

Production of Gunpowder in Early Modern India, 1757-1849

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Abstract

India in the eighteenth century was in political turmoil. Taking advantage of the waning authority of the Mughals, numerous regional powers were engaged in internecine warfare for political supremacy. Various European trading companies also joined the fray, in order to acquire territorial gains to further their trade. In the resultant battles and sieges, systematic use of gunpowder emerged as a common feature. Both the indigenous powers and the foreigners began to focus on developing and improving their ordnance establishments. This article seeks to make a comparative study of the production of gunpowder under the East India Company on one hand; and the indigenous powers, namely—the Marathas, the Sikhs and Kingdom of Mysore on the other. The aim of this article is to analyse, if the East India Company had a qualitative and quantitative advantage over the Indian powers, in terms of gunpowder production. It will examine the manufacturing processes of gunpowder by both contenders, to see whether the East India Company had a technological lead over the indigenous rulers, which made them victorious in the battlefield. The article will be primarily based on archival sources, such as Military Board Proceedings, Military Department Proceedings and printed primary sources, like regimental histories, autobiographies and memoirs.

Keywords: East India Company, Gunpowder, Ishapore, Marathas, Mysore, Sikh

Introduction

If a person living in India in the first half of the eighteenth century was asked, who they thought will rule the country after the Mughals; he would have probably said the Marathas. He most definitely would not have said the East India Company (henceforth EIC). But by the middle of the nineteenth century, it was the EIC which emerged as the new sovereign of India. This was because the EIC never behaved like a mere trading concern and displayed willingness towards using military force in order to advance and protect its trade in India. From late seventeenth century it fortified its settlements in India, which were garrisoned with small detachments. In the following decades, these small detachments were expanded considerably. In fact, this practice was not common among the other European companies operating in India. According to Sanjay Subrahmanyam and I. Bruce Watson, the ideology of using force and defensive fortifications was an indispensable feature of the European Companies, as they believed that the indigenous rulers only responded to fear generated by force.¹ The EIC understood that given the contemporary political scenario, territorial control would give it a chance at better profits. And so it entered in the on-going competition for political supremacy. It waged wars with all the major contenders and came out victorious. The political ramifications of this were immense, but it also greatly affected the military culture of the subcontinent.

The EIC introduced a new kind of warfare in India, one that depended primarily on gunpowder artillery and infantry armed with muskets. The Indian powers reacted by trying to modify their armies on the EIC's model. As a result of this, gunpowder gradually came to play a central role in Indian warfare. However, there was an essential difference between EIC's artillery and the artillery of the indigenous powers. While, the indigenous powers sought to create firepower heavy armies, the EIC focussed on creating a firepower efficient army. It understood that quality heavily influences the efficacy of a particular weapons system. The use of capital intensive weapons (like cannons) in large quantities cannot ensure victory. Rather, the superior quality of military hardware influences the outcome. For e.g., the EIC manufactured corned gunpowder², which held more power than grain gunpowder. This provided the EIC's artillery with an edge in the battlefield. To ensure a steady supply of superior quality military hardware for its army, the EIC developed a network of procurement, production and distribution. The production of gunpowder formed a key part of this network and gunpowder manufactories were set up in Bombay, Madras and Bengal. The indigenous rulers too, established their own powder factories to supply their new divisions. This article seeks to investigate the production of gunpowder under the EIC and the indigenous powers, like the Marathas, the Sikhs and Kingdom of Mysore during the late eighteenth and early nineteenth century. The aim of this article is to show that the EIC had a qualitative and quantitative advantage, in terms of gunpowder production which gave its army a technological lead over its opponents. The article is based on archival sources, like Military Board and Military Department Proceeding, Military and Home Department files; printed primary sources like regimental histories. It will take the form of history from top and will concern itself with matters of state-building and administration.

Historiography of Gunpowder and Warfare in India

The role of gunpowder weapons in Indian warfare is not an uncharted terrain; in fact many scholars have tried to approach the subject from different perspectives. For the sake of clarity, the historiography of gunpowder warfare will be divided into three sections: those which deal with Indian powers, those works which concentrate on the EIC and those which concern themselves with a confrontation between the EIC and the Indian powers. With regard to India in pre-colonial times, a good place to start would be Iqtidar Alam Khan's monograph. According to him, gunpowder weapons formed a key feature of the Mughal army and the Mughal administration actively invested in developing the technology till Akbar's time. He points out that the spread of gunpowder technology gave rise to a contradictory political situation: on one hand, the capital intensive nature of gunpowder weaponry ensured only the state could afford it, thus making it stronger compared to small power holder; on the other hand the diffusion of the technology to the grass root level gave rise to armed resistance, because even a village blacksmith could now manufacture handguns and muskets.³ R. Balasubramaniam's work focuses on artillery in medieval India. He dispels the notion that the Indian metallurgists were inferior to those in the West and asserts that the technology of cannon making was not stagnant in India. In fact, through his analysis of the artillery establishment of the Mughals and later the Marathas, Ranjit Singh, Haider Ali and Tipu Sultan; he emphasized that the rise and fall of states in India was directly related to use of artillery.⁴ Ziauddin Chowdhury

and Pranab K. Chattopadhyay in an essay on the cannons at Chittagong Museum provide an idea of the technology prevalent in construction cannons in Bengal during Mughal times, the prevalence of its use and its antiquity.⁵ Kaushik Roy in a recent monograph challenges the notion of Western superiority by analysing military structure of four Asian empires (the Chinese, the Ottomans, the Mughals and the Safavids). According to him these powers created military establishments that corresponded with their geography, culture and the character of their enemies. These powers therefore incorporated gunpowder technology within their existing military and administrative structures without experiencing any ground breaking transformations.⁶

EIC's ordnance establishment, however, has not received much attention from scholars. Kaushik Roy in an article enumerates the development of the ordnance establishment of the EIC from 1639 to 1856. He is of the opinion that the EIC endeavoured to develop its ordnance manufacture to maintain its technological lead on the Indian powers.⁷ Another article written by Jan Lucassen partially deals with the production of gunpowder by the EIC. Although the main focus of the article is on the condition of labour at the Ishopore gunpowder factory, it provides substantial information about the size of the establishment, the manufacturing processes observed and the rate of production of gunpowder at the factory.⁸ Arun Bandopadhyay's work provides a detailed analysis of the Gun and Shell Factory at Cossipore. He argues that Cossipore was a crucial source of ordnance of the British Indian army and records its continuous development, first as a gun carriage manufactory and later as a gun foundry.⁹

Scholars have also focused on the confrontation between the EIC and the post-Mughal military powers in India. Roy in a series of articles enumerates the development of the ordnance establishment of the major Indian powers, namely, the Kingdom of Mysore, the Marathas and the Sikhs. In addressing the question of whether the Indian powers experienced a military transformation or not, he is of the opinion that while elements of centralization, change in battle tactics and attempts at systematic production were made by the Marathas, Sikhs and the rulers of Mysore; they in the long run failed to construct a fire power centric, military fiscal state.¹⁰ Balasubramaniam and Ruth Rhynas Brown in an essay provide an analysis of the evolution of artillery in India between 1800 and 1857. They depict the condition of Maratha and Sikh artillery in particular and emphasize on the ingenuity of the Indian engineers in adapting European technology to the Indian conditions. They compared the state of the British artillery establishment with that of the Indian, to arrive at the conclusion that superiority in firepower was not a major factor in the military success of the British prior to 1857.¹¹

Despite receiving much attention from scholars, there is still more scope of research in the field. A major lacuna that exists in most of the current scholarship is that they did not focus on the battlefield importance and applicability of artillery. They have mostly ignored the crucial role that gunpowder plays in it. Without a steady supply of good quality gunpowder, no artillery can perform to its fullest potential. This article seeks to redress this by bringing into focus the manufacture of gunpowder under the EIC and the role that it played in increasing the fire power efficiency of the EIC's artillery in the battle field. Before we delve into that, let us take a look at the development of

gunpowder based warfare in India in the pre-colonial times and intervention made by the EIC.

Gunpowder and Warfare in India

As the above mentioned literature review shows, gunpowder was not an unknown technology in India. Gunpowder came to India from China primarily through the Mongols, who introduced this technology in northern India during the second half of the thirteenth century. Gunpowder is manufactured by combining three ingredients: saltpeter (75%), charcoal (15%) and sulphur (10%).¹² According to Khan, one of the first pyrotechnic devices which gained wide currency in India was the rocket. It was extensively used as a weapon of war by the Delhi Sultanate, the Bahmani Kingdom and the Vijaynagar Empire. By the fifteenth century, firearm in the form of simple cannons had made its appearance in India. However, before the First Battle of Panipat (1526) firearms was used in limited capacity in warfare. They were almost exclusively used in sieges either as heavy mortars or small cannons.¹³ The First Battle of Panipat introduced India to the importance of gunpowder weapons on the battlefield. Babur deployed his cannons and his gunners in the middle and surrounded them with wagons that were chained together. The large cannons fired five and a quarter pound balls, while the larger pieces fired fifty two pound balls. In between these, he stationed his infantry armed with matchlocks. He also has horse archers on the flank and cavalry men as reserve. Ibrahim Lodi on the other had no gunpowder weapons in his army. The bulk of his frontal charge was composed of elephants and behind them he placed in infantrymen. Babur's guns open fired on the elephants, which then fled back into the massed infantry. The horse archers closed in on the Lodi's troops and the cavalry encircled them. Babur's guns not only succeeded in turning away the elephant charge but also affected the psychological condition of Lodi's troops.¹⁴ After this, the use of gunpowder weapons spread rapidly through the sub-continent. By the time the Second Battle of Panipat (1556) took place; Hemu's army was technologically at par with Mughals forces. Hemu, the Suri Sultanate's Hindu general had assembled an artillery park consisting of fifty one cannons. According to Roy, Hemu's artillery was qualitatively and quantitatively superior to Mughal artillery.¹⁵ Thus by the middle of the sixteenth century gunpowder weapons have become a part of the Indian military establishment. Although the Mughals made cavalry their chief arm of combat they did not neglect their artillery.¹⁶ The artillery establishment was kept firmly under the control of the central government and numerous innovations like swivel guns were introduced. However, after Akbar's death a trend of technological stagnation set in.¹⁷ Although, much information cannot be found about the actual manufacturing procedures, it can be assumed that an increased use of artillery saw an increase in the production of gunpowder. The rapid growth in saltpeter manufacture in medieval India is a testament of this. In the sixteenth century, large quantities of saltpeter were brought being from Agra, Patna, Ajmer and Bengal and stored in the Imperial store house at Ahmedabad.¹⁸ Evidence suggests that in the medieval times powder makers followed the army and manufactured gunpowder on the spot.¹⁹

The emergence of European trading companies as political contenders in the eighteenth century, introduced a new kind of military system in India. The Europeans gave little importance to cavalry and instead focused on infantry and artillery. According to G. J. Bryant, infantry formed the core of

the Company's forces in India. But artillery was gaining importance and gradually came to be seen as a crucial arm that would keep the British ahead of its competitors in South Asia.²⁰ From the mid seventeenth century small detachments of artillery were introduced in the three presidencies of Bombay, Madras and Bengal in for strengthening the defence of the forts. By the middle of the eighteenth century, these small detachments had expanded into artillery companies stationed at each of the presidencies. Initially, the gun room crew of ships were charged with the duties of manning the artillery and magazines. But the Company realized that such an ad hoc crew will not suffice for regular artillery. Instead, centralised control and efficient organization based on latest tactical doctrines and training methods was necessary. The cannons that were used by the artillery units were either made of iron or brass and came in various calibres such as, 3, 6, 9, 12, 18, 24 and 32 pounds. Along with this, howitzers and mortars of various descriptions were also used.²¹ Artillery played a dominant role in gaining victories for the EIC against the indigenous powers. For e.g., during the Second-Anglo Maratha War (1803-5), artillery played a decisive role in capturing a number of Maratha strongholds. The fort of Aligarh, which was the primary repository of Daulat Rao Sindhia in the Doab region, was attacked by General Gerald Lake. On 4th September, 1803, an infantry assault was made on the fort from a distance of a 100 yards and their advance was covered by two batteries of four 18 pounders each. In order to breach the first gate of the fort, a 12 pounder cannon were used. In order to seize the Agra Fort a breaching battery was erected on the morning of 17th October, 1803. It comprised of eight 18 pounders and four howitzers at 350 yards along with four 12 pounders on the left and two 12 pounders on the right. Under the combined fire of the guns, the garrison at the fort capitulated on the same night.²² Access to gunpowder was therefore crucial to the functioning of the EIC's army.

The Mughal successor states had to adapt to this change in mode of combat. Most of them reconstructed their army to incorporate Western-styled infantry units armed with muskets and gave artillery a more significant role. They also paid attention to the production of war materiel. However, the Indian powers, paid more attention on manufacturing cannons and gun carriages than gunpowder. Tipu Sultan set up iron foundries in all districts of Mysore for manufacturing cannons, shots and shells. Two foundries were established at the Seringapatnam fort for manufacturing cannons and machines for boring guns and muskets were installed. He also employed French mechanics to supervise the production of gunpowder. Gunpowder factories were also established in Seringapatnam, Bangalore, Bangalore, Chitaldurg and Bednur. Sulphur was imported from Muscat for manufacturing gunpowder.²³ Within the Maratha Confederacy, Mahadji Sindia was first to realize the necessity of restructuring his forces to combat the EIC. He employed 260 European officers for westernizing his army. Big brass guns and gun carriages were manufactured at the Gwalior arsenal. Light field pieces like 4, 8 and 12 pounders guns were manufactured at Agra.²⁴ Benoit De Boigne, a Savoyard was given the responsibility of supervising gunpowder production. Saltpeter and sulphur were imported from Bikaner. These were then sent to Agra for manufacturing gunpowder.²⁵ Maharaja Ranjit Singh also endeavoured to redesign his army with the help of Europeans. He established foundries and arms manufactories at Lahore and Amritsar.

His artillery included heavy ordnance like 32 and 24 pounder cannons along with light ordnance like 3, 9 and 12 pounder cannons. He deputed John Martin Honinberger to be the superintendent of the gunpowder factory.²⁶ Saltpeter was procured from Lahore for producing gunpowder.²⁷ However, qualitatively the powder manufactured by the Indian powers was inferior to the one manufactured by the EIC. After the Second Anglo-Sikh War (1848-9) was concluded, the EIC compared Sikh gunpowder with the gunpowder manufactured at Ishapore in 1846. An 8 inch mortar was used to fire a 45lbs shell six times (for both kinds of powder), using 2 oz. of gunpowder. The results showed that the while range of Ishapore powder was 75.5 yards on an average, that of the Sikh gunpowder was only 19.16 yards.²⁸ See Table 1, below for further details. Therefore, it can be presumed that the gunpowder manufactured by the EIC, gave its army a technological lead against its opponents. Let us now look into the production of gunpowder under the EIC, to understand how it manufactured gunpowder of superior quality.

Table 1: Comparison of Sikh Gunpowder and Ishapore Gunpowder

Number of Proof	Bengal Powder	Sikh Powder
Proof no. 1	78 yards	14 yards
Proof no. 2	80 yards	31 yards
Proof no. 3	65 yards	13 yards
Proof no. 4	75 yards	18 yards
Proof no. 5	75 yards	20 yards
Proof no. 6	80 yards	19 yards
Average	75.5 yards	19.16 yards

Source: Colonel William Anderson, *Sketch of the Mode of Manufacturing Gunpowder at the Ishapore Mills in Bengal*, (London: John Weale, 1862), p 146.

Production of Gunpowder under the East India Company

The EIC undertook production of gunpowder in India from the late seventeenth century. In 1668, the Council at Surat requested the Court of Directors in London to furnish a person capable of establishing a powder mill in India.²⁹ Production of gunpowder was started in India for many reasons. Importing powder from Europe in large quantities was dangerous task due to the threat of explosion at sea.³⁰ It was also quite expensive: one barrel of imported powder cost the EIC Rs. 80, without making allowance for insurance at sea. But perhaps the most important reason was the easy availability of the necessary raw materials, particularly saltpeter.³¹ Production of gunpowder by the EIC exhibits certain features. It started as a slow and cautious, albeit necessary endeavour, which gained momentum as time went by. Initially, gunpowder mills were established on a small

scale and were relocated numerous times within the presidencies, till a definite location was settled upon. In fact, the development of the gunpowder manufactories corresponded with the changing nature of EIC's aspirations in India. As the EIC transformed itself from a trading concern to a territorial power with political aspiration, its demands for gunpowder increased. Another feature was the emphasis that the administrators put on the quality of the gunpowder. They insisted that the powder be tested on numerous occasions to ensure that it is of the highest quality. Because of this, research and development regarding the manufacturing process became a key feature. The three presidencies actively shared information with each other and the Court of Directors in London; to ensure optimization of the manufacturing process and to retain their technological lead. This section of the article will focus on demonstrating these features of gunpowder manufacture.

At Bombay, the first gunpowder manufactory was established in 1677. However, this mill failed to answer the quality requirements of the EIC and a new mill was established in 1741. In 1760, a Powder House Committee was appointed to inquire into the management of the powder mill. This Committee found the mill to be a danger to the town, as it was situated 833 yards from the centre of the town. Hence, any explosion at the mill could threaten the lives of civilians. The Committee therefore suggested that the powder manufactory be moved to a new location. In 1768, a new powder mill was established at Mazagaon which continued to function till 1864, when a new manufactory was set up at Kirkee. The powder mill at Mazagaon grew in size over the years: between 1779 and 1859, multiple powder houses were added to the existing construction to increase production and in 1844; a percussion cap factory was established.³² It is difficult to ascertain when the first gunpowder manufactory was established in Madras. According to sources, in 1683 the Court of Directors gave permission for establishing a gunpowder mill on Island (the piece of land between the two arms of the Coum river was called the Island). This mill continued to function till 1739, when it was abandoned due to its impoverished condition. Hence, a new manufactory was built in the same year on the North West corner of the Island. Later, this gunpowder mill was shifted to Fort St. David, which acted as the seat of Madras Government from 1746 to 1762. But given the poor quality of the powder manufactured at Fort St. David, a new mill was sanctioned in 1753 at the Egmore's Redoubt in Madras. This mill was abandoned in 1806 and new manufactory was established at Perampore. This was the last mill to be established in Madras.³³ Bengal was the last presidency to set up its own gunpowder manufactory. Till 1753, no record of production of gunpowder can be found. In that year, the Council at Fort William signed a contract with Lieutenant-Colonel Caroline Frederick Scott, for manufacturing gunpowder on the behalf of EIC. A gunpowder manufactory was established for this purpose, in a place called Perrin's Garden. In 1779, a new gunpowder manufactory was built at Akra, near Kidderpore Docks. The suitability of Akra as a proper location was questioned in 1787. It was found that the site was situated on low grounds, was unhealthy and the water was putrid. Therefore, a new gunpowder manufactory was established Ishapore, near Palta in 1790. Also, the Council at Bengal approved the establishment of a gunpowder manufactory at Allahabad in 1800.³⁴

The quality of gunpowder to a great extent depends on the quality of the saltpeter used to

manufacture it. Saltpeter is a compound of nitric acid and potassium. This compound, when brought into contact with a combustible like charcoal at a high temperature, results in a sudden and violent decomposition and consequent explosion. The oxygen combines with the carbonic acid gas. This gas expands in volume and pushes the projectile out of the barrel. The rate at which this gas expands depends of the quality of the gunpowder. Good quality powder will give the projectile better range and more accuracy. Sulphur burns at lower temperature than charcoal and saltpeter; hence it assists in the ignition of the charcoal. By combining itself with the charcoal, it also blocks the absorbent pores of the latter; thus making the powder more durable.³⁵ Since refined saltpeter increased the charge of the powder, the EIC was interested in sourcing refined saltpeter for its manufactories.³⁶ Bengal procured saltpeter primarily from Oudh and Bihar.³⁷ Bombay relied on Bengal to fulfil its saltpeter requirements.³⁸ Bengal and Bombay used the ingredients in ratio of 75:15:10 for manufacturing gunpowder, while Madras used them in the ratio of 75:13.5:11.5. It is however doubtful if the difference in ratio affected the quality of the gunpowder.³⁹ The manufacture of gunpowder involves three basic steps: purifying the ingredients, mixing them into a composition and several finishing procedures such as grinding, sifting and glazing.⁴⁰ The process followed for manufacturing gunpowder was the same at all presidencies. But the process itself underwent an evolution. In the early years, the technology used for manufacturing gunpowder was rudimentary. According to Brigadier-General H.A. Young, the Director of Ordnance Factories in India, initially the buildings and plants at the powder mills were crude. The methods used for manufacturing gunpowder were undeveloped and often copied from indigenous powder makers. The buildings comprised of straw sheds and the ingredients were grinded by hand using wooden mortars and pestles. Leather sieves were used to sift them, in order to refine the mixture. The workers employed in these mills were unskilled and mostly comprised of women and boys. Usually, the overseer at the mills was an Indian powder maker who was supervised by a European. Given the basic nature of the manufacturing process, explosions were a common phenomenon at the mills. In fact, till the latter half of the eighteenth century, the process underwent little change.⁴¹ But as EIC's desire for political control increased, its requirement for gunpowder grew. The administrators began to demand powder not only in greater quantities, but also, of better quality. As a result, the process of manufacture was put under intense review. Model of mills were imported from Britain, people from India were sent to Woolwich and the three presidencies actively began to restructure their manufactories. Strict instructions were given on how the powder is to be tested and was accepted only if the necessary requirements were met.⁴²

The process of manufacture employed at the Ishapore Mills in Bengal represents this change in the attitude. At Ishapore, saltpeter, charcoal and sulphur went through various stages of preparation before being mixed. The saltpeter was boiled twice in water to remove impurities (muriatic, common salt, etc.) and drained, so that it can crystallize and solidify. It was then broken up using hard mallets and ground into a powder. This was then dried over an iron stove to remove any remnant water and sifted to ensure purity. The indigenous powers did not follow such intensive procedures of purifying the ingredients. On an average, the saltpeter used at Ishapore yielded 69 per cent purity after going

through the preparation process. The Madras gunpowder manufactory however followed a slightly different purification procedure. Instead of boiling twice, the saltpeter and water mixture was constantly stirred during boiling. This prevented the formation of large crystals and pure saltpeter in the form of fine powder could be obtained. While this saved time and labour by eliminating a few processes, it is doubtful if it added to the purity of the saltpeter. In order to prepare the charcoal, the wood was cut into small pieces and separated into parcels. These were then packed into an iron cylinder, which was placed inside a brick furnace. This was done to remove water, gum, mucilage and other volatile parts from the wood. Once the cylinder has cooled down, the newly formed charcoal was taken out. The charcoal was then rubbed between two pieces of cloths to remove dust, bark, etc. It was then pulverized in a mill and sifted. The Madras manufactory found an alternative and time saving method of doing this. There, the charcoal grinded between several pairs of rollers instead of a single mill. A sieve was placed under the rollers which sifted the charcoal at the same time. The next step was the preparation of sulphur. The sulphur was heated in iron pots at 600°F in order to melt it. This mixture was constantly stirred till the liquid was clear and amber in colour. All the impurities that had risen to the surface were skimmed off and the mixture was left to cool. Once the mixture had sufficiently cooled, the pots were upturned and the solidified sulphur was removed. The refined sulphur was usually uneven in colour and only the pale yellow coloured parts (pure sulphur) were taken out and used for making gunpowder. Once the three ingredients have been prepared, they were further tested for their purity. The next step was the most crucial to preparing high quality gunpowder: mixing the three ingredients. The components were first dry-mixed, whereby they were put in tritulating barrels with an equal weight of brass bullets. The barrels were then revolved on their axes for about one and a half hours. The bullets were added to the mixing barrels to ensure that the components were evenly distributed and incorporated. The composition was then added to the bed of the cylinder mills and some water on sprinkled to dampen the mixture. Each of these cylinders was 6 feet in diameter and weighed almost 6 tons. The compound action of grinding and compression provided by the revolving cylinders, merged the components even further and made the mixture homogenous. The composition, which by this time has taken a form of a cake, was then taken into the bruising house. Here the caked gunpowder was broken down into smaller pieces, rubbed between rollers, till the powder acquires uniform consistency. Then the composition was taken to the press to transform the semi loose powder into a dense block, which was subsequently broken up. The repeated compression and breaking up of the powder gave it more density and protected it from absorbing moisture. This not only increased the impellent force of the newly made gunpowder, but also, ensured that it retained this force at a later time. The next process involved in manufacturing gunpowder was granulation or corning. For this process, the powder from the pressing house was sifted in sieves made of parchment paper to separate the larger grains from the smaller ones. At the same time a flat and circular piece of wood was placed on the top of the sieves, which broke up the larger grains of powder during sifting. The powder was then sifted one more time being before taken for glazing. Here, the powder was put into a skeleton rib-barrelled frame covered with coarse canvas. These barrels were turned on their axis for three

hours, which gave a polish to the grain and cleared all the residual dust in them. This process added more durability to the powder and gave uniformity to its range, by reducing all the grains to the same size and equalising the combustion of the charge. Finally, the powder was sent for drying in the sun. Wooden tables covered in sheet copper were laid out on the terrace. The copper sheets were covered in canvas and the powder was placed upon it. The powder was kept in the sun for almost 6 hours, during which it was repeatedly raked and turned. The powder is dried like this for three days, before being weighed and filled into barrels. The barrels are then sent to the arsenal for proofing.⁴³

In the initial days, EIC's authority was limited to the fortified cities of Bombay, Madras and Calcutta, which meant its gunpowder requirement was small. But as its political ambitions grew and large tracts of land came under its control; the EIC established numerous arsenals and magazines to defend its territory. From the late eighteenth century onwards, the gunpowder manufactories were therefore required to supply powder to the arsenals and magazines, along with meeting the demands of the fortified cities. Thus, the rate of production of gunpowder gradually increased. For e.g., in 1779 the rate of production at the Bombay powder mill was 60,000lbs each season, but by 1817 it had increased to 360,000lbs.⁴⁴ Although, the powder mills generally operated on the assumption of three years peace consumption, the actual amount differed from presidency to presidency. Fort St. George for example, required 3,27,600lbs of gunpowder yearly; while Fort William required 500,000lbs. Along with this, Madras was also responsible of supplying approximately 832,000lbs of gunpowder to EIC's thirteen principal army stations, spread across southern India (Bellary, Bangalore, Leannamore, Chittledroog, Dengidul, Ganjam, Gooty, Hyderabad, Masaulipatam, Seringapatam, Trichinopoly, Vellore, Vizagapatam). To achieve this, the powder mill at Madras had to maintain a production rate of 72,000 lbs per month.⁴⁵ However, in times of war, the Madras manufactory repeatedly failed to cope with the added demand for gunpowder. In 1763, during the Third Carnatic War (1756-63), the stocks at Fort St. George were insufficient and powder had to be supplied from Vellore to conduct the siege of Madura. Similarly, a year before the Fourth Anglo-Mysore War, Bengal was asked to furnish the requirements of Madras Presidency in the ensuing years.⁴⁶ The Ishapore Manufactory in Bengal was always in the lead in terms of rate of production. In 1790, Ishapore could only produce 13,680 lbs in a month.⁴⁷ By 1795, the figure rose to approximately 80,000 lbs per month.⁴⁸ And by 1800, it was producing approximately 445,000 lbs of powder per month, thus making its yearly production rate 5,340,000 lbs.⁴⁹ Ishapore supplied gunpowder not only to Fort William and the other arsenals in Bengal, but also to Bombay and Madras. During the Second, Third and Fourth Anglo-Mysore War, it supplied Madras with gunpowder in quantities ranging up to almost 600,000 lbs. Bombay received powder amounting to 200,000 lbs from Bengal from 1797 to 1800.⁵⁰ Even during peacetime, Ishapore supplied the two presidencies with gunpowder, when the latter failed to cope with local demand. When the powder mills in Madras were being repaired, 200,000 lbs of gunpowder was sent from Bengal in 1806. Bombay requested Bengal to send her 200,000 or 300,000lbs of gunpowder in 1807.⁵¹

Concern over the quality of gunpowder plagued both the Agents of gunpowder and the EIC officials. Rigorous proofs were carried out on freshly made gunpowder before it was sent to the

arsenals. In fact, old gunpowder was also tested at regular intervals in Bengal, Bombay and Madras, to ensure that the powder did not lose its strength over prolonged storage. Prior, to nineteenth century, each presidency had separate parameters of proofing. Bombay for example, tested its gunpowder in a 7 inch mortar which was fixed on a brass plate, at an elevation of 45 degrees. The mortar was loaded with 3 oz. of gunpowder and fired three times, using different samples. The shell used for testing weighed 50lbs and 167 yards was approved as the proofing distance.⁵² At Ishapore powder was tested in an 8 inch mortar set at an elevation of 45 degrees. 2 oz. of gunpowder was used to fire a shell weighing 68 lbs and the proof distance was set at 63 yards.⁵³ When tested, the range of the gunpowder manufactured at Ishapore, was found to above the approved proof range.⁵⁴ At the beginning of the twentieth century, a new method of proofing was established by the Brigade Major of the Artillery, which had to be followed in all the presidencies. According to the new system, gunpowder was to be tested using a 4 2/5th inch mortar. The mortar was to be loaded with 1.5 oz. of gunpowder and the proof distance was set at 94 yards.⁵⁵ In 1845, the Agent of Ishapore made a comparative analysis of the gunpowder manufactured in Bengal, Bombay and Madras to test their difference in range. He used an 8 inch mortar with a charge of 2 oz. of gunpowder. The results showed that the Madras powder tested at proof range, the Bombay powder was 3 yards above the proof range and the powder manufactured at Ishapore was 2 yards above the proof range.⁵⁶ Thus, it can be said that gunpowder that was being manufactured by the EIC satisfied the needs of its army both quantitatively and qualitatively. See Table 2, for further details.

Table 2: Comparative Proof Report on Powder taken from Bengal, Madras and Bombay

Name of Presidency where the gunpowder was manufactured	Year of manufacture	Description of Mortar Used for Proofing	Quantity of powder	Range
Bengal	1845	8 inch mortar	2 oz.	96 yards
Madras	1845	8 inch mortar	2 oz.	94 yards
Bombay	1845	8 inch mortar	2 oz.	97 yards

Source: Colonel William Anderson, *Sketch of the Mode of Manufacturing Gunpowder at the Ishapore Mills in Bengal*, (London: John Weale, 1862), p. 125.

Research and development was crucial to maintaining and improving the quality of production. The officials in charge of the production along with the administrative bodies of the presidencies

were always keen to improve the quality of the products. Thus, there existed an urge to introduce innovations that would help keep a tandem between demand and supply. This was done in three ways: individual agency, exchange of information and administrative intervention. John Farquhar, the Agent of Gunpowder at Ishopore travelled to different provinces in India to study the procedure of extracting and refining saltpeter. He wanted to understand why the saltpeter found in Awadh was superior to others.⁵⁷ Those directly in charge of production sought to improve the quality of gunpowder whenever possible. This led to the development of a chain of communication between the three presidencies with reference to the methods of manufacture, the difference in quality of products and gaining familiarity with the latest innovations. Reports of manufacturing process, models of mills etc were exchanged and studied by presidencies. In 1797, the Military Board at Madras asked Bengal to furnish a cylinder mill and bed, so that pilon mills could gradually be phased out use in Madras.⁵⁸ In 1803, the Madras government sent a report to Bombay and Bengal on the improvements made in the art of manufacturing gunpowder, at the Madras powder mills. The two other presidencies studied the reports and conducted experiments to test the validity of these improvements.⁵⁹ This drive towards improvement was also actively supported by the higher administration. The Court of Directors tried to help the process in every way possible, be it by sending experts from Europe or sending finished products to be studied and hopefully replicated.⁶⁰ The administrative counterpart in India, through the introduction of governing bodies such as Board of Ordnance and later the Military Board sought to regularize the production of gunpowder and gunpowder weapons. Committees were repeatedly set up to investigate the mode of manufacture. Their reports were read and discussed in minute details and were also circulated among the presidencies. Their goal was to provide their troops with high quality gunpowder.

Conclusion

The EIC were not the first to introduce gunpowder weapons in India. In fact, long before the EIC set foot in India, gunpowder and gunpowder weapons were being successfully utilized in battles and sieges all across the subcontinent. But, the intervention of EIC in struggle for political supremacy did create a ripple, if not an upheaval among the indigenous contenders. Faced with a military system they have not encountered before, the local powers sought to bridge this gap. But what they failed to grasp was that each component of the artillery, namely gunpowder, cannons and carriages play a crucial role in optimizing its performance. Cannons will not be able to fire with enough force and accuracy, if the gunpowder used was of poor quality. Similarly, the best quality gunpowder will fail in its purpose, if the cannons are not well-cast or the carriages are poorly made. Moreover, without adequate supply of gunpowder, even the best artillery park will fall silent in the battlefield. This is where the EIC differed from its opponents. It successfully combined its knowledge of powder making with locally available resources, to create a manufacturing establishment that could provide its army with high quality gunpowder in sufficient amounts. Its production of gunpowder was qualitatively and quantitatively superior to its opponents. While, the Kingdom of Mysore, the Marathas and the Sikhs focussed on creating firepower-heavy armies, EIC concentrated on establishing a firepower-efficient army. The Indian powers did not ignore importance of gunpowder,

but they did neglect it. They established gunpowder factories to guarantee a steady supply, but took little notice of its quality. Conversely, the EIC focussed more on gunpowder. By the second half of the eighteenth century, powder mills were established in all its presidencies, whereas the gun foundry only came up in 1770.⁶¹ Gun Carriage manufacture did not even begin till the nineteenth century.⁶ While the EIC could import cannons and carriages from England or take them off the ships, gunpowder could not be imported easily. The establishment of the gunpowder manufactories made the EIC's army formidable in the battle field and ultimately gave it repeated victories.

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