grossly inadequate. An intensified search for saltpetre in India eventuated. Indians found saltpetre plentifully to that extent that the King of Spain requested for Indian saltpetre in 1605; Louis XIV, the King of France, authorized importing Indian saltpetre in the 1680s (ref. 14). Hyder Ali (1721–1782), the ruler of Mysore, used saltpetre-propelled rockets. He is supposed to have employed 1200 rocketeers in his army; 5000 by Tipu Sultan (1750–1799)[15]. A caricature by James Gillray (1791) depicts the use of cannons in Mysore, which fired gun powder made with saltpetre (Figure 1).

Saltpetre was a key commodity that was exported from India to Europe[16]. The search for saltpetre resulted in finding this material first – as traces – in the Coromandel. Later saltpetre was found in Gujarat, Agra, Bengal, and in parts of the Malabar coast. By mid-17th century, Bihar became the most prominent region for saltpetre extraction; the Ganges enabled rapid transport to Hooghly for export. An Indian civil servant, Lewis O'Malley[17] (p. 25) says:

'Under the vigorous superintendence of Job Charnock (note 7), who was the chief of the factory from 1664 to 1680, the English trade developed, and fleets of Patna boats laden with saltpetre were a common sight along the Ganges. The Court of Directors were never weary of asking for saltpetre from Patna, where it could be so good and cheap that the contract for it was discontinued on the west coast in 1668 and at Masulipatam in 1670.'

However interest in the exploration of saltpetre in the Madras region persisted. John Clark[18] (p. 94), an assistant surgeon, 13th Light Dragoons, Madras Army, while reporting on the geology of Bangalore and parts of Mysore, in 1839 says: 'It is probable that some chemical action is constantly at work, not by us well understood, but perhaps in some measure similar to that which leads to the formation of saltpetre.'

In 1834, Johnstone Napier[19], also of the Madras Army, published a crisp translation of the first chapter *du Salpêtre* (pp. 4–119) from Jean Joseph Bottée and Jean Riffault des Hêtres' *Traité de l'Art de Fabriquer la Poudre à Canon* (Leblanc, Paris, 1811, p. 537). This Napier translation refers to details of processes followed in France for saltpetre manufacture, on the treatment of saltpetre water using potasse (potash) or by the sulphate of potasse or by ashes, on the decomposition of the earthly nitrates by the sulphate of potasse as practised by the manufactory of saltpetre at Montpellier, on the decomposition of earthly nitrates by means of ashes, mode of conducting the evaporation, on the treatment of water of crystallization, and assay of saltpetre according to the principle established by Bottée and Riffault in France.

The Dutch East India Company's (*Vereenigde Oostindische Compagnie*) interest in saltpetre promoted Bihar to become a prominent saltpetre extracting and refining region (note 8). Freshly extracted saltpetre in Bihar was 80% pure, which could be refined to 95% purity[20]. The Dutch equipped the Biharis with better technology to achieve purer saltpetre, which enabled a better quality material and consequent export revenue[21]. Methods used by the Biharis for saltpetre extraction in the 17th century and the advanced technological capacity introduced by the Dutch have been documented[21]. British chronicles and non-Dutch chronicles emphasize that the British played a role in improving saltpetre extraction in Bihar, whereas the Dutch sources indicate otherwise. The Royal Charter of 1693 enunciated that the East India Company was to supply the British Government in England 500 tonnes of saltpetre/annum at a price of £38–45/tonne (ref. 22, p. 599). Bengal supplied 570,300 maunds of saltpetre between 1840 and 1847 at the rate of Rs 5.6.5/maund (note 9) (≈£16 per tonne)[20]. For a comprehensive review of Indian saltpetre trade and how it influenced the Indian and British economies, particularly in the context of gunpowder production, refer to Frey[23].

Etymology of saltpetre (saltpeter, American)

The term 'saltpetre' evolves from the medieval Latin terms *sal petra* and *sal petrae*. *Petros*, in ancient Greek, meant rock, stone. Saltpetre therefore means 'salt of the rock'. Egyptians referred to saltpetre as *ntr*. In Biblical Hebrew it was *neter*. These usages refer to 'soda', which could be either Na_2CO_3 or $NaHCO_3$, since *nitron* (Greek) and *nitrum* (Latin) have been used interchangeably for soda and saltpetre, which, at that point of time, were not recognized as different materials. The term *nitron* metamorphosed into *nitrum* (Latin) and later, as *nitre* in European languages. References exist indicating *nitron* used by Hippocrates (5th century BCE) and *nitrum* by Pliny the Elder (1st century AD), their English equivalent *nitre* referring to soda obtained from either evaporitic lakes or plant ash[24]. With the passage of time, soda came to be called *natron*, whereas saltpetre as *nitrum*, the commonness between the two being salty in taste. In medieval Europe, *sal petra* could not replace *salitre* (Spanish), because *salitre* already existed, implying NaCl, which was rock salt, *Steinsalz* (German), *sel gemme* (French) referring to the mined table salt and not the evaporated sea salt. The two terms *sal* and *petra* combined into one with time in popular usage. Documents written in Middle High German (note 10) include terms such as *salniter*, *salliter*, *saliter*, *salbeter* and *salpeter*. Lorenz Diefenbach[25] (1806–1883), a renowned philologist–lexicographer of Hesse–Darmstadt region refers to the above remark in his classic:

Salpeter, wenn er gelûtert ist, so haiszet er nit mêr salpeter, er haiszet salniter.
[Saltpetre, when refined, is no longer saltpetre, it is sal nitre.]

We conclude this section with words from Forschheimer[26] (p. 106).

> 'Just as the *t* in English saltpeter is due to popular etymology, the whole name has most likely developed by the same process from salnitro, most likely influenced by a pseudo-Latin salpetra, but not derived from it.'

Figure 1. Firing cannons on the fort wall of Sri Rangapatna [a caricature featuring Charles Cornwallis's battlefield reverses at Sri Rangapatna, Mysore. James Gillray, 1791, published by H. Humphrey, London; http://www.npg.org.uk/collections/search/portrait/mw63240/The-coming-on-of-the-monsoons-or-the-retreat-from-Seringapatam].

The Cambridge dictionaries online website (http://dictionary.cambridge.org/pronunciation/british/saltpetre) offers pronunciation keys to *saltpetre*, a Greco-pseudo-Latin term presently, highlighting the subtleties in British and American ways of saying this term.

Gustav Oppert of Madras on saltpetre

Gustav Salomon Oppert (Figure 2) was a professor of Sanskrit and Logic at the Madras Presidency College[27] and was, concurrently, the Telugu translator for the Government of Madras in 1872–1893 (note 11). He wrote *On the Origin of Æra Diosyana or Æra Vulgaris* (1876), *On the Ancient Commerce of India* (1879), *On the Classification of Languages: A Contribution to Comparative Philology* (1879), *On the Weapons, Army Organization, and Political Maxims of the Ancient Hindoos with Special Reference to Gunpowder and Firearms* (1880), and the *Original Inhabitants of Baratavarśa or India: the Dravidians* (1893). After returning to Germany, he documented his travels in northern India in the article Reise nach Kulu im Himalaya (Travels in Kulu in the Himalaya) (1895).

In one of his books, Oppert[28] (pp. 58–82) offers several remarks on saltpetre as used in ancient Indian warfare. He builds the context for saltpetre by validating and explaining *Śukra-niti* (*Śukra-niti-sãrã* (note 12)).

Figure 2. Gustav Oppert (1836–1908).

Oppert[28] (pp. 106–107) explains saltpetre use from verses 141, 143, 146 in *Śukra-niti* (note 13):

> 141. Five weights (pala) of saltpetre, one weight of sulphur, one weight of charcoal, which consists of *Calotropis gigantea*, of *Euphorbia neriifolia*, and other (plants) and is prepared in such a manner that the smoke does not escape.
>
> 143. There may be six or even four parts of saltpetre in the gunpowder used for tubular arms, but the parts of sulphur and charcoal remain as before.
>
> 146. With a similar greater or less proportion of charcoal, sulphur, and saltpetre, of realgar, of orpiment and likewise of graphite.

Oppert comments on saltpetre by referring to the variation between *natron* (Na_2CO_3 and/or $NaHCO_3$) and saltpetre (KNO_3). He clarifies that *nitrum* in the writings of the ancients was not saltpetre, but *natron*, which is either Na_2CO_3 or $NaHCO_3$. He indicates the later disappearance of *natron* in Greco-Roman literature, but contends that *nitrum* and *natron* are of similar root (p. 58), building on the remarks of: (i) Herodotus who has referred to *nitrum* as *litron* while describing the embalming of the dead in Egypt, (ii) Pliny who spoke of *nitrum* repeatedly, and (iii) Galen's remarks that saltpetre is to be burnt to strengthen its qualities. Oppert says that these treatments would have no effect when extended to saltpetre. Had the ancients known saltpetre, its oxidizing properties would have been discovered by them or the Europeans, says Oppert, as the most vital step in inventing gunpowder.

Saltpetre (KNO_3) is found in India, Egypt and in parts of America. Since the introduction of gunpowder in European warfare, saltpetre has been manufactured wherever the native compound could not be obtained in sufficient quantities. It was obtained, from the efflorescence on walls (*sal murale*) and other sources. This exudation, together with all the other artificial modes of producing saltpetre, thus became a prerequisite (p. 59).

Because saltpetre occurs throughout India, Indians know of its properties; it is used in medicine in the country. India was famous for exporting saltpetre, and is still so (*sic.* the later decades of the 19th century). The Dutch, when in India, traded especially in saltpetre. In Bengal, it is gathered in large masses wherever it effloresces on the soil, particularly after the rainy season. In the *Śukra-niti* saltpetre is *suvarçi-lavana*, the shining salt. The *Dhanvantari-nighantu* describes saltpetre as a tonic; it is also called *tilakam*, *kṛṣṇa-lavanam*, and *kãla-lavanam*. It is light, shiny, hot in digestion and acidic. It is good for indigestion, acute stomach ache, and constipation. It is a common medical prescription (p. 60).

Saltpetre in traditional Indian medicine

Whitelaw Ainslie author of the *Materia Medica of Hindoostan* (1813) refers to saltpetre as a material extensively used in traditional Indian medical practice[29]. The *Siddha* practice recognizes saltpetre (*védi-uppu*, Tamil) as a useful material. It uses saltpetre after cleaning it several times (in water?) and purifying it with $KAl(SO_4)_2 \cdot 12H_2O$ (ref. 30).

In *Siddha* practice saltpetre is used as a coolent, diaphoretic and diuretic. Therapeutic indications include œdema, urinary-tract infections, ascitis, and infertility[31]. The recommended dosage[32] is 650–1300 mg. Various formulations using saltpetre have been validated for their efficacy. *Védi-uppu çenduram*, a calcinized red oxide form of saltpetre, is indicated for treating urine retention and urinary-tract infections. This *çenduram* is safe at 200 mg/kg dose as established in an acute and a sub-acute toxicity study[33]. *Védi-uppu çeyanir*, prepared by the process of distillation of saltpetre, is used in treating kidney stones[34]. *Uppu-parpam*, a calcinized oxide form of different salts, of which saltpetre is a major ingredient, induces ovulation folliculogenetic activity[35].

In *Ayûrvéda*, saltpetre is *sauvarçala* used in transmutation process (*rasãrnavã*). It is also used to transform the metallic properties of gold along with other components[36]. Saltpetre-including preparations act on the vascular system and alter pulse frequency. They are also used in treating early stages of dropsy, small pox, measles, influenza, gonorrhoea, acute rheumatism and internal bleeding[36]. Saltpetre has been used along with dried leaves of *Datura stramonium*

(Solanaceae) as fumes to relieve respiratory paroxysms[37].

Saltpetre is known as *shora qalmi* in the *Ûnãni* system. The earliest mention of *shora qalmi* occurs in *Kitab al-jami'fi al-adwiya al-mufrada* (an encyclopaedia of Islamic medicine) by Ibn al-Baitar (AD 1147–1248). *Ûnãni* hakims (doctors) use saltpetre as a potent diuretic and in treating fevers, gout, splenomegaly and asthma[38]. A piece of paper is soaked in a solution of saltpetre and dried. It is then ignited in a closed jar. The fumes produced in the jar are inhaled by an asthmatic. Burning of the material soaked in saltpetre generates several oxides of nitrogen, including NO, which on inhalation relax the muscles of the respiratory system and help patients suffering from asthmatic spasms[38].

Conclusion

Saltpetre has had a chequered history. It influenced world trade, technology and politics; its relevance in gunpowder manufacture necessitated its extraction from natural formations. 'Farms' extracting saltpetre existed in Europe[39]. Interest in the extraction (or mining) of naturally occurring saltpetre waned in Europe soon after the World War I, and a little later in India, with the Haber process driving the production of NH_3 and related nitrogen-based materials. However, saltpetre continues to bear some relevance to humans, from preserving and colouring meat products to being an additive in toothpastes to fight teeth sensitivity[40]. The traditional Indian medical practitioners continue to use saltpetre in some of the preparations. Alfred Nobel (1833–1896), while experimenting with explosives, used saltpetre in early trials. However, in later years when he used nitroglycerin, synthesized by Ascanio Sobrero in 1847, Nobel avoided saltpetre[41]; worthy of note, we imagine.

Notes

1. Spelt thus in the original.
2. Kulfi, the creamy, milk-based Indian dessert, which originated in the Mughal period, was made using ice (snow?) brought from the Himalaya (ref. 42, p. 48).
3. In 1633, some people in Masulipatam secured permission to settle at Balasore, a town in modern Odisha at about 7 miles (11 km) inland on River Burubalang, a factory to procure silk and saltpetre was established there in 1642. This factory was subordinated to the Hooghly factory in 1657, although it maintained close contact with Fort St George. The mouth of Burubalang filled up rendering Balasore inaccessible to ships by 1700s. The town's commerce eventually transferred to Calcutta.
4. 1 Bushel = 56 lb, 25.40 kg.
5. *Nitrosomonas* mediates $NH_3 \rightarrow NO_2$ and *Nitrobacter* mediates $NO_2 \rightarrow NO_3$ transformations.
6. Jean de Thévenot (1633–1667) was a French traveller, who wrote on his travels. *Batavia* was a ship of the Dutch East India Company (*Vereenigde Oostindische Compagnie*) built in 1628 and armed with 24 cast-iron cannons and several bronze guns.
7. Job Charnock has an interesting connection with Madras. The landscape along the periphery of Madras city – from Guindy southwards – occurs with a rocky outcrop. These formations are of an uncommon construct that they are made of the quartz-bearing granite, viz. charnockite. Charnockite bears a distinct greenish-yellow hue, unusual from the other types of granites, and is so partly because of the fine fractures in the silica-based inclusions. Charnockite – referred as a part of the Charnockite series – occurs in all continents, but its incidence is hard to locate elsewhere except peninsular India, where it occurs abundantly. Charnockite occurs in parts of the Nilgiris, particularly in stretches extending to Malabar, and the Shevroys in Tamil Nadu, and in the Biligiri Ranga Hills near Mysore, Karnataka, and in parts of the Western Ghats extending southwards up to Sri Lanka. The charnockite in Madras is considered special and hence is known as the Madras charnockite, which differs from charnockites of other regions in the levels of orthopyroxene, garnet and biotite. In 2008, the Madras charnockite was shown to include magnatites and this finding is implicated in the design of the Gondwana. This igneous–metamorphic rock was named after Job Charnock (1630–1692), the 'founder' of Calcutta, by Thomas Henry Holland (1868–1947), the superintendent of Geological Survey of India (GSI) in 1893, although the special nature of the 'granite' of peninsular India was recognized by Thomas Oldham (1816–1878), the first superintendent of GSI, much earlier. Holland showed that the Madras rock samples were special because of *norite*. He found that the headstone in Charnock's grave in Calcutta was of the rock material from St Thomas Mount, Madras, brought to Bengal in the 17th century. Holland presented a paper on this rock at a meeting of the Asiatic Society of Bengal in 1893, naming the rock charnockite, which was formalized through a publication by the GSI in 1900. Nearly 200 years after Charnock's death, the gneiss from the St Thomas Mount–Pallavaram landscape was named charnockite celebrating Charnock.
8. Adrian van Ommen and van Heck, representatives of Henrdrik van Rheede, the Dutch Governor of Cochin (1636–1691), were stationed in Patna.
9. 1 maund = 82.38 lb; 37.3242 kg. 1 Rupee = 16 annas; 1 anna = 8 pies. Therefore, Rs 5.6.5 means 5 rupees, 6 annas, and 5 paise.
10. Mittel-hoch-deutsch was spoken in southern Germany and parts of Austria and Switzerland between AD 1050 and 1350 (the end year could be AD 1500, as well).
11. Gustav Salomon Oppert was born in Hamburg, Germany on 30 July 1836. He studied Ancient Philology, Oriental Studies, and History at the universities of Bonn, Leipzig, Berlin respectively. After his doctoral degree from the University of Halle, he went to the University of Oxford in 1860. He taught at the Queen's College in Belfast until 1865. He was an Assistant Librarian at the Royal Library of Windsor, where he strengthened his foundations in Oriental Culture and History, and Indology. For two years he stayed at the Punjab University College, and in 1872 he accepted the professorship of Sanskrit (and Logic) at the Madras Presidency College, succeeding John Pickford, the first professor of Sanskrit. He returned to Germany, after touring northern India, China, Japan and America, and settled in Berlin in 1894. He worked as a *Privatdozent* in Dravidian languages at the University of Berlin, until his death on 1 March 1908. Oppert's first Sanskrit work was his *List of Sanskrit Manuscripts in Private Libraries of Southern India* (two volumes, 1880–1885). He published *Die Gottheiten der Indier (Gods of Indians)* in 1905. His *Contributions to the History of Southern India* (1882) was an epigraphical study. Oppert edited the philosophical works *Níti-prakā-śika* (1882), *Śukra-níti-sāra* (1882), *Sutra-pāṭa* of the *Śabdanuśāsana* of *Śakaṭayāna* (1893), followed by an edition of *Śakaṭayāna*'s grammar with the commentary of *Abayaçandrasuri* (1893) while at Madras.
12. Oppert indicates *S*ukraçarya who belonged to the times o*f Śmriti*-s as the author of *Śukra-niti*. Varma[43] rejects this date, since chapter IV of *Śukra-niti* refers to fire-spitting tubular devices (gun barrels?). Varma ascribes *Śukra-niti* to the 16th century, by when guns were known in India because of invading foreigners. He, however, reinforces that the fundamental concepts and ideas mentioned by Oppert[28] belong truly to earlier political traditions.

13. Original verses set in Roman typefaces are available in pp. 106–107. *Pala* was a measurement unit used in India until 1958, when the metric system replaced the *seer–tola–maund* system.

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ACKNOWLEDGEMENTS. We thank Ramesh Maheshwari (formerly at Department of Biochemistry, Indian Institute of Science, Bengaluru), T. S. Suryanarayanan (Director, Vivekananda Institute of Tropical Mycology, Chennai), and Srinivasan Narasimhan (Asthagiri Herbal Research Foundation, Chennai) for valuable remarks on the manuscript. Ramesh Maheshwari alerted us to Alfred Nobel's interest in and work on saltpetre.

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Edited by R. Srinivasan, and printed & published by G. Madhavan for Current Science Association, Bangalore 560 080.
Typeset by WINTECS Typesetters (Ph: 2332 7311), Bangalore and Printed at Lotus Printers Pvt Ltd, Bangalore (Ph: 2320 9909)