A life saving medicine made by a vanishing species

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Kasturi (musk) obtained from Kasturi mriga (musk deer), was chiefly used as a Rasayana (immunomodulator) as well as Vajikarana (aphrodisiac) by the ancient physicians of Ayurveda. It was once considered as a last resort of emergency medicine. Some experimental studies on its stimulant and antivenom properties are reported to be promising. Detailed discussion on kasturi has been made in the review.

Keywords: Musk, Sex stimulant, Antisnake venom, Aphrodisiac Activity, Immunomodulator, Ayurveda, Kasturi, Rasayana Drug, Anti venom activity.

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About five thousands years ago, a symposium on health care system was organized by some Indian holy scholars (Rishis), near the base of Himalayas under the chairmanship of Rishi Bharadwaj. Several ancient Indian holy scholars attended the meeting for consensus regarding the problem on health care delivery system. Herbs, minerals, animal and marine products were introduced as medicines for the prevention and remedy of diseases. Kasturi, an animal product, was also considered as one of the life saving medicines. It is usually obtained from a graceful animal, the kasturi mriga (musk deer; Moschus chrysogaster Hodgson, Phylum: Chordata, Class: Mammalia, Order: Ungulate, Family: Cervidae).

On discovery of hundreds of synthetic medicine, random killing of musk deer for collection of musk, loss of ancient belief of therapeutics, explosion of global population, there is gradual decline of flora and fauna, leading to gradual disappearance of the medicine, musk and its source, musk-deer.

In recent past, some scientists obtaining some promising results performed few experimental studies.

Kasturi (musk) and Kasturi Mriga (musk deer)

The musk deer, a solitary terrestrial animal and an endangered species is about 80-100 cm in height (Fig. 1). The food consists of grass, lichens, leaves and flowers. On the nape of the neck, there are several horizontal blotches of yellowish hairs. The body slopes forward, as the hind legs are almost one third longer than the forelegs. The general colour of the coat composed of brittle hairs, is a slightly grizzled sandy brown. As the name suggests, on the chest is a wide vertical whitish-yellow stripe, which extends up the throat to the chin. The ears are tipped with yellow or orange hairs. The ears are large and rounded, generally lined with whitish fur. Both sexes have well-developed upper canines, and in males these grow 7-10 cm long and protrude from the mouth in a fang-like manner. The canines are constantly growing, but, due to their mobility and fragility, they are easily broken. They do not have any antlers. The tail is completely buried in the long hairs of the anal region. The males have a musk gland situated beneath the skin of the abdomen. The breeding season is believed to be January and the young are born in June. The female usually gives birth to one young, their gestation period is about 150-180 days.

Kasturi is a dark resinous secretion moist or semi liquid in nature, present with ammonia like odour, collected in a small sac (pod) covered with hair (Fig. 2), which is made by an infolding of skin situated a short distance behind the navel and in front of preputial orifice of the deer (Fig. 3). It is secreted from the preputial follicles in the sac of the adult male musk deer during their breeding season only as a natural measure to attract the female deer with its...
Fig. 1. The musk deer (*Moschus chrysogaster*).

Fig. 2. The intact sac containing Kasturi of *Moschus chrysogaster*.

Fig. 3. The pod of Kasturi (*Mriganabhi*) excised from *Moschus chrysogaster*. 
characteristic aroma. The ejection of the secretion from the sac takes place through a small canal which is situated on the outer surface of the pod and opens near the preputial orifice.

When *Kasturi* is free from moisture and ammonia, it yields a charming aroma. After being dried, it becomes granular which is soluble in water (50-75%) and alcohol (10-12%). Quality musk is dark purplish in colour and has a bitter aromatic taste and odour.

The chemical constituents of musk are ammonia, olein, cholesterol, fat, wax, gelatinous matter, albuminous substances, inorganic salts of sodium, potassium, calcium; and an aromatic volatile oil, muscone.

The smell of musk is identical with that of synthetic cyclopentadecanone and its methyl derivatives. Muscone, a constituent of *Kasturi* is a methyl derivative of the fifteen cyclic ketone (Fig. 4).

Hunters used to collect the whole area around the navel (Navi) of the deer including the tumour like swelling (the musk pod) by killing it. Hence, it is called *Mriganavi Kasturi* in India. The deer is a small graceful and timid animal weighing about 17 kg. It was once well distributed along the Himalayan region at the altitudes of 2700-4200 meters high snow-line running through northern Pakistan, Afghanistan, North-western and northern India, Sikkim, Bhutan, Nepal, Myanmar, parts of Tibet and South-western China. Now it is restricted to some isolated pockets in the region.

**Mode of use of Kasturi**

Therapeutically in indigenous systems of medicine, it is used orally and topically. For the purpose of animal experimentation, it is used parenterally, orally and intraperitoneally in intact animals. It is also used in aqueous bath on isolated animal tissue. However, in the western system of medicine, its therapeutical use is not mentioned.

In certain Indian literature like *Ritu Samhita, Paja Bhaskar*, etc., *Kasturi* is described to be used as a charming substance and cosmetics. *Kasturi* is a great discovery of ancient Indian physicians, who used it in diversified ailments. Its use in ancient period was so great that it was once considered as the last resort of emergency medicine. Vivid description about its quality, types, uses, etc. is mentioned in Ayurveda and Unani literature. Bhava Mishra, an ancient writer on Ayurvedic pharmacopoea mentioned three types of *Kasturi* e.g. *Kamrupiya, Naipali* and *Kaslulli*.

![Fig. 4. Chemical Structures](image)

The *Kamrupiya Kasturi* obtained from musk deer in Assam (Kamrup) was blackish in colour and was considered as the best quality. The *Naipali Kasturi* obtained from Nepal was bluish in colour and medium in quality. The *Kashmiri Kasturi* obtained from Kashmir valley was brownish grey (kapil) in colour and considered as the lowest quality of musk. The *Kasturi* obtained from Tibet was the best according to Unani System of Medicine. In *Raj Nighantu*, five types of *Kasturi*, according to its appearance have been mentioned:

1. *Kharika* — It is of dust form.
2. *Tilaka* — Its size is like *Til* seed (*Sesamum indicum* Linn.).
3. *Kulattha* — Its size is like *Kulattha* seed (*Dolichos biflorus* Linn.).
4. *Pindika* — Its size is slightly greater than the seed of *Kulattha*.
5. *Nayika* — Its size is slightly greater than that of *Pindika*.

Musk is characterised by Ayurvedic pharmacodynamics as *Laghu* (light), *Tikshna*.
(pungent) and Rukshna (rough). Its taste is Tikta (bitter) and Katu (irritant). The taste of musk is changed into Katu (pungent) after Vipaka (after effect). Its Vira (potency) is Ushna (hot). Kasturi can change the imbalanced effect). Its foul odour emitting from the individuals. One can feel basic humours of Ayurveda to normal. It prevents foul odour from musk (Shit nashak). It is bitter in taste, yellowish in colour, and burns skin odour'. It is used in breathlessness (Swashara) especially in bronchial asthma (Tamak swas). It causes sexual stimulation in both sexes as well as improves appetite (Kshudha bardhak).

Artificial Kasturi
Aroma of Kasturi is now industrially produced by a group of chemicals like trinitrometatertiary butyl toluene and the corresponding compounds. Trinitro butyl toluol (C₆H₅NO₂CH₃) is considered to be the best substitute of aroma of natural Kasturi discovered by Baure (1888). These substitutes have been widely used in perfumery industry. Seeds and seed oil of Latakasturi (Hibiscus abelmoschus Linn.) have musk like quality and odour. These are used as the substitute of Karatal for medicinal purpose in indigenous medicine. Kankol (Piper cubeba Linn.) and Jatipushpa (Jasminum officinale Linn.) can be used as the substitute of Kasturi.

Once Kasturi had a high demand, mainly for the drug preparations in traditional medicine. The poachers cut the skin of hunting musk deer and made artificial pod and filled it with blood, liver, barley grains, etc.; and placed a very small amount of pure musk at the mouth of artificial pod and tied the mouth of the pod. These false musk pods were supplied with original musk pods.

Characteristics of pure Kasturi
Swādetikta pinjaraketokinam, Gandham dhaie lāghaham tolkena, Yāpsunyastane baibhrayakiyat, Kasturi ya rajabhogya prashasta. (Raj Nighantu) Ya gandham ketakinam harati parinallaibrarnata pijjarabha, Swade tikta katurbalaghu ratitulita mardita chikkasayat, Dhaham ya naiti bahanau chimi chimi kurute charmagandhahatashe, Sa Kasturi prashasta bara migatamana rajate raj bhogya. (Raj Nighantu)

Pure Kasturi is bitter in taste, yellowish in colour, yielding aroma like Ketaki (Pandanus odorattisimus Linn. f.) flower. When added to water, its colour does not change. If placed on fire, it emits a peculiar sound and burning skin odour.

Some of the several methods adopted by the ancient physicians to detect pure Kasturi are as follows:

1. Some water is placed on hand (Karatal) and a very small amount of Kasturi is added to water. If the water immediately changes into red or yellow colour, then it is believed that the musk is impure, if not, then it is pure. But this test is not always dependable. When the blood of musk deer is mixed with pure musk, this test will be positive.
2. The experienced people who know the taste of pure Kasturi, can easily detect the musk, and can also detect the quality, impurity, etc.
3. If in a room, pure Kasturi is placed, the room will be filled with a charming aroma but the false musk will yield an unpleasant strong odour.
4. When pure Kasturi is rubbed by hands, the special aroma on the hands will persist for 2 to 4 hrs. If pure musk is added to any material, the material yields the same odour for a longer period.
5. Pure Kasturi cannot be burnt out by the fire, but yields a smell of burning skin (Yatha dahamm ya naiti bhusam rajbhogya).
6. An interesting popular test for pure Kasturi has been reported by some workers. A cotton thread is passed through Hinga (Asafoetida) or through Rasuna (garlic) and again passed through the
musk pod. After this, if the smell of Hingu (Ferula assafoetida Linn.) or garlic (Allium sativum Linn.) remains in the thread, the Kasturi is not considered to be genuine.

7. Few grains of Kasturi are placed on a live piece of charcoal. Pure musk melts and bubbles. If not, it at once becomes hardened and cinder and is considered to be adulterated.

8. Few grains of Kasturi are placed in water, if it remains granular, the musk is genuine and if these melt, the musk is considered to be adulterated.

9. Kasturi is put inside the soil. If the odour does not change, it is considered to be pure musk.

10. Pure Kasturi is soft, while impure one is hard.

11. Kasturi when placed on a paper, leaves yellowish spot (Pita dag), and is considered to be pure.

Biological activities

The biological actions of musk are due to the combined actions of the constituents. Many clinical trials are mentioned in Indigenous Systems of Medicine using musk as a whole. In recent past, some investigations on musk have been made with the whole substances, rather than with any of its active principles. Muscone, an essential oil isolated from musk is said to be devoid of any pharmacological activity except stimulation of olfactory nerve cells due to its specific characteristic odour. Earlier Kasturi was widely used as an aphrodisiac agent as well as Rasayana (immunomodulator) medicine. Some important properties observed in some experimental studies are described here.

Aphrodisiac activity

A very small dosage of Kasturi taken orally can stimulate the sexual urge both physically and mentally in both the sexes. It prevents the quick discharge of semen and also increases the coital time. According to Unani medicine when placed in vagina or rubbed on male genitalia, it can initiate the sexual urge leading to act of sex without the feeling of exhaustion. Many sex stimulant preparations (Vajikaraka medicines) mentioned in Ayurveda have musk as main ingredient namely Kamagni sandipanrasa, Rativallav modak, Kanchanabhrat rasa, etc.

Cardiac stimulant activity

Kasturi is used as a cardiac stimulant in Indian Systems of Medicine. It has been reported to stimulate the amplitude of contraction of isolated rabbit heart but heart rate and coronary flow are unaffected. It increases the amplitude of contraction of isolated frog heart by 50% without a significant change in heart rate in hypodynamic heart induced by low calcium fluid (Straub’s technique).

Respiratory stimulant activity

Kasturi is said to be a respiratory stimulant medicine although no authentic report has been obtained so far. Indian physicians used it in respiratory failure in ancient days. It is probable that it has a gross stimulatory effect on brain, respiratory and vasomotor centres in medulla and spinal cord. But detailed investigation of the respiratory stimulant action has not been done so far.

Antisnake venom activity

In an experiment, the protective action of Kasturi in male albino rats was determined against LD₅₀ and LD₉₀ of saw scaled viper (Echis carinatus) venom. All the rats were protected effectively by 10 mg/kg body wt dose of musk administered through intraperitonial route. After envenomation it was observed that there was a significant reduction of haematuria, local necrosis, bleeding from nose and mouth etc. No mortality was observed in all musk treated rats. The result therefore, proves the effectiveness of musk against a snake venom and if offers a great promise in the field of snake poisoning.

Antihistaminic activity

In some experiments on healthy mice, presence of naturally occurring antihistamine like substances in musk was observed. It also exhibited a wide range of activity preventing in vitro effects of histamine, S-hydroxytryptamine, bradykinin, prostaglandin and acetylcholine. Russell’s viper venom (Schultz–Dale) reaction was completely inhibited by the musk. Such contractions were caused by the liberation of histamine and other substances due to the antigen antibody reaction. Musk prevented the capillary damage induced by the snake venom. So, it is possible that musk inhibits some activities of local substances secreted under different conditions of inflammation. Inhibition of prostaglandin E by musk on guinea pig ileum opens the vista to study the action of musk in this direction.
β-adrenoceptor stimulant activity

Kasturi possesses β-adrenoceptor stimulating activity and potentiation of isoprenaline, adrenaline and noradrenaline on papillary muscles of cats. It resembles the antihistaminic activity of human tissue extracts which explains that the antihistaminic activity of musk has a stronger command over its β-adrenoceptor stimulating property.

Antispasmodic activity

Kasturi is used as an antispasmodic medicine in Indigenous Systems of Medicine in India. Few experiments were performed on isolated frog skeletal muscles, isolated guinea pig ileum and tracheal smooth muscles. It was observed that musk has a potent Spasmolytic property. Antispasmodic action of musk is selective to different tissues. The impairment of contraction of smooth muscles induced by different agonists in presence of musk might be due to membrane stabilization.

Central Nervous System stimulant activity

Kasturi reduces the sleeping time induced by hexobarbitone. The activity is not related to the doses administered. Analgesic activity in rats was also found to be dose dependent, maximum (60%) activity was observed after administration of musk 100 mg/kg body weight. In mice, musk reduced the mortality rate due to amphetamine at the dose of 25 mg/kg, while in other doses (50 and 100 mg/kg), mortality rate increased.

Antinflammatory activity

Kasturi possesses Antinflammatory property similar to hydrocortisone acetate on male albino rats. Musk was found to be about two times more potent than phenyl butazone and was almost equipotent to hydrocortisone.

Diuretic activity

On conscious adult albino rats it was observed that musk can produce significant increase in both volume and sodium excretion in urine. The colour of urine turns to deep brownish after treatment with musk.

Blood pressure modulating activity

In an experiment, Kasturi (musk) produced irreversible hypotension in cats causing death. It produced rise of blood pressure in albino rats, which was probably due to peripheral vasoconstriction. In dogs, musk did not bring any change in blood pressure. So far no clear explanation regarding the effect of musk in blood pressure of mammals has been offered.

General stimulant activity

It is interesting to note that the Kasturi was widely used as a general stimulant medicine since time immemorial. But no experimental report has been obtained so far.

Method of collection of Kasturi from Kasturi mriga

Poachers kill the Kasturi mriga (Musk deer) and cut down the whole area around the navel where musk pod is situated. Then Kasturi is collected from the musk pod. The scientists in Indian Systems of Medicine (Ayurveda and Siddha) collect Kasturi from musk deer in musk deer farms without killing them by the following methods:

1) The deer is kept firmly in lying down position.
2) Then Kasturi is collected from the musk-pod by screwing.

There is no ill effect on the health of the deer observed by this method of extraction of musk. By this method of collection, only 10 to 11 gm of Kasturi is obtained from an adult musk deer in farm. Second time extraction would have to be done after 3 or 4 years. At the age of 2 years, musk deer in farms secrete Kasturi.

There are few musk deer farms in India for conservation of musk deer. All the farms are located in high altitudes in cold remote areas in an attempt to replicate the musk deer habitat and have similar plant resources that are their preferred diet. Some of them are:

1. Kufri Musk Deer Farm (near Shimla): It is run by the Himachal Pradesh Forest Department. It is not only a musk deer farm but also a natural park.
2. Musk Deer Research Centre (in Almora district): It is run by the Central Council for Research in Ayurveda and Siddha (CCRAS), Department of AYUSH, Ministry of Health & Family Welfare, Government of India.
3. Kanchula Khark Musk Deer Farm in Chamoli district (near Kedarnath): It is run by the Forest Department in Uttaranchal.
Conclusion

Newly developed artificial sex stimulant drugs like Sildenafil citrate are very harmful while Kasturi (musk) offers a natural healthy sexual urge without any deleterious effect\(^7\). Sometimes there were some unfortunate deaths due to the adverse reaction of antivenom drug. But some experimental studies proved the effectiveness of Kasturi against snake venom and if offers a great promise in the field of snake poisoning. Some studies present a newer application of musk in the conditions of allergic disorders, inflammation etc. Once Indian physicians also used it as a general stimulant as well as emergency medicine. There is need to establish the scientific basis of the ancient belief of therapeutics of musk. Urgent attention to these farms as well as the Himalayan field is needed to save the vanishing species.

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