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RESEARCH ARTICLE

ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF OPIUM POPPY

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ABSTRACT

Poppy belongs to the family Papaveraceae, genu Papaver and species Papaver somniferum**.** Other scientific name is *Papaver bracteatum*. Common name are Bengali: Pasto; Hindi: Aphim, Khash-khash; Kannada: Afim, Biligasgase, Gasagase, Kasakase; Malayalam: afium, avin, karappu, kasakasa; Marathi: afu, aphu, khuskhus, posta; Sanskrit: Aaphuka, Ahifenam, Ahiphena, Afenam; Tamil: abini, gashagasha, kasakasa, postaka; Telugu: abhini, gasagasala, gasagasala-chettu; Urdu: Aphim, Khashkhash; Nepali: Aphim. The flower color is Orange, Pink, Purple, Red. Commercial part used is capsules and flowers. With so many varieties, choosing which to plant can be exhausting. Here are a few we like, and if you can't decide, many vendors sell a seed mix:

1. Common poppy, also called Flanders, American Legion, or Red corn poppy (*Papaver rhoeas*). This is the famous red flower worn for remembrance in Canada, the United States, the UK, and other countries. Stunning in extensive plantings, they are not well-suited to breezy locations.
2. 'Oriental Scarlet' is a perennial poppy (*P. orientale*) with unique, six-inch diameter orange blooms on strong stems. The foliage will die back in summer, so interplant with other flowers to avoid a bare spot in your garden. Check out this page from NC State Extension for more information about Oriental poppies.
3. 'Hungarian breadseed' is an annual with stunning lavender and purple flowers and dark blue or black seeds for baking.
4. Shirley poppies are direct descendants of the Flanders or common poppy but were bred to provide a mix of pinks, reds, and even an occasional white. Economical to plant en masse, they are annual and self-seeding.

One of the oldest plants known to humans is the opium poppy (*Papaver somniferum* L.). It's where opium and opium alkaloids come. By 4000 BC, Sumerians had discovered its therapeutic, nutritional, and narcotic properties, and by 1400-350 BC, Greeks had discovered it. Mutagenesis significantly suppresses enzyme function, weakening or blocking secondary metabolite production. Opium and opium-alkaloids, particularly morphine, are addictive opioids in the opium poppy, leading to serious global drug misuse. In the straw mutant LL-34, the genetic conversion of latex 'opium poppy' into latex less seed poppy' resulted in opium less and very low alkaloids variety Sujata. Medicinal and aromatic crops were recently introduced to the mutant breeding program, maybe in the 1980s in India. Nonetheless, there have been notable achievements, some of which may be one-of-a-kind. Coordinated efforts were made for genetic tailoring (restructuring) of the plant frame, enhanced seed productivity in *Papaver somniferum* L., and weak or absent latex biosynthesis (Opium poppy). Several qualitative macro alterations, such as an opium-free oil-seed variety of opium poppy Sujata have been developed for commercial use. The abundant quantitative variation was also created by reshuffling the polygenic background in both seed and vegetatively propagated medicinal and aromatic crops (MACs), and then superior varieties were evolved and released after a rigorous screening in the field evaluation or the pipeline for release using the mutation breeding approach. The opium poppy varieties Sujata and Vivek are notable.

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INTRODUCTION

Poppy belongs to the family Papaveraceae, genu Papaver and species Papaver somniferum (Pushpangadan and Singh, 2012; Wikipedia, 2025b). Other name is *Papaver bracteatum* (Drugs, 2025). Common names are in Bengali: Pasto; Hindi: Aphim, Khash-khash; Kannada: Afim, Biligasgase, Gasagase, Kasakase ; Malayalam: afium, avin, karappu, kasakasa; Marathi: afu, aphu, khuskhus, posta; Sanskrit: Aaphuka,

Ahifenam, Ahiphena, Afenam; Tamil: abini, gashagasha, kasakasa, postaka; Telugu: abhini, gasagasala, gasagasala-chettu ; Urdu: Aphim, Khashkhash ; Nepali: Aphim (Pushpangadan and Singh, 2012; Samom, 2025; IBP, 2025). Common names in forign languages are Poppy, opium poppy (English); adormidera, planta del opio (Spanish); pavot somnifère, pavot à opium, pavot des jardins (French); papoila-dormideira (Portuguese); slaapbol (Dutch); papavero da oppio (Italian); mpopi (Swahili); anh túc (Vietnamese); Μήκων (Greek) (Tran, 2015). Flower color is Orange, Pink, Purple, Red (Wilcox, 2025). Commercial part used is seed (Indianspices, 2025); Capsules, flowers (Botanical, 2025). Hindi : Kashash, Bengali : Kashash, Gujarati : Khuskhush, Kannada : Khasksi, Malayalam : Kashakasha, Marathi : Khus khus, Punjabi : Khush khush, Khas, Sanskrit : Khasa, Khakasa, Tamil : Gaehagesha kasakasa Telugu : Kasakasa, Gasagasla, Gasalu, Urdu : Kashkash sufaid (Indianspices, 2025). Spanish : Adermidera, French : Pavot, German : Mohn, Swedish : Opiumvallmo, Arabic : Khashkhash, Dutch : Slaapbol, Italian : Papavero, Portuguese : Dormideira, Russian : Mak, Japanese : Keshi, Chinese : Ying Shu (Indianspices, 2025).

Poppies have long been used as a symbol of sleep, peace, and death: Sleep because the opium extracted from them is a sedative, and death because of the common blood-red colour of the red poppy in particular. In Greek and Roman myths, poppies were used as offerings to the dead. Poppies used as emblems on tombstones symbolize eternal sleep. This symbolism was evoked in L. Frank Baum's 1900 children's novel The Wonderful Wizard of Oz, in which a magical poppy field threatened to make the protagonists sleep forever. A second interpretation of poppies in Classical mythology is that the bright scarlet colour signifies a promise of resurrection after death. Red-flowered poppy is unofficially considered the national flower of the Albanians in Albania, Kosovo and elsewhere. This is due to its red and black colours, the same as the colours of the flag of Albania. Red poppies are also the national flower of Poland. The California poppy, Eschscholzia californica, is the state flower of California. The powerful symbolism of *Papaver rhoeas* has been borrowed by various advocacy campaigns, such as the White Poppy and Simon Topping's black poppy (Wikipedia, 2025).

With so many varieties, choosing which to plant can be exhausting. Here are a few we like, and if you can't decide, many vendors sell a seed mix (Wilcox, 2025):

1. Common poppy, also called Flanders, American Legion, or Red corn poppy (Papaver rhoeas). This is the famous red flower worn for remembrance in Canada, the United States, the UK, and other countries. Stunning in extensive plantings, they are not well-suited to breezy locations.
2. 'Oriental Scarlet' is a perennial poppy (P. orientale) with unique, six-inch diameter orange blooms on strong stems. The foliage will die back in summer, so interplant with other flowers to avoid a bare spot in your garden. Check out this page from NC State Extension for more information about Oriental poppies.
3. 'Hungarian breadseed' is an annual with stunning lavender and purple flowers and dark blue or black seeds for baking.
4. Shirley poppies are direct descendants of the Flanders or common poppy but were bred to provide a mix of pinks, reds, and even an occasional white. Economical to plant en masse, they are annual and self-seeding.

Forms (Museum, 2025).

Poppies as Food: Besides being used for drug manufacturing, the poppy is also the source of poppy seeds which are greatly prized as food. Items such as poppy seed bagels and lemon poppy seed cake are sought after for their delicious flavors.

Poppy Seeds for Cooking: Poppy seeds for use in cooking can be purchased at local markets. The majority of poppy seeds used for food come from the opium poppy, *Papaver somniferum*. Although these seeds do have opium content, the amount used for cooking purposes is extremely small. Consumption of poppy seeds can produce a positive result on drug tests.

Poppies for the Garden: Poppy flowers come in a variety of colors and are prized for the beauty they bring to the landscape. In several states, various species of poppies are planted along the sides of highways for erosion control, for example, the red corn poppy (*Papaver rhoeas*). Although the opium poppy (*Papaver somniferum*) has the highest concentration of narcotics, all poppies in the *Papaver* genus do contain some amount of narcotic.

Good things about poppy seeds (Slurrp, 2022).

- Enhancement of fertility and libido.
- Reduces sleeplessness: The opium poppy is known for its sedative properties and has long been used to reduce stress because of its calming properties.
- Solid Bones: Poppy seeds are good for bone health because they have a lot of copper and calcium. They are also a great source of the protein collagen, which protects bones from damage.
- Aids the digestive process: Poppy seeds have a lot of insoluble fiber that help the digestive process, and can be used to treat constipation as well as improve overall digestive health.
- Benefits for Heart Health: Poppy seeds help lower bad cholesterol and keep healthy cholesterol levels steady. They also improve blood flow because they have iron in them, which lowers the risk of heart disease.
- Benefits Mental Performance: Increased hemoglobin and improved blood purity are two benefits of this. Poppy seed consumption has been shown to increase blood flow, bringing a healthy dose of oxygen to every part of the body, including the brain. It can boost neurotransmitter efficiency, which in turn can enhance mental performance.
- Kidney Stones: Poppy seeds, thanks to their potassium content, can be used to treat kidney stones and prevent them from forming again.
- Thyroid: poppy seeds' significant contribution to healthy thyroid function can be attributed to the zinc they contain.
- Managing Diabetes: Poppy seeds contain manganese, which aids in the management of diabetes.
- Non-Synthetic Pain Reliever: Poppy seeds have been used as a pain reliever for a long time by traditional medical practitioners.

Facts about Poppy (NS, 2025).

1. **They grew on battlefields because of rubble:** Eating even a small amount of food containing poppy seed can lead to a false positive on drugs tests. You probably know that poppies sprung up in their thousands on Flanders fields after the fighting had ceased in World War I, but you might not know this was because of the rubble left behind after artillery bombardments. The lime in the fragmented masonry was a great fertiliser for poppies. After a few years, when all the lime had been absorbed by the plants, the poppies largely disappeared.

2. **Remembrance poppies were designed to be made with one hand:** In 1922, Major George Howson set up the Poppy Factory in Richmond to employ disabled ex-servicemen. Assembling the poppy required only one hand, allowing veterans who had lost an arm to work on the production line. This factory still employs disabled veterans, and they make approximately 36 million poppies each year.
3. **Scottish remembrance poppies look different from the rest of the UK:** The Scottish poppy (top) looks different to poppies worn elsewhere in the UK. Scottish poppies are made exclusively in Lady Haig Poppy Factory in Edinburgh. When it was established in 1926, this factory used a different design of four petals and no leaf, and they still use it to this day.
4. **The first British poppy crop was destroyed by hares:** In the 19th Century, British horticulturalists who were incentivised by the booming opium trade attempted to establish an opium poppy crop in the UK. Unfortunately for them, it was eaten by a plague of hares.
5. **Poppies are needed to make morphine:** Morphine is created from the milky latex in the seed head of the opium poppy. For this reason, the poppy is featured on the Royal College of Anaesthetists coat of arms.
6. **Poppy seeds are banned in China, Taiwan and Singapore:** Because of the opiate traces that can be found in poppy seeds, and because of the potential for the seeds to be used to grow opium poppies, they are banned as food a food ingredient in China, Taiwan and Singapore. These trace amounts of opiate also mean that eating even a small amount of food containing poppy seed can lead to a false positive on drugs tests.
7. **There were poppies in Tutankhamun's tomb:** King Tutankhamun was entombed in 1325 BC with ceremonial clothing made partly from the poppy plant and with illustrations of poppies on his jewellery and furniture. In Ancient Egypt the poppy was emblematic of Osiris, the god of death.
8. **They were a symbol for remembrance before WWI:** While most people know poppies for their association with WW1 and WW2, the flower has long been linked with young men dying too soon, especially in poems reflecting on war. In The Iliad, Homer described the death of a young Trojan prince as being like a "full-blown poppy, overcharg'd with rain", sinking to the ground.

Wartime remembrance

The poppy of wartime remembrance is *Papaver rhoeas*, the red-flowered corn poppy. This poppy is a common plant of disturbed ground in Europe and is found in many locations, including Flanders, which is the setting of the famous poem "In Flanders Fields" by the Canadian surgeon and soldier John McCrae. In Canada, the United Kingdom, Australia, South Africa and New Zealand, artificial poppies (plastic in Canada, paper in the UK, Australia, South Africa, Malta and New Zealand) are worn to commemorate those who died in war. This form of commemoration is associated with Remembrance Day, which falls on 11 November. In Canada, Australia and the UK, poppies are often worn from the beginning of November through to the 11th, or Remembrance Sunday if that falls on a later date. In New Zealand and Australia, soldiers are also commemorated on ANZAC day (25 April), although the poppy is still commonly worn around Remembrance Day. Wearing of poppies has been a custom since 1924 in the United States. Moina Michael of Georgia is credited as the founder of the Memorial Poppy in the United States. Artificial poppies (called "Buddy Poppies") are used in the veterans' aid campaign by the Veterans of Foreign Wars, which provides money to the veterans who assemble the poppies and various aid programs to veterans and their families (Wikipedia, 2025).

Restrictions

In most of Central and Eastern Europe, poppy seed is commonly used for traditional pastries and cakes, and it is legal to grow poppies throughout the region, although Germany requires a licence. Since January 1999 in the Czech Republic, according to the *167/1998 Sb. Addictive Substances Act*, poppies growing in fields larger than 100 square metres (120 sq yd) is obliged for reporting to the local Custom Office. Extraction of opium from the plants is prohibited by law (§ 15 letter d/ of the act). It is also prohibited to grow varieties with more than 0.8% of morphine in dry matter of their capsules, excluding research and experimental purposes (§24/1b/ of the act). The name *Czech blue poppy* refers to blue poppy seeds used for food (Wikipedia, 2025b). The United Kingdom does not require a licence for opium poppy cultivation, but does for extracting opium for medicinal products. In the United States, opium poppies and poppy straw are prohibited. As the opium poppy is legal for culinary or esthetic reasons, poppies were once grown as a cash crop by farmers in California. The law of poppy cultivation in the United States is somewhat ambiguous. The reason for the ambiguity is that the Opium Poppy Control Act of 1942 (now repealed) stated that any opium poppies should be declared illegal, except if the farmers were issued a state permit (Wikipedia, 2025b).

Introduction

Most people want to grow perhaps the most beautiful poppy – the 'Bread Poppy' or 'Opium Poppy' – Papaver somniferum, or more commonly now sold by seed catalogs as P. paeoniflorum to avoid legal issues due to some restricting sales due to the amount of opiates in this species (Mattus, 2012). Properly, this group should be called Papaver paeoniflorum Group, with some varieties referred to as P. lacinatum, since they can have flowers that are fringed. The large flowers on this magnificent yet short-lived plant look exactly like tissue paper pom poms. The colors are gentle, encompassing the full range of pinks, with some dark maroon, almost black, and tea-stained colors like beige, buff pink and striped fringed varieties (Mattus, 2012).

Poppy is the common name for several species of the genus *Papaver* of the family Papaveraceae. It includes many species which are grown as garden flowers (garden poppies) and the species *P. somniferum* and its different varieties grown for the production of the important narcotic medicine opium (the dried latex exudate from the fully grown green capsule) and its edible seeds and seed oil (Pushpangadan and Singh, 2012). Opium is one of the oldest known painkillers and is the source of several alkaloids used for analgesic, antitussive and antispasmodic purposes in modern medicine. *P. somniferum* is named as the opium poppy. The opium poppy was cultivated by the ancient civilizations of Greece, Egypt, Italy, Persia and Mesopotamia. Poppy is now cultivated mainly for the production of opium and for the edible seed and seed oil. Poppy seeds are highly nutritive having no narcotic effect and used in breads, curries, sweets and confectioneries, and seed oil for culinary purposes (Pushpangadan and Singh, 2012). Opium poppy is widely distributed in the temperate and subtropical regions of the old world extending from 60ºN in North-West Soviet Union to the southern limit reaching almost the tropics (Pushpangadan and Singh, 2012). The centre of origin of Papaver somniferum (L.) is believed to be somewhere in the western Mediterranian region of Europe from where it spread through the Balkan Peninsula to Asia Minor as early as the tertiary period (Pushpangadan and Singh, 2012). The plant poppy belongs to the genus Papaver of the dicot family Papaveraceae. There are about 100 species of Papaver distributed all over the world (Pushpangadan and Singh, 2012). Divided the genus *papaver* into nine sections, of which two sections '*Mecones*' and '*Mycrantha*' (Oxytona) are the only economically important groups (Pushpangadan and Singh, 2012). Valuable alkaloid yielding and edible seed producing species like *P. somniferum, P. setigerum* D.C. belong to the section '*Mecones*', but *P. somniferum* is the only species which is commercially cultivated. *P. somniferum* is not found in the wild state (Pushpangadan and Singh, 2012).

But other members of this genus under the section *Mecones*, *P. setigerum, P. glaucum, P. glacile* and *P. dicaisnei* are found wild in the Mediterranean region. The species under the section *Oxytona* are *P. bracteatum*, *P. orientale*. Opium poppy (*Papaver somniferum* L.) has its importance as a plant based natural pain reliever from the time dating back to early civilization till today (Mishra *et al.,* 2013). Its pain relieving properties had been described in various books of unani, allopathy and ayurvedic medication system (Mishra *et al*., 2013). Today our pharmaceutical industries solely depend on opium poppy for their crude resources for manufacturing of pain killing drugs (Mishra *et al*., 2013). The medical practitioners around the world routinely prescribe important life saving drugs, are the secondary metabolites produced as a result of complex plant metabolism (Mishra *et al.,* 2013). The important life saving drugs are mostly derived from five major alkaloids *viz*., morphine, codeine, thebaine, noscapine and papaverine which are present in opium latex in ample amount (Mishra *et al.,* 2013).According to a report from an international organization i.e. WHO (World Health Organization), about 85% of the population in developing countries depend on herbal plants for curatives, medicinal and other medico related applications (Mishra *et al.,* 2013). India being one of the twelve mega biodiversity centers of the world is fully fledged with diverse array of herbal and medicinal plants which makes it "Botanical Garden of World" (Mishra *et al.,* 2013). About 10,000 different medicinal plant species are found in India among which opium poppy occupies the highest place in terms of food (seeds) and pharmaceuticals (alkaloids) (Mishra *et al*., 2013).

In India, where they are known as khuskhus, poppy seeds were used as a food source more than 5,000 years ago (Slurrp, 2022). About 2,000 years ago, the seeds were also found in Native American societies, where they were very important for both food and rituals (Slurrp, 2022). Poppy seeds have a rich history dating back to ancient civilizations. In addition to their practical uses as an ingredient in food and beverages, poppy seeds also feature prominently in various cultural practices and rituals (Slurrp, 2022). These tiny, bitter-tasting seeds are produced by several species of the poppy plant. The most common type of poppy seed is that from the blue or black opium poppy (Papaver somniferum) (Slurrp, 2022). Poppy seeds are commonly used as a spice or seasoning, but they also have many other uses (Slurrp, 2022). Poppy seeds are the tiny edible seeds of the poppy plant. The seeds come from the same plant as opium (made from the sap of the unripe seed pod), but are not in themselves psychoactive (Slurrp, 2022). In fact, poppy seeds are a source of food for humans and many other animals, and they have a long history of cultivation, with evidence dating to 10,000 BC (Slurrp, 2022). The Sumerians, Egyptians, Greeks, and Romans, who considered poppy seeds to be a valuable and highly prized food, harvested them to make oil, cake, and wine (Slurrp, 2022). In the 8th century AD, Arab traders brought poppy seeds westward to the Iberian Peninsula (Spain and Portugal), where they quickly became a very important commercial crop and a main source of income for the people (Slurrp, 2022). The first evidence of the use of poppy seeds in China dates back to 3,000 BC (Slurrp, 2022). In India, where they are known as khuskhus, poppy seeds were used as a food source more than 5,000 years ago (Slurrp, 2022). About 2,000 years ago, the seeds were also found in Native American societies, where they were very important for both food and rituals (Slurrp, 2022).

Opium poppy (*Papaver somniferum*) is one of the world's oldest medicinal plants and a versatile model system to study secondary metabolism (Hong *et al*., 2022). Knowledge of its genetic diversity is limited, restricting utilization of the available germplasm for research and crop improvement (Hong *et al.,* 2022). We used genotyping-by-sequencing to investigate the extent of genetic diversity and population structure in a collection of poppy germplasm consisting of 91 accessions originating in 30 countries of Europe, North Africa, America, and Asia (Hong *et al.,* 2022). We identified five genetically distinct subpopulations using discriminate analysis of principal components and STRUCTURE analysis (Hong *et al.,* 2022). Most accessions obtained from the same country were grouped together within subpopulations, likely a consequence of the restriction on movement of poppy germplasm (Hong *et al*., 2022). Alkaloid profiles of accessions were highly diverse, with morphine being dominant (Hong *et al*., 2022). Phylogenetic analysis identified genetic groups that were largely consistent with the subpopulations detected and that could be differentiated broadly based on traits such as number of branches and seed weight (Hong *et al.,* 2022). These accessions and the associated genotypic data are valuable resources for further genetic diversity analysis, which could include definition of poppy core sets to facilitate genebank management and use of the diversity for genetic improvement of this valuable crop (Hong *et al.,* 2022).

The paper-like blossoms and vibrant colors of the poppy flower have been gracing flowerbeds and fields for centuries (Volpe, 2024). These iconic flowers can get a bad rap for their hand in the opium trade, which is not helped by the everlasting-sleep scene depicted in The Wizard of Oz (Volpe, 2024). But not all poppies are bad! Coming in more than one hundred different varieties and colors, the poppy flower will add a splash to your garden (Volpe, 2024). The recorded history of the poppy flower dates back to 2700 BC, when it was grown and cultivated in the Mediterranean Basin for its medicinal and recreational use—primarily as a mild sedative (Volpe, 2024). Now found all over the world, its pain-relieving properties are the base source from which morphine and codeine may be extracted (Volpe, 2024). Poppies played a significant role in ancient mythology and medicine. They have been found in Egyptian tombs dating back thousands of years and are believed to have been associated with ancient Egyptian veneration of gods. They were featured in their jewelry and furniture (Volpe, 2024). Ancient Greeks regarded poppies as a source of fertility, health, and strength (Volpe, 2024). Greek Athletes consumed a mixture of poppy seeds, honey, and wine to improve performance. In Greek mythology, the poppy flower is associated with Morpheus, the god of sleep and dreams. In fact, the drug morphine, which is derived from poppies, is named after the Greek god, Morpheus (Volpe, 2024). The Greek gods are believed to have given Demeter, goddess of agriculture and harvest, poppies to help her sleep (Volpe, 2024). Subsequently, poppies sprang up from Demeter's footsteps. Poppies were found at the cave of Hypnos, the god of sleep. Nyx, the goddess of night, and her brother, Hypnos, the god of sleep, are also associated with the poppy flower symbol (Volpe, 2024). Predating Greek mythology, the Assyrians called the poppy 'daughter of the fields' for its association with agriculture and its ability to give nourishment to the soil and grains, a symbol of life, fertility, and death (Volpe, 2024).

The genus Papaver classified in the Papaveraceae family, is a valuable, non-alternative medicinal plant which has illustrated a massive variety of pharmacologically important alkaloids (Rasekh and Karimzadeh, 2024). Chromosomal and monoploid genome size diversity of seven populations collected from different districts of Balkh Province in northern parts of Afghanistan were studied (Rasekh and Karimzadeh, 2024). All populations were diploid, six of which (P1-P6) had 22 chromosomes, while P7 had 20 larger chromosomes (Rasekh and Karimzadeh, 2024). The mean chromosome length (CL) of P1-P6 populations was 1.32 µm (0.91-1.74 µm), but that of P7 population was 2.24 µm (Rasekh and Karimzadeh, 2024). The results of flow cytometric analysis showed that the mean monoploid 2Cx DNA of P1-P6 populations was 5.701 pg (5.574-5.901 pg), whereas that of P7 population was 5.795 pg, confirming intraspecific variation (Rasekh and Karimzadeh, 2024). This study is being reported for the first time from the northern part of Afghanistan's opium cultivation area, and P7 population is also being reported for the first time in terms of chromosome number (Rasekh and Karimzadeh, 2024). Valuable information on Cytogenetics can be used in some research fields, including polygenetic analysis, taxonomic relationships, evolutionary characteristics, and plant breeding (Rasekh and Karimzadeh, 2024). All poppies are members of the family Papaveraceae, and most of the poppies we grow in our gardens are also included in the genus Papaver. The gorgeous blue Himalayan poppy, Meconopsis betonicifolia, and California poppies, Eschscholzia californica, are exceptions (Wilcox, 2025). The poppy flowers that are familiar to most people have tissue paper-like crinkled blossoms with 4 to 6 brightly-colored petals and a ring of

stamens in the center. Their drooping pods and delicate foliage add extra interest to the flower bed from mid-spring through summer (Wilcox, 2025). Available in both single and double blooms, this flower also comes in many colors, including red, white, orange, cream, yellow, blue, and purple (Wilcox, 2025). The poppy has long been a symbol of remembrance, dating back to the Egyptians and, of course, the World Wars because it sprang up on the battlefields after the dead were buried (Wilcox, 2025). Some species have also been valued for culinary and medicinal uses since ancient times. Poppies have been featured in poetry and film and painted by several of Europe's most famous artists, including Claude Monet and Vincent Van Gogh (Wilcox, 2025). Poppies can be annuals (dying after one growing season) or perennials (return each year). Many types readily reseed themselves in the garden, coming back on their own to delight you year after year! (Wilcox, 2025). After being sown in the spring, annual poppies will bloom during spring and summer following planting. How long they last depends on the variety and weather conditions as many poppies prefer cooler nights (Wilcox, 2025). Perennial (Oriental) poppies started from seeds will not bloom until their second growing season but will then bloom every year. Oriental poppies purchased from a garden center should bloom the same year you plant them. Once established, perennial poppies may reliably bloom every year for decades (Wilcox, 2025).

The red poppy flower, also known as the *Papaver somniferum*, is one of the world's most popular wildflowers (Red Poppy, 2025). The red poppy is native to most of Eurasia and North Africa, but today is best known for its presence in Central Europe. This small flower ranges from 12 to 14 inches and 2 to 3 inches wide (Red Poppy, 2025). Red poppy flowers represent consolation, remembrance and death. Likewise, the poppy is a common symbol that has been used to represent everything from peace to death and even simply sleep. Since ancient times, poppies placed on tombstones represent eternal sleep. Additionally, poppies are used as a symbol around the world to remember those who died in military service (Red Poppy, 2025). After the Napoleonic wars in the early 19th century, the land was destroyed as it was left desolate, arid and infertile. Shortly after, red poppy flowers magically grew around the bodies of the fallen soldiers. Poppies then became a symbol of hope and peace with an underlying meaning that the sacrifice of soldier's lives were for the greater good. Again in 1914, the fields of Northern France broke out in fighting as World War 1 began. Once the world war was over, one of the only plants to regrow were red poppy flowers (Red Poppy, 2025). Poppies are significant because of cultural interpretation that these flowers promise resurrection. Red poppies flowers strongly became a symbol of remembrance because of Lieutenant-Colonel John McCrae and American professor Moina Michael. McCrae was a poet and soldier during World War 1 and is best known for his war memorial poem "In Flanders Fields" (Red Poppy, 2025). In this poem, McCrae referred to the red poppies that grew over the graves of the fallen soldiers and started the remembrance symbolism of the red poppy flowers. After the conclusion of World War 1 in 1918, Moina Michael wrote a response poem, "We Shall Keep the Faith", that officially declared that red poppy flowers would be a year-round honor for the soldiers who had died in combat (Red Poppy, 2025). Today, the remembrance poppy has become one of the world's most recognized memorial symbols for fallen soldiers. Even a century after World War 1 ended, people still continue to use the red poppy flower as a symbol for remembrance. Millions of people worldwide from the United Kingdom to Canada to New Zealand wear the flower every November 11th to commemorate the anniversary of the 1918 armistice, also known as Remembrance Day or Armistice Day (Red Poppy, 2025). On the contrary, in the United States the tradition has developed differently as Americans wear the red poppy on Memorial Day, the last Monday in May. In America, November 11th is formally known as Veterans day which honors all living veterans whereas Memorial Day is to honor the sacrifice of the men and women who have given their lives fighting for the United States (Red Poppy, 2025).

Opium, narcotic drug that is obtained from the unripe seedpods of the opium poppy (*Papaver somniferum*), a plant of the family Papaveraceae (Rogers, 2025). Opium is obtained by slightly incising the seed capsules of the poppy after the plant's flower petals have fallen (Rogers, 2025). The slit seedpods exude a milky latex that coagulates and changes colour, turning into a gumlike brown mass upon exposure to air (Rogers, 2025). This raw opium may be ground into a powder, sold as lumps, cakes, or bricks, or treated further to obtain derivatives such as morphine, codeine, and heroin. Opium and the drugs obtained from it are called opiates (Rogers, 2025). The pharmacologically active principles of opium reside in its alkaloids, the most important of which, morphine, constitutes about 10 percent by weight of raw opium (Rogers, 2025). Other active alkaloids such as papaverine and codeine are present in smaller proportions. Opium alkaloids are of two types, depending on chemical structure and action. Morphine, codeine, and thebaine, which represent one type, act upon the central nervous system and are analgesic, narcotic, and potentially addicting compounds. Papaverine, noscapine (formerly called narcotine), and most of the other opium alkaloids act only to relax involuntary (smooth) muscles (Rogers, 2025). The opium poppy was native to what is now Turkey (Rogers, 2025). In the 1st century ce the Greek physician Dioscorides described opium in his treatise De materia medica, which was the leading Western text on pharmacology for centuries (Rogers, 2025). The growth of poppies for their opium content spread slowly eastward from Mesopotamia and Greece (Rogers, 2025). Apparently, opium was unknown in either India or China in ancient times, and knowledge of the opium poppy first reached China about the 7th century. At first, opium was taken in the form of pills or was added to beverages. The oral intake of raw opium as a medicine does not appear to have produced widespread addictions in ancient Asian societies (Rogers, 2025). Opium smoking began only after the early Europeans in North America discovered the Indian practice of smoking tobacco in pipes. Some smokers began to mix opium with tobacco in their pipes, and smoking gradually became the preferred method of taking opium. Opium smoking was introduced into China from Java in the 17th century and spread rapidly (Rogers, 2025). The primary goal was to breed a variety well-adapted to specific environmental conditions, with a focus on producing poppy straw rich in morphine for industrial applications (Fejér *et al*., 2025). Progeny evaluation was conducted using selection and pedigree methods, with morphological characteristics assessed according to UPOV TG 166/4 guidelines (Fejér *et al*., 2025). Six years of selection resulted in the material becoming homogenized and stabilized (Fejér *et al*., 2025). The progeny achieved an average morphine content of 1.31% to 1.55%, with the best lines reaching up to 2.00% (Fejér *et al*., 2025). These stable lines formed the foundation for the approval process. Following successful evaluations in Slovak state variety trials, the cultivar Senmorteco was officially registered. This variety serves a dual purpose: producing poppy straw for morphine extraction and poppy seeds for food use (Fejér *et al*., 2025).

ORIGIN AND DISTRIBUTION

Papaver somniferum (L.) is believed to originate somewhere in the western Mediterranean region, spreading from there throughout Europe and via the Balkan peninsula to Asia Minor as early as the tertiary period. Today, the opium poppy is widely distributed across the temperate and subtropical regions of the old world, extending from 60°N in northwest Russia almost as far as the tropics. Because of its narcotic properties, its growth is restricted in North America, but it can still be found in old gardens and nearby waste areas to which it has escaped (Pushpangadan and Singh, 2012). *Papaver somniferum* (L.) is believed to originate somewhere in the western Mediterranean region, spreading from there throughout Europe and via the Balkan peninsula to Asia Minor as early as the tertiary period. Today, the opium poppy is widely distributed across the temperate and subtropical regions of the old world, extending from 60°N in northwest Russia almost as far as the tropics. Because of its narcotic properties, its growth is restricted in North America, but it can still be found in old gardens and nearby waste areas to which it has escaped (Pushpangadan and Singh, 2012). In India, the main opium cultivating areas are divided into 12 divisions including Madhya Pradesh, Uttar Pradesh and Rajasthan while in other parts minor cultivation is also practiced. In Uttar Pradesh, the opium cultivation belt is around Barabanki, Shahjahanpur, Faizabad and Bareilly while Ratlam, Mandsaur and Neemuch in Madhya Pradesh are major opium producing areas. Kota,

Chittorgarh and Jhalawar in Rajasthan are the areas producing opium. The opium poppy is distributed in the temperate and subtropical regions of the old world extending from 60° North West Soviet Union whereas the southern limit reach almost the tropics. Legally it is cultivated in India, China, USSR, Egypt, Yugoslavia, Czechoslovakia, Poland, Germany, Netherland, Japan, Argentina, Spain, Bulgaria, Hungary and Poland. India is the largest opium producing and exporting country in the world. Globally the licit opium poppy cultivation is under the strict control of Central Bureau of Narcotics with its headquarter at Vienna, Austria. But at some places illegal cultivation is also being practiced which include Golden Crescent (Iran, Afghanistan and Pakistan) and Golden Triangle (Thailand, Burma, Myanmar). In Afghanistan, illegal cultivation of opium poppy to a large extent is the reason for very high drug trafficking compared with other illegal cultivating areas. Eleven other countries i.e. Australia, Austria, France, China, Hungary, the Netherlands, Poland, Slovenia, Spain, Turkey and Czech Republic also cultivate opium poppy, but they do not extract gum. They cut the bulb with 8" of the stalk (CPS system) for processing to extract alkaloids (Mishra *et al*., 2013). The native range of opium poppy is probably the Eastern Mediterranean, but extensive cultivation and introduction of the species throughout Europe since ancient times have obscured its origin. It has escaped from cultivation, or has been introduced and become naturalized extensively in all regions of the British Isles, particularly in the south and east and in almost all other countries of the world with suitable, temperate climates (Wikipedia, 2025b). The centre of origin of Poppy is the Western Mediterranean region of Europe and is cultivated in India, Russia, Egypt, Yugoslavia, Poland, Germany, the Netherlands, China, Japan, Argentina, Spain, Bulgaria, Hungary, and Portugal for its legal pharmaceutical use. It is also grown illegally for the narcotic trade in Burma, Thailand and Laos (Golden Triangle) and Afghanistan, Pakistan and Iran (Golden Crescent). Poppy is cultivated in temperate and sub-tropical region and requires well drained, highly fertile, light black cotton soil having good percentage of fine sand. In India it is a licensed crop since the latex of the mature fruit are collected for the production of opium, a narcotic substance (Indianspices, 2025).

TAXONOMY

The poppy belongs to the genus *Papaver* of the dicot family Papaveraceae. There are about 100 species of Papaver distributed all over the world. The genus Papaver divided into nine categories, of which only two – '*Mecones*' and '*Mycrantha*' (Oxytona) – are economically significant. Valuable alkaloid-yielding and edible seed-producing species such as P. somniferum and P. setigerum DC belong to the 'Mecones' category, but only P. somniferum is commercially cultivated. P. somniferum and P. setigerum display close similarity and are now believed to have originated from a common ancestral stock. P. somniferum does not grow in the wild, unlike P. setigerum and other members of this genus in the same category, such as P. glaucum, P. glacile and P. dicaisnei. The species in the Mycrantha/Oxytona category are P. bracteatum, P. orientale, P. pseudo-orientale – these also contain some opium alkaloids (Pushpangadan and Singh, 2012). The genus *Papaver* belongs to Plantae kingdom, Angiosperms clade, Ranunculales order, Papaveraceae family and Papaveroideae subfamily. Papaveraceae is a cosmopolitan family of about 40 genera and 800 species, that grows from tropical to alpine ecosystems. The word poppy has been used for many species of the Papaveraceae family, while opium word has been used for the air dried latex extraction obtained from *Papaver somniferum* L., one of the most useful plant species belonging to this family. All parts, but seeds, of plants of this genus are characterized by the watery and milky latex of vessels. About 240 species of the family, 170 belong to Papaveroideae, and the genus Papaver includes approximately 100 species. At the tribal level, Romneyeae (two genera) have been separated from Papaverae, because of the different water-like colorless juice instead a milky latex that characterize them respectively. Species of genus *Papave*r are classified 9 sections in accordance with life cycle and related characters. Opium poppy and 3 other species (P. glaucum, P. gracile, P. decaisnei) form the most developed annual *Papaver* section. *P. somniferum* has 3 subspecies (*setigerum* (DC.) Corb., *somniferum*, and *songaricum* Basil.), describing 52 botanical varieties. Four covariates have been later described (Labanca *et al*., 2018).

Based their classification on a few morphological characters like: capsule dehiscence, shape of stigmatic lobes, color of flowers and seeds. Nevertheless, the application of these characters is associated with some problems. In fact, it is not so easy to distinguish between round and angular stigmatic lobes and different seed colors may be present in the capsules of one plant. The analysis of anthocyanin pigments (cyaniding and pelargonidin derivatives and in addition yellow compounds which were not anthocyanin) supports the proposed division of this genus into sections. Species of the same section develop the same anthocyanins, like pelargonidin and cyaniding. The reduction of lifetime and the development of anthocyanins are clear signals of differentiation due to evolution in the *Papaver* genus and they depend on more stressful condition of the late Industrial Age. Thus, we assist to a shift from perennial plant with yellow anthers to biennal or annual poppies with anthocyanated anthers. Given the importance of taxonomy, many attempts have been made to associate taxonomic proximity, to morphological similarity. Some studies showed seed character variations are useful for the taxonomy characterization at the specific and generic level, while, the morphology of leaf epidermis, with few exceptions, is one of the most useful character separation of taxa within species. Epidermal cell shape the anticlinal wall pattern, the testa sculpturing and the brightness of the seeds are he most taxonomically valuable characters related to *Papaver* seed morphology, while ornamentation, shape and size, together with color of seeds are not reliable. Leaf epidermal morphology, due the similarity between species and the high variability among different population of same taxon, does not provide univocal characters for Papaver classification (Labanca *et al*., 2018).

Genera (Wikipedia, 2025).

Papaver – *Papaver rhoeas*, *Papaver somniferum*, *Papaver orientale*, *Papaver nudicaule*, *Papaver cambricum*
Eschscholzia – *Eschscholzia californica*
Meconopsis – *Meconopsis napaulensis*
Glaucium - the horned poppies including *Glaucium flavum* and *Glaucium corniculatum*
Stylophorum – celandine poppy
Argemone – prickly poppy
Romneya – matilija poppy and relatives
Canbya – pygmy poppy
Stylomecon – wind poppy
Arctomecon – desert bearpaw poppy
Hunnemannia – tulip poppy
Dendromecon – tree poppy

The poppy is a flowering plant grown around the world for its distinctly beautiful colors. The poppy family consists of nearly 800 distinct species that are sorted into 42 different genera. Typically, the plant grows to an average height of 4 inches and flowers up to 6 inches across. Poppy plants have four to six petals per flower, which appear crumpled at the bud of the flower and straighten out as they extend away from the bud.

Poppies are incredibly adaptable and can be found in a wide range of environments. These resilient flowers flourish from the frigid expanses of icy tundras to the searing temperatures of hot deserts. While they predominantly grow in the Northern Hemisphere, their versatility allows them to thrive in various climates globally. Whether they are blooming in temperate meadows or braving the extreme conditions of harsh landscapes, poppies demonstrate their remarkable ability to prosper in diverse settings (Kremp, 2025).

Opium poppy is the species of poppy from which seeds and opium are derived. Opium is used for its medicinal properties, while poppy seeds are used for seasoning. The Latin botanical name of the opium poppy translates to "sleep-bringing poppy," given to the plant due to its sleep-inducing properties.

Oriental poppies are native to northern Turkey and Iran and typically bloom in the spring. Their pollen is deep blue in color, and their flowers are somewhat hairy. As spring comes to a close and summer begins, the plant's flower begins to fall off. The oriental poppy withstands the summer heat and blooms fresh flowers when the fall arrives.

Common poppies are also referred to as corn poppies, red poppies, corn rose, or field poppies. This species of poppy is sometimes referred to as coquelicot due to its bright red color with orange tint. The pollen found in the common poppy is a deep green or dark gray.

California poppies are the state flower of California and also commonly found in Mexico. These poppy plants are yellow in color and sometimes referred to as golden poppies. The Welsh poppy is also yellow in color but native to the British Isles.

Celendine poppies have bristly stems and wavy flower petals. These poppies are native to the woodlands in China and eastern North America. Similar to the California and golden poppy, celendine poppies have yellow flowers with four petals.

Prickly poppies are categorized by their sharp, pointed leaves. They can be found throughout the United States, particularly in Hawaii.

Matilija poppies, sometimes called tree poppies, belong to the genus Romneya, named after famed astronomer John Thomas Romney Robinson. This species of poppy is native to southern California and Mexico. Their flowers have white petals and yellow centers and are often referred to as fried egg flowers.

Pygmy poppies are categorized by being very small, tight clusters of flowers. This species of poppy grows very close to the ground, with flowers spanning only a few millimeters across. Similar to the tree poppies, pygmy poppies have white petals with yellow centers.

Wind poppies are a species native to California and northwestern Mexico. They are a bright orange color with four petals.

Bear poppies, or bear-paw poppies, are very uncommon but can be found sparsely throughout the Mojave Desert. The plants' flower petals appear light blue or gray in color and are wedge-shaped with edges that are divided into several spikes, giving them the appearance of a bear paw.

Tulip poppies are native to the highlands of Mexico. They are yellow in color with orange anthers and vaguely resemble a tulip.

Synonyms (IBP, 2025**).**

Papaver album Mill.
Papaver album-nigrum Crantz
Papaver amoenum Lindl.
Papaver amplexicaule Stokes
Papaver glabrum Gilib.
Papaver hortense Hussenot
Papaver indehiscens Dumort.
Papaver nigrum Garsault
Papaver officinale C. C. Gmelin
Papaver opiiferum Forssk.
Papaver polycephalum Hort. ex E.Vilm.
Papaver somniferum subsp. *hortense* Arcangeli
Papaver somniferum subsp. *nigrum* (DC.) Thell.

BOTANICAL DESCRPTION

P. somniferum is an erect, annual herb, 30–150 cm long with 0.5 to 1.5 cm thick stem. The root is either shy branched or much branched, tapering and yellow. The stem is glabrous with thick waxy coating. The leaves are numerous, alternate, sessile, spreading horizontally; the lower ones are about 15 cm long oval oblong deeply pinnatisect with acute segments. The upper ones reaching as much as 25 cm in length, gradually wider and with more cordate base, the uppermost ones in very broadly ovate, amplexicaul prominent veins, midrib very wide, nearly white. In the race 'Safaid patta', the leaves are variegated with white streaks or blotches. In 'Kutila' or 'Kutapatta', the foliage is deeply cut into more or less narrow segments up to midrib and primary veins. A wide variation of leaf serration in Indian poppy was noticed. Flowers are few, solitary on a 10–15 cm long penducle. Flower buds are ovate-ovoid dropping, hermaphrodite, regular with two caducous sepals, smooth, green, petals four, very large, polypetalous, generally white. Stamens are numerous, hypogynous, arranged in several whorls; anthers are linear attached with filaments, cream coloured becoming pale brown and twisted after dehiscence. Ovary large depressed, globular, smooth pale green, one-celled with large spongy parietal placentae. Stigma is sessile, capitate with 8–20 short obtuse oblong rays. The fruit is a capsule varying in colour, shape and stigmatic rays. The immature capsule is covered with a waxy coating which imparts greyish-blue line to the capsule. The mature capsule is pale-brownish and sometimes may be variegated. The mature capsule may be globose or roundish, spherical, oblong to ovate oblong, depressed in some cases. The capsule has a rounded base but ends abruptly at the pex, opening by pore beneath the stigmatic rays. The stigmatic rays vary

from 7 to 18. Seeds are numerous, very small, white grey, violet or black in colour, testa with a raised reticulated network, its embryo is slightly curved in the axis of the oily endosperm (Pushpangadan and Singh, 2012).

The opium poppy (*Papaver somniferum* L.) is a multipurpose crop. It is an annual erect plant, 60-120 cm in height, rarely branching, with ovate-oblong leaves. It bears large showy flowers and nearly globose to spherical capsules, containing small black, white, blue or brown kidney-shaped seeds. The opium poppy is generally grown for the latex extracted from the immature seed capsules. The dried latex, or opium, is the source of many opiates, including morphine, thebaine, codeine and papaverine. The oil extracted from the seed is used for culinary and pharmaceutical purposes, as well as for making soaps, paints and varnishes. The seeds, which are normally free of alkaloids, are used for birdseed and as a food item in confectionery and bakery food products.

The main feed ingredient derived from the poppy is the poppy seed meal, which is the protein-rich by-product of oil extraction. The terms poppy seed meal and poppy seed cake usually refer to the solvent-extracted and mechanically-extracted by-products respectively (Tran, 2015). The poppy, in general, does not require any particular caution until the time of flowering; actually, its critical time is at the harvest, in July, because if it is not done at the right time, it could affect the quality of the latex produced by the poppy. The latex, which contains opium, could be collected only after the poppy has bloomed, the morphine level/content will be low if it is harvested too early, while the morphine will be biodegraded to codeine if it is harvested too late. Opium contains many natural alkaloids like narcotine, papaverine, codeine, thebaine, morphine (the most important) and some semi-synthetic products have been obtained starting from them (Labanca *et al*., 2018). Herb, annual, 0.27–1.5 m tall; latex, smelly, milky, turning pale orange or pale orange–pink, brown, and turning dark brown or black when dry (when exposed to the air), secreted from cut roots, stems, branches, leaves, peduncles, ovaries, and fruits. Taproots gradually narrow towards the apex, 4.1–23.7 cm long, 0.4–2 cm in diameter. Stems erect, branched or unbranched, cylindrical, basal part 0.3–1.7 cm in diameter, middle part 1.5–9.7 mm in diameter, glabrous, and glaucous (covered with a whitish waxy coating). Leaves simple, cauline, spiral, sessile; lamina unlobed or pinnately lobed, lanceolate, lanceolate-ovate, ovate, or broadly ovate, 3.2–37 × 1.5–17.5 cm, apex acute, base amplexicaul, margin from irregularly shallow to deeply dentate and undulated, green above, paler below, rarely purple–green, glabrous and glaucous on both surfaces, midrib broadly grooved (from the base to the middle) and flattened (from the middle to the apex) above, raised below, secondary veins irregularly branched, curvy, and connected in distinct loops (anastomosing) on both sides of the midrib, reticulated veinlets, distinct veins on both surfaces; fresh leaves crispy when crushed; chartaceous dry leaves; young plants with basal leaves, petiolate. Flowers solitary, terminal, 1–3(–6) per plant, showy, actinomorphic, fully opened and erect flowers, 2.9–10 cm × 2.1–10 cm; peduncle terete, 5–32 cm long, basal part 1–6.5 mm in diameter, middle part 0.8–6 mm in diameter, glabrous, glaucous; flower buds drooping at first, erect before anthesis, ellipsoid, lanceoloid-ovoid, or lanceoloid, 1.8–4.7 cm long, 0.7–2 cm in diameter, apex obtuse; two sepals, united in flower buds, nearly opened flowers separated from the base to the apex, caducous (sepals falling off before being fully opened flowers), green outside, turning pale green or pale green–yellow (nearly opened flowers), white inside, concave, elliptic, lanceolate-ovate, ovate, broadly elliptic, or lanceolate, 1.9–4.6 cm × 0.6–3.8 cm, apex obtuse, white membranous margin, both sides are glabrous, veins are dichotomously branched, distinctly inside; four petals, free, in two whorls, the outer pair larger than the inner pair, variable in color and morphological characteristics. caducous, crumpled in flower buds, the outer pair flabellate, 2.5–9.5 cm × 2.4–12 cm, the inner pair flabellate or obovate, 2.5–9.2 cm × 1.5–9.7 cm, margin undulated or irregularly and longitudinally deeply lobed, veins dichotomously branched; numerous stamens, (25–)60–223, usually longer than the pistil, 0.9–3 cm long; white or purple filaments with a white basal part, flattened, linear, 0.8–2.4 cm long, apex obtuse, the apical part broader than the lower part, with a central, longitudinal vein; pale yellow or cream colored (creamy white) anthers, turning brown, basifixed, narrowly oblong or oblong, sometimes linear or broadly elliptic, retuse at both ends, each side with a central, longitudinal groove, two-locular, opening by slits; pistil syncarpous, (4–)8–15(–16)-carpellate; short gynophore (a stalk carrying the pistil), 1.4–5 mm long, constricted; ovary superior, pale green, ovoid, lanceoloid-ovoid, ellipsoid, broadly ovoid, narrowly ellipsoid, or obovoid, 0.8–3.2 cm long, 0.4–2.1 mm in diameter, glabrous, glaucous, unilocular with parietal placentation (through intrusion of the radiate placentas to the center of the ovary but not fused), numerous ovules; sessile stigmas, pale green, pale yellow, or pale green with purple ridged stigmas, radiated, deeply (4–)8–15(–16)-lobed, ridged, apex obtuse, apical part to middle part of ridged stigmas grooved, united into flattened disk (a flat plat-shaped), recurved, covering the apical part of the ovary, umbrella-like, 0.4–2.1 cm in diameter; disk margin radiated, shallow (4–)8–15(–16)-lobed, rounded apex. Fruits capsular, poricidal (pores below stigmatic disk), green, glabrous, glaucous, turning stramineous, brown, or black–brown when dry, broadly ovoid, lanceoloid-ovoid, ovoid, ellipsoid, narrowly ellipsoid, or obovoid, 1.7–7 cm long, 0.8–3.7 cm in diameter; enlarged, persistent, sessile stigmatic disk, patent, 0.9–2.5 cm in diam., with (4–)8–15(–16) radiating stigmatic rays; stipitate 0.3–1.2 cm long, constricted; fruit stalks same as peduncles (of flowers). Seeds are numerous, 593–4685 seeds per capsule, white when young, turning creamy white, brown, black–brown, or black–grey, reniformed (kidney-shaped), 0.9–1.2 × 0.7–1 mm, faveolated, and have a minutely pitted surface (with small depressions) (as observed under a stereo microscope) (Ngernsaengsaruay *et al.,* 2023).

Poppies have lobed or dissected leaves and milky sap. The buds are often nodding and are borne on solitary stalks. The flowers have four to six petals with numerous stamens surrounding the ovary. The two sepals usually drop off as the petals unfold. The ovary develops into a spherical capsule topped by a disk formed by the stigmas. The many small seeds escape from pores beneath the disk when the capsule is shaken by the wind. Opium, from which morphine, heroin, codeine, and papaverine are derived, comes from the milky latex in the unripe seed capsule of the opium poppy (*Papaver somniferum*), which is native to Turkey. An annual plant, it bears 13 cm wide purple flowers on plants 1 to 1.5 metres (about 3 to 5 feet) tall, with lobed or toothed silver-green foliage. The opium poppy is also grown for its nonnarcotic ripe seeds, which are used for seasoning, for oil, and in baked goods. White-, pink-, and red-flowered strains with double or semidouble blooms have been developed as garden ornamentals (Petruzzello, 2025).

The plant is an erect, herbaceous annual, varying much in the colourof its flowers, as well as in the shape of the fruit and colour of the seeds. All parts of the plant, but particularly the walls of the capsules, or seed-vessels, contain a system of laticiferous vessels, filled with a white latex. The flowers vary in colour from pure white to reddish purple. In the wild plant, they are pale lilac with a purple spot at the base of each petal. In England, mostly in Lincolnshire, a variety with pale flowers and whitish seeds is cultivated medicinally for the sake of the capsules. Belgium has usually supplied a proportion of the Poppy Heads used in this country, though those used for fomentations are mostly of home growth. The capsules vary much in shape and size. They are usually hemispherical, but depressed at the top, where the many-rayed stigma occupies the centre; they have a swollen ring below where the capsule joins the stalk. Some varieties are ovoid, others again depressed both at summit and base. The small kidney-shaped seeds, minute and very numerous, are attached to lateral projections from the inner walls of the capsule and vary in colour from whitish to slate. The heads are of a pale glaucous green when young. As they mature and ripen they change to a yellowish brown, and are then cut from the stem if the dried poppy heads are required. Opium is extracted from the poppy heads before they have ripened, and from Poppies grown in the East, those grown in Europe yielding but little of the drug. When the petals have fallen from the flowers, incisions are made in the wall of the unripe capsules, care being taken not to penetrate to the interior. The exuded juice, partially dried, is collected by scraping - the

scrapings being formed eventually into cakes, which are wrapped in poppy leaves or paper and further dried in the sun, the white milky juice darkening during the drying (Botanical, 2025).

Papaver species are erect, annual, biennial or perennial herbs, with milky white, yellowish or orange fluid. Stem simple bristly or rarely glabrous. Leaves mostly pinnatipartite, pinnatifid, pinnatilobed, basal leaves petioled, cauline ones sessile, margin incised, dentate or serrate rarely entire, bristly or glabrous. Inflorescence panicle, raceme, adpressed setose. Flowers bisexual, solitary on long pedicels or on scapose stems, ebracteate, buds subglobose to ovoid, Sepals 2 rarely 3, free, deciduous, ovate-orbicular, early caducous, petals 4 sometimes 6, obovate, slightly clawed or not, red, orange, yellow, white or purplish. Stamens numerous, filaments filiform or dilated, anthers linear or oblong. Ovary ovoid, unilocular, superior, glabrous or setose, ovules numerous, stigmas 4-20, on disc crenate margin to deeply dissected, stigmatic rays opposite to placentas. Fruits capsules, globular, cylindric to subcylindric, ellipsoid-obovoid, dehiscing by subapical pores or persistent disc. Seeds many, bean shaped, reticulate-alveolate, reniform, black, brown, gray or white, albumin fleshy, rich in oil **(**IBP, 2025**).**

Opium poppy is the plant from which opium and poppy seeds are extracted. It is an annual herb, up to 1.5 m in cultivation. Taproot is erect, almost conical. Stems are erect, glaucous, hairless. Alternately arranged leaves are ovate or oblong, 7-25 cm, both surfaces hairless, glaucous and rather waxy, with veins distinct, slightly raised, base heart- shaped, margin irregularly wavy-toothed, tip long pointed to blunt. Lower leaves are shortly stalked but upper ones are stalkless and stem-clasping. Flowers occur singly, deeply cup-shaped, 5-12 cm in diameter, born on long stalks up to 25 cm. Flower buds are nodding at first, erect when the flower opens fully, oval-oblong or broadly ovoid, 1.5-3.5 cm × 1-3 cm. Sepals are 2, green, broadly ovate, margin membranous. Petals are 4, white, pink, red, purple, or various, often with a dark basal blotch, roundish, 4-7 cm × 3-11 cm, margin wavy or variously lobed. Stamens are many, with white filaments 1-1.5 cm. Ovary is green, spherical, 1-2 cm in diameter, capped by stigmas united into compressed star-like disk. Capsule are brown when mature, spherical or oblong-elliptic, 4-9 cm × 4-5 cm. Seeds are many, black or deep gray. Poppy seeds are commonly used in both North and South Indian Cusine. Poppy seeds can be dry roasted and ground to be used in wet curry (curry paste) or dry curry (Samom, 2025).

		
Seeds	**Seeds**	**Seeds**
		
Plant	**Plants**	**Plants**
		
Flowers	**Flower**	**Flower**
		
Close-up of flower center	**Capsul having pink brown latex**	**Capsul havig white latex**

Collecting latex in the field

Dried capsuls

Plants

Fig. 1: Botanical Description

Pollination

Poppy is generally considered to be a self-pollinating plant, but some studies have also reported certain degree of outcrossing. In fact reported as much as 97 % outcrossing. More outcrossing as a result of insect activity can be expected in this species. However, planned breeding of opium poppy is very recent, with different selection methods for opium yield and quality and oil seed yield the main objectives of the extensive breeding research carried out by many European and Indian breeders (Pushpangadan and Singh, 2012).

GENETICS AND CYTOGENETICS

As shown in the drawing, 2n = 22 was counted in the Australian material. First, 2n = 22 is only known from the opium poppy, *Papaver somniferum* L., and only *Papaver setigerum* DC. (2n=44) is shown to have the same basic number, n = 11. The chromosomes are rather small, and some favourable spaced metaphase plates showed two pairs of chromosomes with minute satellites. In South African materials this number was also found, however, in some cases, 2n=24, 25, 26 was observed (Reckin, 1970).

GENETIC DIVERSITY

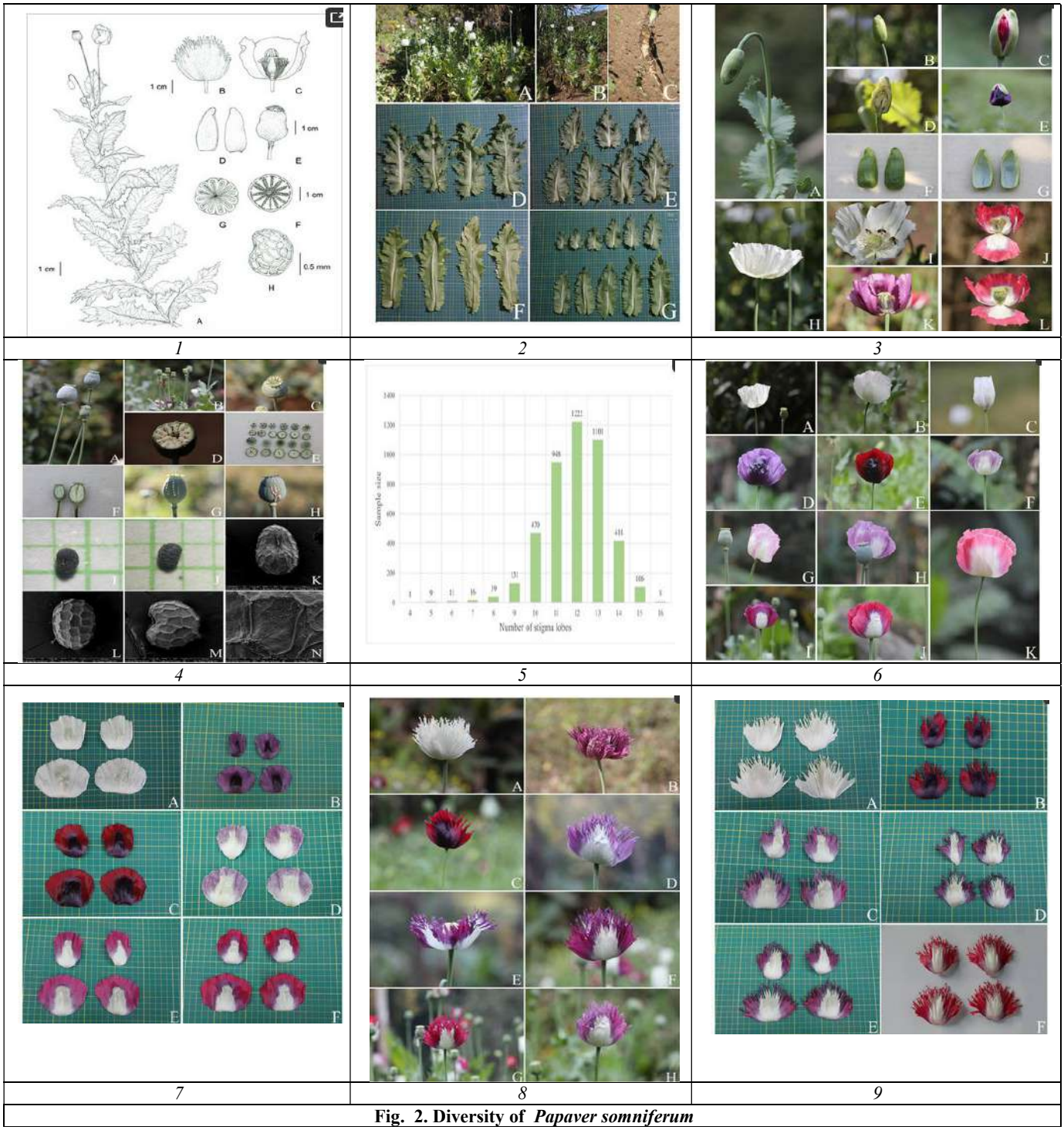
Diversity analysis through conventional tools: One of the foremost teps in the genetical improvement of any crop through conventional breeding program is to study the genetic diversity available in the introduced plant/crop material. To conduct any breeding program judiciously, diversity analysis based on morphological and biochemical traits is prerequisite. In opium poppy, several of the exotic collections at different research institutes have been evaluated for genetic diversity. Few studies on genetic diversity undertaken so far in opium poppy are summarized here. Studied genetic divergence using 101 germplasm lines of different ecogeographical origin for seed and opium yield per plant and its 8 component traits following multivariate and canonical analysis. They grouped the germplasm into 13 clusters on the basis of multivariate analysis which was also confirmed by canonical analysis. 68% genotypes were found genetically close to each other and grouped in 6 clusters while apparent diversity was noticed for 32 percent of the genotypes who diverged into rest 7 clusters. They concluded that the genotypes in clusters IX, X, XI and XII had greater potential as breeding stock by virtue of high mean values of one or more component characters and high statistical distances among them (Mishra *et al.,* 2013).

Creation of variability through hybridization

A breeding programme focused to develop improved varieties requires knowledge about the genetic variability that exists for the concern trait. It is documented that sufficient variation for composition and content of secondary metabolites occurs in a number of medicinal plant. Several studies have been carried out in opium poppy to study the existing variability in different set of materials which showed varying results for composition of secondary metabolites and other chemical compounds along with morphological variations. F_8 genotypes obtained through interspecific cross between Papaver somniferum and Papaver setigerum had higher oil (>40%) and fatty acid concentration than respective parental species. They also obtained varying results for linoleic (68%-74.4%) and oleic acid (13.6%-20.3%) content in F_8 genotypes. High oleic desaturation ratio and C18 polyunsaturated fatty acid with very low linolenic (18:3) acid (0.37%) indicated the possibility of using poppy oil for *-edible purposes. However, oleic (18:1) acid was not correlated with other fatty acids, except for significant negative correlation with linoleic (C18:2) acid. Conducted correlation and path coefficient analysis for qualitative and quantitative traits in four poppy cultivars in Central Anatolia. They found statistically significant differences for all the studied traits among all the four genotypes. Positive and significant correlation of morphine yield with morphine content, seed yield, capsule yield, oil yield; capsule yield with oil yield; seed yield with capsule yield, oil yield were noticed. Through path analysis, it was noticed that morphine content, capsule yield, seed yield and oil yield had positive direct effect on morphine yield (Mishra *et al.,* 2013).

Stability analysis for identification of stable and adaptable varieties

The analysis of genotype x environmental interaction, which indicates the stability of genotypes has always been part of plant breeding programmes before release of any variety for commercial cultivation. To study the GxE interaction, several methods have been proposed to analyze it *i.e.* univariate methods such as Francis and Kannenberg's coefficient of variability, Plaisted and Peterson's mean variance component for pair-wise GE interactions, Wricke's ecovalence, Shukla's stability variance, Finlay and Wilkinson's regression coefficient, Perkins and Jinks's regression coefficient and Eberhart and Russell's sum of square deviations from regression. Simultaneously, two other stability models based on graphical representation of the genotypes in different environments are available *i.e.* Yan's GGE Biplot model and AMMI model. Investigated stability for seed yield, opium yield and morphine content in 11 advanced breeding lines over five years in opium poppy. Combined ANOVA showed that both main effects and interactions were significant, indicating the presence of genotype x environment interactions (Mishra *et al.,* 2013).



1 2 3

4 5 6

7 8 9

Fig. 2. Diversity of *Papaver somniferum*

Figures Legend

1. Papaver somniferum. (**A**) Fertile branch; (**B**) flower; (**C**) opened flower showing stamens and pistil (side view, an outer petal removed); (**D**) sepals: inside (left) and outside (right); (**E**) fruit with radiating stigmatic rays, united into an enlarged, persistent, sessile stigmatic disk and a constricted stipitate; (**F**) transverse section of fruit; (**G**) an enlarged, persistent, sessile stigmatic disk with radiating stigmatic rays (top view); and (**H**) seed showing faveolated and a minutely pitted surface (as observed under a stereo microscope).
2. Papaver somniferum. (**A**,**B**) Habit; (**C**) taproot; (**D**–**F**) leaf shapes: lanceolate, (**G**) lanceolate-ovate, ovate, and broadly ovate.
3. Reproductive parts of Papaver somniferum. (**A**) Drooping flower bud; (**B**) erect flower bud before anthesis; (**C**) nearly opened flower bud; (**D**) longitudinal section of flower bud; (**E**) nearly opened flower and sepals separated from the base to the apex (sepals falling off before being fully opened flower); (**F**) sepals (outside); (**G**) sepals (inside); (**H**) opened flower; (**I**) flower showing stamens and pistil (top view); (**J**) flower showing stamens with white filaments and longer than the pistil (side view); (**K**) flower showing stamens, purple with a white basal part of filaments, and pistil (side view, some stamens and an outer petal removed); and (**L**) flower showing stamens and pistil (side view, some stamens and an outer petal removed).
4. Reproductive parts of Papaver somniferum. (**A**) Pistil (petals and stamens falling off) and fruits; (**B**) pistils (petals and stamens falling off); (**C**) fruit (top view); (**D**) transverse section of fruit; (**E**) transverse section of fruits showing carpels, ovules, parietal placentation, and radiating stigmatic rays, united into an enlarged, persistent, sessile stigmatic disk; (**F**) longitudinal section of fruit; (**G**,**H**) latex secreted from cut fruits; (**I**,**J**) LM micrographs of seeds; and (**K**–**N**) SEM micrographs of seeds showing faveolated and a minutely pitted surface. Photos: Chatchai Ngernsaengsaruay (**A**–**H**); Pichet Chanton (**I**,**J**); and Scientific Equipment Centre, Faculty of Science, Kasetsart University (**K**–**N**).

5. Number of stigma lobes per flower of Papaver somniferum.
6. Variability in the color of the flowers of Papaver somniferum, Group 1, undulated petal margin. (**A**) White; (**B**) white tinged with pale pink on the apical part; (**C**) white with longitudinal purple lines on the basal part; (**D**) purple with a very dark purple middle blotch; (**E**) dark red (crimson) with a very dark purple middle blotch; (**F**) white–pale purple; (**G**) white–pale pink; (**H**) white–pale purple tinged with scattered pink on the pale purple part; (**I**) white–magenta (red–purple) tinged with purple on the basal part or the magenta basal part; (**J**) white–red tinged with purple on the basal part or the red basal part; and (**K**) white–pink tinged with purple on the basal part or the pink basal part.
7. Variability in the color of the petals of Papaver somniferum, Group 1, undulated petal margin. (**A**) White; (**B**) purple with a very dark purple middle blotch; (**C**) dark red with a very dark purple middle blotch; (**D**) white–pale purple tinged with scattered pink on the pale purple part; (**E**) white–magenta tinged with purple on the basal part or the magenta basal part; and (**F**) white–red tinged with purple on the basal part or the red basal part.
8. Variability in the color of the flowers of Papaver somniferum, Group 2, irregularly, longitudinally deeply lobed petal. (**A**) White; (**B**) purple with a very dark purple middle blotch; (**C**) dark red with a very dark purple middle blotch; (**D**) white–pale purple tinged with pink on the lobes or the pale purple basal part; (**E**) white–purple tinged with red on the lobes or the purple basal part; (**F**) white–magenta tinged with purple on the lobes or the magenta basal part; (**G**) white–red tinged with purple on the lobes or the red basal part; and (**H**) white–pink tinged with purple on the lobes or the pink basal part.
9. Variability in the color of the petals of Papaver somniferum, Group 2, irregularly, longitudinally deeply lobed petal. (**A**) White; (**B**) dark red with a very dark purple middle blotch; (**C**) white–pale purple tinged with pink on the lobes or the pale purple basal part; (**D**) white–purple tinged with red on the lobes or the purple basal part; (**E**) white–magenta tinged with purple on the lobes or the magenta basal part; and (**F**) white–red tinged with purple on the lobes or the red basal part.

BREEDING

Breeding objectives

Since, opium poppy is widely and commonly used for dual purpose *i.e.* food (seed) and pharmaceuticals (alkaloids) so the major emphasis has been given for its genetical upgradation on both these aspects. The different breeding objectives are depicted in following subheadings (Mishra *et al*., 2013).

Poppy Breeding Goals

In the past, poppy breeding was aimed at seed production. As an oil crop, the poppy straw was a by-product intended for the production of morphine. The main breeding goal was a universal cultivar with a high yield of quality seed: 50% oil content, blue-colored seed with good color balance as well as a high content of morphine in capsules. Breeding of such a cultivar is very problematic due to the negative correlation between the two traits, *.i.e.* seed yield and morphine content in capsules. Positive correlation was found between the grey color of seeds and the morphine content of capsules. This statement was verified by the fact that Central-European cultivars with a high content of morphine in straw have lower yields of grey-colored seed. In the past, the emphasis was put on resistance to diseases and pests, resistance to lodging, and uniform plant height suitable for mechanized harvest. In a global perspective, however, poppy is mainly grown and utilized for alkaloid production by the pharmaceutical industry. Although this trend was taken into consideration in breeding programs, still the endeavor to breed high yielding, blue-colored seed ripening cultivars was predominant. For this reason, up to now none of the cultivated and registered cultivars can be labelled as universal (Fejér, 2015).

Worldwide trend is to cultivate the following three different types of poppy cultivars (Fejér, 2015):

1. Cultivars accumulating high amounts of morphine or other alkaloids (narcotine, codeine, thebaine, etc.) for industry.
2. Cultivars for oil and seed production, containing no or only low quantities of alkaloids.
3. Ornamental types with special flower appearance or capsule shape, accumulating limited amount of alkaloids.

With respect to the trends and requirements resulting from agricultural practice and pharmaceutical industry, two main goals in poppy breeding were defined (Fejér, 2015):

1. Breeding of commercial poppy cultivars, *i.e.* the cultivars accumulating high content of morphine in dry capsules (over 1.0%) or cultivars producing other commercially utilizable alkaloids, *e.g.* thebaine.
2. Breeding food poppy cultivars, *e.g.* the cultivars producing high yields of quality seeds with moderate to low morphine content, as well as those lacking the morphine content, the so called “non-narcotic” cultivars. Beside high seed yields and a high content of alkaloids in dry capsules, poppy research concentrates on creating new cultivars with other commercially important traits, including:
   a. Yield of capsules – is an important production trait, mainly in commercial types for poppy straw production.
   b. Overall plant height – in general, suitable for mechanized harvest, i.e. low to medium-height plants with well-developed root systems, solid and elastic stems, low tendency to branch, so that the stand matures evenly.
   c. Resistance to water deficit – relates to above described plant structure, particularly to the well-developed root system, solidity and elasticity of stem, so that the plant is resistant to uprooting and water deficit.
   d. Resistance to diseases – mainly to the most important diseases of poppy seed, e.g. helminthosporiose, Pleospora papaveracea and downy mildew, Peronospora arborescens. Breeding practices focus on either the exclusion of infected or the selection of resistant lines.
   e. Resistance to abiotic stress-factors at certain vegetation stages. It is important to choose material with rapid initial growth at the beginning of vegetation and quick enrooting so that the plants are able to overcome soil moisture deficit during initial growth stages.
   f. Resistance to the undesirable opening of capsules, i.e. to prevent openings on corona under stigma through which seeds can shed during the maturation stage.
   g. Resistance to herbicides, an important trait in large-scale production. It is possible to secure the resistance by means of application of herbicides registered and used for poppy from very first generations of breeding cycle with following selection of resistant lines. For example, the resistance to active substances of herbicides, which used for poppy treatment – mesotrione, chlortoluron, clomazone, fluroxypyr, isoxaflutole, clopyralid and tembotrione (Fejér, 2015).

Breeding for modified opium yield, seed yield and specific alkaloid variety

Due to ever increasing global demand of opium latex raised by the pharmaceutical industries for manufacturing of life saving drugs, scientists/plant breeders took the challenge of developing high opium yielding varieties. However, they have been able to develop several high opium yielding varieties, but yet it is not able to fulfill the pressure created due to enhance global demand raised as a consequence of population growth. At present our scientists have been able to discover more than 80 alkaloids of immense medicinal importance. Despite of their best possible efforts to identify more and more alkaloids, the demand for five major alkaloids i.e. morphine, codeine, thebaine, narcotine and papaverine have elevated due to major application in medical field. The importance of these five major alkaloids has been discussed earlier (Mishra *et al.,* 2013).

Previously, morphine being the main pain killer was in high demand, for which our scientist made great success in development of high morphine containing varieties. But now a days, the demand for specific alkaloids i.e. thebaine, codeine, narcotine and papaverine have arisen due to their specific use in different medical treatments. The scientists are now trying to develop varieties with specific alkaloid in opium latex through conventional and molecular techniques. Opium poppy is a narcotic crop, due to the presence of morphine (narcotic constituent) in major proportion of opium latex. In recent days, scientists are working to develop low morphine or morphine less varieties to check its illegal cultivation. The development of low morphine or morphine less varieties can also help Narcotics Department, as it will not require issuing license for growing opium poppy to the cultivators. Globally, different group of researchers are engaged in this direction using both conventional and molecular approaches (Mishra *et al*., 2013).

Poppy seeds having high nutritive values are also in high demand and major emphasis has been given for the development of food grade poppy which can only be possible, if opium-less poppy varieties can be developed. Both conventional and molecular approaches are being applied aiming at this target, fortunately a variety “Sujata” has been developed by Central Institute of Medicinal and Aromatic Plants, Lucknow. The development of such varieties can assist opium cultivators to grow food grade poppy without any restriction or permission in form of license. Seeds of opium poppy have high value in global market which puts a great pressure on plant breeders to develop high seed yielding varieties that can substantiate the ever increasing global demands. The importance of poppy seeds has been described earlier in details. However, many high seed yielding varieties have been developed but since global population is increasing at an enormous rate, plant breeders are continuously putting their best possible efforts to capture this ever increasing demand (Mishra *et al.,* 2013).

Breeding for disease resistant variety, causal organism and their management

Diseases are major problem in cultivation of any crop. The development of multiple disease resistant varieties is in need from very long time in opium poppy. A number of diseases occur which ruins the entire crop and ultimately the opium products. Several researchers especially plant breeders have faced many challenges during specific breeding objectives due to severe disease in opium poppy. Our scientists have put their best possible efforts and continuously trying to develop such varieties resistant to major diseases through molecular and conventional tools. One of the major hindrances in any successful breeding program is the prevalence of certain fungal, bacterial, insect borne diseases etc., which cause an unexpected loss in terms of productivity. Opium poppy crop is highly susceptible to certain diseases but the most contagious diseases are caused by fungus results high losses in yield (Mishra *et al*., 2013).

Conventional breeding strategies applied for genetic upgradation of opium poppy

The conventional breeding approaches are a step by step procedure to develop desired plant type. The important steps involved in opium poppy breeding program are described in following subheadings:

Plant Introduction: Conventional plant breeding programs require distinct plant genotypes with specific characteristics to initiate any hybridization technique. The distinctness in the base material ensures higher percentage of success through breeding programme. The collection of diverse germplasm from different geographical regions can be the best approach for initiation of any breeding programme with specific objectives. The foremost step to initiate any crop breeding program is plant introduction. The procedure of growing a variety or a species into an area where it has not been grown earlier is termed as Plant Introduction. However, bringing plant material from one environmental condition to another within a country or continents is also called as plant introduction. Plant introduction and germplasm collection thus becomes one of the richest sources of creation of variability (Mishra *et al*., 2013).

In India, researches on opium poppy are confined at some agricultural and scientific institutes *viz.*, Central Institute of Medicinal and Aromatic Plants, Lucknow, National Botanical Research Institute, Lucknow, Jahawarlal Nehru Krishi Vishwavidalaya-College of Agriculture, Jabalpur, Narendra Dev University of Agriculture and Technology, Faizabad, National Bureau for Plant Genetic Resources, New Delhi, Rajasthan Agricultural University, Udaipur. These centers have been working on genetic upgradation of opium poppy for the last four to five decades. However, the cultivars of Iran were only possible to cultivate in India by introduction (Mishra *et al.,* 2013).

They screened capsule husk of a set of 115 Indian land races of opium poppy (Papaver somniferum L.) for papaverine, reticuline, narcotine, thebaine, codeinone, codeine, morphine and oripavine at CIMAP, Lucknow. These germplasms were grouped into four clusters on the basis of alkaloid profile. Based on the study of alkaloid profiles of these germplasm and correlations between alkaloids in all the four groups of accessions, they concluded that in Indian genetic resources of P**.** somniferum (a) morphine is synthesized from codeine rather than oripavine, (b) n*et al*kaloid content was low under narcotine deficiency, and (c) accumulation of morphine and codeine was in limited upstream of codeinone and morphinone. It was also depicted from their study that the accessions identified based on alkaloid profiles, harboring genetic blocks in phenanthrene and benzylisoquinoline biosynthetic pathways can be useful for understanding the genetic control of secondary metabolism in opium poppy (Mishra *et al*., 2013).

Evaluated 300 accessions of opium poppy for 35 morphological and agronomic traits collected from all over the world at IPK Gene Bank, Gatersleben, Germany. Based on their study on five major alkaloids taken for two years, they concluded highly significant correlation between total alkaloid content and morphine. However, four other major alkaloids *i.e.* codeine, thebaine, noscapine and papaverine did not show any correlation between them or with total alkaloid content. Additionally they also noticed that there is no important correlation between morphological traits and alkaloid content. They also determined the chromosome number in each accession and found that the

subspecies setigerum was natural tetraploid while the rest of the subspecies were diploid. They finally concluded that none of the studied morphological traits could be used for prediction of alkaloid content which may give erroneous information in breeding programmes (Mishra *et al.,* 2013).

Screening and evaluation for oil and fatty acids

One of the important aspects of breeding programmes is selection which is based on several factors and requires experience and command to observe. Selection can be based on maturity period, disease resistance, lodging, withering and yield. Investigation about oil yield, fatty acid compositions and total protein content of three varieties of Turkish poppy were done and found that solvent extraction of yellow seed gave highest oil yield upto 49.2%, while white seed had 36.8% and blue seed 33.6% which was considerably low. Fatty acid compositions of oils were determined by GC/MS in which major components were of linoleic (56.4–69.2%), oleic (16.1–19.4%), and palmitic (10.6–16.3%) acid depending on the color of the seeds. Similar investigation on volatile compounds of several seed oil samples from Papaver somniferum L. using solid phase micro extraction (SPME) with DVB/Carboxen/PDMS Stable-Flex fiber was done. They identified 1-Pentanol (3.3-4.9%), 1-hexanal (10.9-30.9%), 1-hexanol (5.3-33.7%), 2-pentylfuran (7.2-10.0%), and caproic acid (2.9-11.5%) as the main volatile compounds in all examined poppy seed oil samples. Furthermore, the TAG (Triglyceride) composition of these oils was analyzed by MALDI-TOF and ESI-IT-MS/MS. The predominant TAG components were found to be composed of linoleic, oleic and palmitic acid, comprising 70% of the oil (Mishra *et al.,* 2013).

Mutation breeding approaches

Besides, different hybridization programs, mutation breeding program was also flourished and encouraging results were obtained all over the world. An era of mutation breeding came into existence due to significant achievements obtained in many crops of pharmaceutical, industrial and food interest. In opium poppy also scientists obtained fascinating results. A mutation breeding experiment was carried out using physical and chemical mutagens to develop non-narcotic opium poppy from narcotic crop. They isolated two families containing twenty latex less/opium-less and twelve partial latex bearing plants in M_1 generation which gave similar observations in M_2 generations also. The best mutant genotype, LL-34 of family C^{1}-Comb-113-2 with 5.66 g seeds/capsule had 52.6% oil was designated as cv. 'Sujata'. This was the world's first opiumless and alkaloid free seed poppy cultivar, offers a cheap and permanent (fundamental) solution to the global problem of opium-linked social abuse. Simultaneously, it serves as a food grade crop with proteinacious seeds along with healthy unsaturated seed oil (Mishra *et al.,* 2013).

Studied induced mutation through gamma rays, EMS and their combined doses in two varieties of opium poppy (NBRI-1 and NBRI-5) to create new genetic variability for isolation of high yielding genotypes along with specific alkaloids. The genetic coefficient of variability (GCV), heritability and genetic advance was noticed higher for opium and seed yield and capsule weight for all the doses in both the varieties with some exception. They finally concluded that the criteria for selection of plants should be based on capsule weight and capsule number which can provide ideal plant type with enhanced yield potential. Found a variant plant of opium poppy (*Papaver somniferum* L.) having high thebaine content. The M_2 seeds of variant plant were subjected to in vitro studies to investigate the prospects of thebaine production through tissue culture. Consequently, alkaloid profile of variants showed higher thebaine in stem followed by leaf callus, stem callus and cotyledons. From the same mutation breeding experiment made an effort of identify appropriate dose of the mutagens for the enhancement of specific alkaloid especially thebaine and also studied correlation between cytological aberrations and their effects on alkaloid quantity in two stable high yielding varieties of opium poppy i.e. NBRI-1 and NBRI-5. They found that NBRI-1 was more sensitive than NBRI-5 and that the mutagen EMS was most potent in creating chromosom*-al abnormalities. They concluded that two doses i.e. kR 10 + 0.2% EMS and 0.2% EMS was most effective for getting fruitful results. The dose kR 10 + 0.2% EMS possessed high chiasms frequency while 0.2% EMS in combinations with all doses of gamma was effective in enhancing the total alkaloid as well as specific alkaloids (Mishra *et al.,* 2013).

Also tried to broaden the genetic variability and to evaluate the advance generations for different agronomic and chemotypic traits in the experimental high yielding varieties *i.e*. NBRI-1 and NBRI-5 through induced mutations. Here, they noticed that the dose kR30 and kR10 + 0.4% EMS gave highest positive results for genotypic coefficient of variability, heritability and genetic advance (%) for seven traits in NBRI-1 and ten traits in NBRI-5 respectively. They further concluded that their study confirmed that the morphinan and phthalideisoquinilone pathway bifurcated at lower combined doses *i.e*. kR30 and kR10 + 0.4% EMS which was effective in causing micromutation in morphinan and phthalideisoquinilone pathways respectively. A mutant variety known as 'TOP 1' ('thebaine oripavine poppy 1') in opium poppy (Papaver somniferum) was developed by Tasmania Company. In this mutant the morphinan pathway is blocked at thebaine results in absence of codeine and morphine. The major loss of this blockage is on the end product *i.e*. morphine which is absent in this mutant. This mutant was developed by a mutagen treatment to seeds of commercial poppy cultivar (P. somniferum). Phenotypically the mutation is visible in the form of pigmented latex than normal white. In TOP 1 mutant, one possibility is that the gene responsible for an enzyme 6-O demethylase which act on thebaine and oripavine might be affected at its transcriptional level or modified protein structure. It may be possible that there is an alteration occurs in transport component that blocks the entry of substrates (thebaine and oripavine) of the enzyme to the subcellular compartment for 6-O demethylation. These mutant plants are very important since the production of thebaine is only amenable which can help in checking of drug trafficking. However, identification of the candidate genes which has been blocked can be identified and characterized. The complex mechanism involved in morphinane biosynthesis can also be elucidated. These morphine free plants can be beneficial for the treatment of opioid addiction. But there is a slight risk with this mutant for licit to illicit uses (by conversion of non-narcotic alkaloids to narcotic alkaloids). The Tasmania drug industry has been using TOP 1 mutants since 1998 for production of various analgesic drugs *viz.* buprenorphine, oxycodone, naloxone and naltrexone (Mishra *et al.,* 2013).

Other conventional approaches

Apart from different conventional breeding strategies applied for genetic upgradation of opium poppy, several researchers with similar aim carried out several studies in opium poppy. A unique study was carried out on honey bees foraging on plant flowers. They noticed significantly higher foraging response of honeybees (Apis mellifera) manifesting honeybee's preference towards specific plant morphotypes in genetically divergent plant of opium poppy (Papaver somniferum). Furthermore the genotype specific for foraging response of honeybees could be attributed to physico-chemical properties of opium poppy flowers. This could have implications for the development of opium alkaloid fortified honey for novel pharmaceuticals and isolation of natural spray compounds to attract honeybee pollinators for promoting crossing and sustainable hybridity in crops. Since the seed of opium poppy is widely used as food in almost all parts of the world, several researchers tried different ways to develop plants producing nutritionally rich seeds (Mishra *et al*., 2013).

Investigated the effects of water stress on the alkaloid production and content at three different developmental stages *i.e.* Rosette, Flowering and Lancing in opium poppy. They used four types of water conditions i.e. control, withdrawal, 50% water supply and inundation and found that leaves responded significantly to water stress conditions. They further concluded that constant water supply is beneficial for the accumulation of alkaloids in poppy capsules. In many parts of the world, seeds of opium poppy are widely used as food and efforts are continuously made to develop nutritionally rich poppy seeds. In Central European countries, the content of selenium is very low in poppy seeds. Hence, with the aim of supplementing opium poppy plants with selenium (a trace element), tried to explore the effect of foliar application of this element on seed yield, selenium content in seeds and its uptake by the roots. They applied a single dose of selenium of 300 g/ha at two different stages *i.e.* during the stage of the end of elongation growth and after the fall of blossoms. They found that seed yield was reduced by 11.5% and 11.8% after both stages of application respectively but the content of selenium increased significantly from 139 µg/kg to 757 µg/kg of seeds. However, the uptake of selenium also increased significantly upto 4.8 times. Since for the last few decades, scientific researchers have been continuously contributing for the genetic upgradation of opium poppy through various approaches including conventional breeding methodologies, mutation breeding and molecular techniques with breeding and it is a matter of high enthusiasm for the development of varieties, hybrids, synthetics and GMO in opium poppy till date (Mishra *et al*., 2013).

Heterosis

It was reported that poppy exhibits heterosis for many economically significant characteristics. This has allowed a number of high-yielding cultivars of poppy to be created through selection and breeding. The creation of an opium-less variety that produces a high seed yield and high-quality oil for use in food is considered to be a particularly important development, in light of the high nutritional value of poppy seed and oil (Pushpangadan and Singh, 2012).

Varieties developed by National Botanical Research Institute, Lucknow

In due course of time many breeding approaches have been applied in opium poppy for the development of new high yielding and disease resistant varieties. These varieties are now stabilized and suited for different agro-climatic conditions. A brief characteristic description of the varieties are given below (Mishra *et al.,* 2013).

BROP-1: In this variety the plants are medium sized having 3-4 capsules/plant and capsules are of three types viz. oily, parrot coloured and black peduncle. Flowers are white. It is a synthetic variety stabilized after hybridization/intermating between three high yielding cultivars viz. kali dandi (black peduncle), suga pankhi (parrot color) and sufaid dandi (white peduncle) followed by selection. The average opium yield, seed yield and morphine content are up to 54kg/ha, 1000-1200kg/ha and 13% respectively. Geographically it can be cultivated mainly in Northern Indian plains (Mishra *et al.,* 2013).

NBRI-1: This variety is developed through selection. The plants are medium tall having large fringed leaves and white flowers. The average opium yield, seed yield and morphine content are up to 52kg/ha, 1000kg/ha and 12-13% respectively. Geographically it can be cultivated mainly in Northern Central India (Mishra *et al.,* 2013).

NBRI-2: This variety has intermediate tall plants, thick stem, broad leaves, long peduncle with big capsules and flowers are white. This variety is also developed through selection amongst local collection having above characters. Average opium yield, seed yield and morphine content are up to 52 kg/ha, 1200kg/ha and 15%respectively. Northern Central part of India is recommended for its cultivation (Mishra *et al.,* 2013).

NBRI-6: In this variety, plants are medium tall with narrow leaves and white flowers. It is developed by hybridization between two germplasm lines BR007 and BR008 (BR007 x BR008) followed by rigorous selection generation after generation up to eight generations. Average opium yield, seed yield and morphine content are up to 55kg/ha, 1200kg/ha and 13-14% respectively. Geographically Northern Indian plains are mainly recommended for its cultivation (Mishra *et al.,* 2013).

NBRI-9: In this variety, plants are intermediate sized with white flowers and large capsules. The variety is high yielding (seed yield) and is developed by hybridization between germplasm lines S-10 x S-18 followed by rigorous selection until the variety is stabilized (up to eight generations). It's average opium yield, seed yield and morphine content is upto 52kg/ha, 1400kg/ha and 12% respectively. For the cultivation of the variety, Northern Indian Plains are recommended as most suitable (Mishra *et al.,* 2013).

NBRI-10: The plants in this variety are medium tall, having dark green leaves and white flowers. The development of variety was done through hybridization germplasm lines (IC-30 x S-10) followed by rigorous selection up*- to eight generations. Average opium yield, seed yield and morphine content are up to 50kg/ha, 1200kg/ha and 12% respectively. Geographically Northern Central plains are recommended for its cultivation (Mishra *et al.,* 2013).

Madakini: It is a high yielding variety for opium poppy, have multiple disease resistance and is granted US patent no.7,442,854B2 in 2009. The variety is developed by hybridization germplasm lines (BR007 x BR008) followed by rigorous selection. Plants of the variety are vigorous having dark green leaves, white flowers with blackish flowering stalk at the bottom of capsule at maturity. Average opium yield, seed yield and morphine content are up to 64kg/ha, 1200kg/ha and 15% respectively. Northern Central India is recommended for its cultivation (Mishra *et al.,* 2013).

High thebaine lines: As we know that thebaine is a non-narcotic alkaloid and can be used in making pain killing drugs. Thus for fulfilling the increasing worldwide demand of thebaine, with the help of interspecific hybridization (**P. somniferum** x **P. setigerum**) and mutation breeding experiments NBRI has succeeded in the development of few stable high thebaine lines. Thebaine content in these lines ranges 8-10% which is much higher than pre-existing varieties and germplasm (Mishra *et al.,* 2013).

Varieties developed by Central Institute of Medicinal and Aromatic Plants, Lucknow (Mishra *et al.,* 2013)

Rakshit:-It is a disease resistant and morphine rich variety in CPS (concentrated poppy straw). The plants are 106-112 cm tall with 20-26 cm long green peduncle and oblong capsules with waxy surface. The variety is developed by hybridization and selection generation after generation up to eight generations. Average seed yield and straw yield of the variety are up to 1200-1400kg/ha and 900-1100kg/ha respectively.

Sanchita:- In this high yielding variety, plants are 107 cm tall and have 2-3 capsules/plant. The average seed yield and straw yield are 840kg/ha and 640kg/ha respectively. Morphine content of this variety is very low in CPS (approx. 0.74%).

Vivek:- The plants of this variety are 112 cm tall with 2-3 capsules/plant. It is also a high yielding variety having seed yield and straw yield up to 840kg/ha and 760kg/ha respectively. Morphine content of this variety is also very low in husk (approx. 0.73%).

Sweta:- It is high yielding variety with 66.5kg/ha opium yield and about 18% morphine content in latex.

Subhra:- In this variety plants are medium sized having 3-4 capsules/plant. The average seed yield and husk yield of the variety are approx. 910kg/ha and 790kg/ha respectively. The morphine percentage in husk is approx. 0.77%.

Shyama:- In this variety plants are 105 cm tall with black peduncle and also has erect incised leaves. It is a high yielding variety having seed yield, husk yield and morphine content up to 720kg/ha, 650kg/ha and 0.75% respectively.
Sujata:- In this variety plants are 80-100 cm tall having 3-4 flat glabrous capsules with 18-20 cm long erratic black peduncle. It is an opium less, alkaloid less and non narcotic variety.

Narendra Dev University of Agriculture and Technology, Faizabad has developed a downy mildew resistant variety by selection and named Kirtiman (NOP-4). The plants of this variety are quite tall having white flowers and 1-2 oval capsules. Opium yield, seed yield and morphine content of the variety ranges 35-46kg/ha, 900-1100kg/ha and up to 12% respectively. Eastern U.P. region is best suited for its cultivation (Mishra *et al.,* 2013).

National Bureau of Plant Genetic Resources, New Delhi developed a variety Trishna (IC 42) for resistance to frost, root rot and downy mildew through inbreeding and selection. The plants of the variety are tall with 5-7 capsules/plant and pink flowers. Opium yield, seed yield and morphine content ranges up to 49-53kg/ha, 1000kg/ha and 12-14.78% respectively (Mishra *et al.,* 2013).

Rajasthan Agricultural University, Udaipur has developed a resistant variety to disease and lodging and named it as Chetak (UO 285)**.** The plants of this variety are average tall with big capsules. Flowers are white with smooth petals. Opium yield, seed yield and morphine content ranges up to 54kg/ha, 1000-1200kg/ha and 12% respectively. Geographically Rajasthan is most suitable for its cultivation (Mishra *et al.,* 2013).

Jawaharlal Nehru Krishi Vishwavidalaya, College of Agriculture, Jabalpur (M.P.) has also succeeded in developing a downy mildew resistant variety by pure line selection and named as Jawahar Aphim 16 (JA-16). Plants of this variety are tall having white flowers and 1-3 big capsules/plant. The variety has opium yield, seed yield and morphine content up to 45-54kg/ha, 900-1000kg/ha and 12% respectively. Madhya Pradesh is geographically recommended for its cultivation (Mishra *et al.,* 2013). During the history of poppy breeding, in Slovakia, several cultivars selected. Some of them were not registered, still were grown for a short period of time (*e.g*. 'Dunajský', 'Galantský', 'Váhovecký'). The cultivars 'Blankyt', 'Magik', 'Dubník' and 'Hybrid HD' belong to the cultivars registered in the past, but presently, not grown any more. To date, the following six blue-coloured seed yielding cultivars are registered: 'Gerlach', 'Opal', 'Bergam', 'Maraton', 'Major', 'Malsar' and one white-seeded cultivar, 'Albin'. These can be also labelled as food cultivars. They have high seed yield and are utilized for direct consumption. Their morphine content is low to moderate (0.3-0.6% in dry capsules). Their straw is used for alkaloid extraction, although it does not meet current requirements for economic feasibility. Therefore, these cultivars cannot be considered as universal. According to recent trends, i.e. quasi since the beginning of the new millennium, poppy breeding has been divided into two directions: food and commercial type of cultivars (Fejér, 2015).

The registered poppy cultivars in the European list maintained by the Community Plant Variety Office (CPVO) are differentiated based on their usage (Labanca *et al*., 2018):

Industrial ('A1', 'Alfa', 'Botond', 'Evelin', 'Buddha', 'Csiki kek', 'Kek Gemona', 'Medea', 'Minoan',
'Monaco', 'Nigra', and 'Tebona' from Hungary.
'Extaz' from Romania; 'Lazur' from Poland; and 'Riesenmohn' from Germany), culinary ('Aristo', 'Florian', 'Josef', 'Zeno', 'Zeno 2002', and 'Zeta' from Austria.
'Albakomp', 'Ametiszt', and 'Kozmosz' from Hungary.
'Albin' from Slovakia; 'Agat', 'Michalko', 'Mieszko', and 'Przemko' from Poland) or dual ('Bergam', 'Gerlach', 'Major', 'Malsar', 'Marathon', and 'Opal' from Slovakia;
'Edel-Weiss' from Austria; 'Kek Duna' from Hungary; 'Marianne' and 'Rosemarie' from Netherland.
'Sokol' from Czech Republic.
'Parmo' from Denmark; and 'Rubin' from Poland)

P. somniferum has had a very long tradition of use, starting in the Neolithic. This long period of time allowed the development of a broad range of different forms. In total there are 52 botanical varieties. Breeding of *P. somniferum* faces a challenge caused by the contradictory breeding goals for this species. On one hand a very high content of alkaloids is requested for medical uses. The global demand for the alkaloids and the pharmaceutical derivatives has increased in the past years. Therefore, there is a need for the development of varieties with a high opium yield. On the other hand, the food industry demands as low alkaloid contents as possible. There is one accepted subspecies, *P. somniferum* subsp. *setigerum* (DC.) Arcang. There are also many varieties and cultivars. Colors of the flowers vary widely, as do other physical characteristics, such as number and shape of petals, number of flowers and fruits, number of seeds, color of seeds, and production of opium. *Papaver somniferum* var. *paeoniflorum* is a variety with flowers that are highly double, and are grown in many colors. *P. somniferum* var. *laciniatum* is a variety with flowers that are highly double and deeply lobed. The variety *Sujata* produces no latex and no commercial utility for opioid production (Wikipedia, 2025b).

Uses

Several part or product of this species have been investigated for their biological activities but the commercial importance of opium poppy derives mostly from its medical properties, which are due to the production of several BIAs, that comprise about 2500 various structures. Several isolated BIAs display effective pharmacological such as: the narcotic analgesics codeine and morphine, the vasodilator papaverine, the cough suppressant and potential anticancer drug noscapine, the antimicrobial agents sanguinarine, cholesterol-lowering berberine and the muscle relaxant (?)-tubocurarine; most of them have been isolated from Papaver species, especially P. somniferum as a commercial source. Poppy seeds are also appreciated in culinary field, in bakery production and for oil, and as an ornamental species. *Opium poppy* is one of the most valuable houseplant species. This study underlies as, nowadays, opium poppy remains the most important commercial natural source of drugs such as codeine, morphine beside a variety of semi-synthetic products, including oxycodone and buprenorphine, mainly derived from thebaine. Poppy genotypes are generally classified in three categories: industrial, when grown for alkaloid extraction from capsule; culinary when it is grown for seeds and oil production; both industrial and culinary when capsules and seeds are used for alkaloid extraction as well as seeds collection. Another dimension of utility of the opium poppy plant is added by its ornamental usage in some countries (Labanca *et al.,* 2018).

Drugs: The earliest use of the poppy plant dates back to 3,400 B.C.E. In Southwestern Asia, opium poppies were cultivated to make opium. The people of Southeast Asia referred to the flower as the joy plant. Opium poppies were ultimately the cause of the opium wars, when the British

began sneaking opium into China, causing many Chinese to become addicted to the substance. In later years, opium would make its way over to America, and later still, it would be transformed into the substance heroin.

Medicine: Prior to being abused as a substance, opium was often used for its healing and medicinal properties. It was a very powerful pain reliever commonly used among the Greeks. It could induce sleep, help with bowel movements, and eliminate sensations of pain. Today, opium is still used by the medical industry in the form of morphine, oxycodone, and codeine. Heroin was also used for medicinal purposes, but it was made illegal in 1924 due to high rates of addiction.

Food: Poppy seeds are used in cooking and baking. Most commonly, poppy seeds are found on bagels or in desserts like lemon poppy cake. They are also used to spice up any meal made with noodles or rice, particularly in Asian cooking.

Memoriam: Red poppy flowers are used most often in remembrance of fallen soldiers. During the First World War, the Flanders battlefield was a location where many soldiers were laid to rest after battle. Among the rows of graves, red poppy flowers were the only thing that would bloom for many years. Every year, Remembrance Day, or Poppy Day, is celebrated to recall the lives of those lost in war. White poppies are also used to symbolize peace and an end to war (Kremp, 2025). The poppy led to the creation and development of opium and its many derivatives. The popularity of drug use was very common among artists, from painters to writers and musicians. In this way, the poppy plant and its derivatives, opium and heroin, have made many significant marks on the arts world. Heroin use became very popular among rock stars and the music scene. Many artists would use drugs while writing or performing their music. Artists also used heroin to help spark their imagination. Many artists throughout the Romantic Era used opiates, which heavily inspired their work. Perhaps the most popular use of opiate use in literature is throughout *Alice in Wonderland*. The caterpillar was an avid opiate user and would spend time puffing on his hookah, daydreaming and giving Alice riddles to solve. Many famed authors were known for their use of opiates throughout their creative process, including Oscar Wilde, Charles Dickens, and Arthur Conan Doyle (Kremp, 2025). Poppies make stunning additions to floral arrangements. Their vibrant colors and delicate petals can infuse any space with natural beauty. However, to enjoy these blossoms as cut flowers, it's essential to handle them with care for maximum longevity (Kremp, 2025):

Harvesting Poppies at the Right Time: Begin by cutting your poppies just before their buds fully open. This timing ensures that the blooms are at their freshest and can last longer once displayed.

Managing the Milky Latex: Once cut, poppy stems release a sticky, milky latex. This substance can significantly shorten their lifespan if not managed properly. To combat this, you'll need to treat the cut ends.

Heat Treatment for Longer Lifespan: **1) Sear the Ends:** Using a match, carefully sear the ends of the stems. This process helps seal the latex inside, preventing it from leaking. 2) **Hot Water Method:** Alternatively, you can place the cut ends in hot water (110 to 180 degrees Fahrenheit). Immerse the stems for about 20 to 30 seconds. This method also works to seal the latex and prepares the flowers to better absorb water once arranged.

Even with these treatments, poppies only remain vibrant for a few days. Display them prominently during this time to fully enjoy their transient beauty. Poppy extracts have traditionally been used to relax smooth muscle tone, making them potentially useful in the treatment of diarrhea and abdominal cramping. The extract has been used as a sedative analgesic and antitussive. Poppy seed oil is used as a vehicle for chemotherapy delivery and to diagnose fistulae. However, there are no clinical trials to support these uses. Morphine is prepared from the opium poppy (Drugs, 2025). The pharmacologic effects of morphine alkaloids differ widely. Codeine and morphine are sedative analgesics and can relax smooth muscle tone, making them useful in the treatment of diarrhea and abdominal cramping. Codeine and its derivatives are used as antitussives. Papaverine relaxes involuntary smooth muscle and increases cerebral blood flow. Chemical modifications of the alkaloids enable different receptor-dependent activities to be elicited. The addictive characteristics of the opium alkaloids have been recognized for millennia (Drugs, 2025).

The ancient use of poppy seeds as a food source is evident in the fact that many modern-day foods and beverages contain poppy seeds. Poppy seeds can be found in a wide range of baked goods, such as cakes, rolls, muffins, scones, bagels, and pastries. Poppy seeds are also used in a wide variety of Asian, Central, and South American dishes, as well as in Mexican dishes like guacamole, salsas, and tacos. Poppy seeds are an essential ingredient in many desserts, like baklava, a Middle Eastern pastry, and the Indian sweet shrikhand. They are also the main ingredient in traditional Thai salads. Poppy seeds can be eaten both raw and roasted, though the flavor is stronger when roasted. Poppy seeds are also used in savory foods, like Indian curries, Mexican sauces, and guacamole. Poppy seeds are used in cultural practices in India and Thailand as offerings to appease spirits. The Chinese use poppies as decorations during the Chinese New Year (Slurrp, 2022). Poppy seed (Khas Khas) is used as food and as a source of fatty oil. It is widely used for culinary purposes. Because of its highly nutritive nature it is used in breads, cakes, cookies, pastries, curries, sweets and confectionery. Its seeds are demulcent and are used against constipation. The capsules are used as a sedative against irritant coughing and sleeplessness in the form of syrup or extract (Indianspices, 2025).

The drug was known in very remote times and the Greeks and Romans collected it. It is probable that the physicians of the Arabian school introduced the drug into India, as well as into Europe. It was originally used only as a medicine, the practice of opium eating having first arisen, probably in Persia. Opium is one of the most valuable of drugs, Morphine and Codeine, the two principal alkaloids, being largely used in medicine. It is unexcelled as a hypnotic and sedative, and is frequently administered to relieve pain and calm excitement. For its astringent properties, it is employed in diarrhoea and dysentery, and on account of its expectorant, diaphoretic, sedative and antispasmodic properties, in certain forms of cough. Small doses of opium and morphine are nerve stimulants. The Cutch horsemen share their opium with their jaded steeds, and increased capability of endurance is observed alike in man and beast. Opium and morphine do not produce in animals the general calmative and hypnotic effects which characterize their use in man, but applied locally, they effectually allay pain and spasm. Owing to the greater excitant action in veterinary patients, the administration of opium does not blunt the perception of pain as effectually as it does in human patients. The British Pharmacopceia Tincture of Opium, popularly known as Laudanum, is made with 3 OZ. of Opium and equal parts of distilled water and alcohol, and for immediate effects is usually preferable to solid Opium. Equal parts of Laudanum and Soap Liniment make an excellent anodyne, much used externally (Botanical, 2025).

Nurtitional Value

Opium is brownish in colour when fresh and turns to brownish black when dried. It has a fruity odour. The total alkaloid content varies from 5–10%. It has a very complex chemical composition containing sugars, proteins, fats, water, meconic acid, plant wax, latex, gum, ammonia, sulphuric and lactic acids and numerous alkaloids (about 40 have been identified so far), most important among them including morphine (10–15%), codeine (1–3%), noscapine (4–5%), papaverine (1–3%) and thebaine (1–3%). The range of major alkaloids contained in the Indian species are morphine (7–17%); codeine (2.1- 4.4%); thebaine (1.0–3.0%); noscapine (3.0–10%) and papaverine (0.5–3%). Papaver straw (dry capsule with 7.5 cm stem) contains a small quantity of alkaloid. All these compounds except thebaine are used medicinally as analgesics. The opioid analgesics are of inestimable value because they reduce or relieve pain without causing a loss of consciousness. They also relieve cough, spasm, fever and diarrhoea. Opium is used as a narcotic, sedative, antispasmodic, hypnotic, sudorific and antidiarrhoeal. The opium is official in pharmacopoeias of several countries. Opium tincture and camphorated opium tinctures are the most generally used in dosage forms for coughs. Suppositories of opium with lead are employed to relieve rectal and pelvic pains and ointment of opium with gall is applied in haemorrhoids. Opium is also used in veterinary practice (Pushpangadan and Singh, 2012).

Poppy seeds are free from narcotics and are highly nutritious and taken by preparing various preparations. Poppy seeds are tiny, kidney shaped, generally white, occasionally red or pink to grey. They are attached to the lateral projections from the inner walls of the capsules and are produced in abundance. The seeds have well developed endosperm filled with aleurone grains. About 3300 seeds weigh 1 g. The poppy seeds do not contain opium. Poppy seeds are devoid of any narcotic compounds, but have high nutritive value and are used as a food and a source of edible oil. They are used in breads, curries, sweets and confectioneries. Analysis of Indian poppy seeds showed moisture 4.3–5.2%, protein 22.3–24.4%, crude fibre 4.8–5.8%, calcium 1.03–1.45%, phosphorus 0.79–0.89% and iron 8.9–11.1 mg/100 g. Seeds also contain thiamine, riboflavin, nicotininc acid and lecithin. Minor minerals in the seeds include iodine (6 g/kg). The seeds have a high protein content, the major component being globulin which accounts for 55% of the total nitrogen. The amino acid make-up of the globulin is similar to that of the whole seed protein and is as follows, arginine (10.41%), histidine (2.9%), lysine (1.5%), methionine (2.3%), theonine (4.2%) and valine (7.1%). The protein are deficient in lysine and methionine. At 10% level of intake they have a biological value of 57.5% and digestibility coefficient of 81% (Pushpangadan and Singh, 2012).

The oil cake after extraction of oil from seeds contains about 32.5% protein and is used as a concentrate in feeding pigs and other animals reared for meat. Poppy seeds are utilized as food and as a source of fatty oil. They are considered to be highly nutritive and used in breads, curries, sweets and confectionery. Seeds are demulcent and are used in the form of emulsion as an emollient and as specific against obstinate constipation and in catarrh of the bladder. The whole seeds are sometimes used in pharmaceuticals (Pushpangadan and Singh, 2012). The small, round, bluish-black poppy seed is rich in fiber, healthy fats, and micronutrients (particularly manganese). They improve digestion, treat asthma and insomnia, and alleviate headaches and coughs. Seeds add a gentle crunch and subtle flavor to many baked goods and dishes: sprinkled on salads and roasted vegetables, topped on bagels, baked into breads and muffins, added to salad dressings, and commonly paired with lemon, creating a popular combination. They may also be pressed into oil, which is commonly used on skin (Volpe, 2024).

The chemistry of the genus Papaver is well known. When the unripened seed capsule is scored, a milky latex exudes. The dried latex is known as opium, which contains more than 30 alkaloids. The most important of these alkaloids are morphine (20%), noscapine (5%), codeine (2%), papaverine (2%), and thebaine (1%). Codeine is the most widely used opium alkaloid and is obtained from natural sources or through the methylation of morphine or synthetic transformation of thebaine. Because of the medicinal importance of morphine derivatives, efforts have been made to identify a species of Papaver that contains high levels of a suitable starting compound for the commercial synthesis of codeine. In some varieties of *P. bracteatum*, thebaine constitutes 98% of the total alkaloid content. Commercially, thebaine may be readily converted to codeine, oxycodone, hydrocodone, or dihydrocodeine. *P. bracteatum* may become the species of choice as a legal source of alkaloid precursors. Poppy seed oil, used as a vehicle for pharmacological substances as well as oil-based paints, varnishes, soaps and liniments contains saturated palmitic and stearic acids and oleic, linoleic, alpha-linolenic, and other unsaturated fatty acids. Poppy seeds and their oil contain only minuscule amounts of opium alkaloids (Drugs, 2025).

Opium was known to ancient Greek and Roman physicians as a powerful pain reliever. It was also used to induce sleep and to give relief to the bowels. Opium was even thought to protect the user from being poisoned. Its pleasurable effects were also noted. The trading and production of opium spread from the Mediterranean to China by the 15th century. Opium has many derivatives, including morphine, codeine, oxycodone, and heroin. Browse the images below to learn more about each derivative. Oxycodone is synthesized from thebaine, a third component of opium. Like morphine, it is used for pain relief. Oxycodone is taken orally. When misused, thetablets are crushed and snorted or dissolved in water and injected (Museum, 2025)

- **Morphine:** In 1803, morphine, the principal ingredient in opium, was extracted from opium resin. Morphine is 10 times more powerful than processed opium, quantity for quantity. Hailed as a miracle drug, it was widely prescribed by physicians in the mid-1800s. Morphine is one of the most effective drugs known for the relief of severe pain and remains the standard against which new pain relievers are measured.
- **Codeine:** Codeine, another component of opium, is medically prescribed for the relief of moderate pain and cough suppression. It has less pain-killing ability than morphine and is usually taken orally. As a cough suppressant, it is found in a number of liquid preparations.
- **Heroin:** First synthesized from morphine in 1874, the Bayer Company of Germany introduced heroin for medical use in 1898. Physicians remained unaware of its addiction potential for years, but by 1903, heroin misuse had risen to alarming levels in the United States. All use of heroin was made illegal by federal law in 1924.
- **Oxycodone:** Oxycodone is synthesized from thebaine, a third component of opium. Like morphine, it is used for pain relief. Oxycodone is taken orally. When misused, the tablets are crushed and snorted or dissolved in water and injected.

CULTIVATION

Economic importance of opium poppy and its derivatives: Opium poppy belongs to the family Papaveracae and has been attracting the interest of researchers because of its pharmaceutical, decorative and alimentary attributes. Scientists have been able to identify 2500 different compounds in opium poppy belonging to different biochemical groups used in pharmaceutical industries. Among the various drugs of medicinal importance, opioids are an important class of compounds produced by opium poppy which are used in medicine as a pain reliever.

These opioids interact with the opioid receptor present in the central nervous system and gastro-intestinal tract.However, several of these medicinal compounds can be made synthetically but alkaloids belonging to various groups *viz.,* Phenanthredene (Morphine, Codeine, Thebaine), the true Benzylisoquinilone (Papaverine) and *Phthalide isoquinilone* (Narcotine) are only obtained from opium which place opium poppy at the highest place among the diverse array of medicinal plants. The most important and potent alkaloid is morphine which can be used for both short term as well as long term pain control, is widely used in many prescriptions of pain medications. The drug occurs as a white crystalline powder or colorless crystals and is available for legal medical use. Recently, scientists at the University of Pennsylvania have noticed complication in patient with hepatitis C disease due to withdrawal of morphine as it suppresses IFN-alpha-mediated immunity and enhances virus replication. This disease is common among intravenous drug users. Due to the interactive role of morphine with hepatitis C disease, interest has been developed in determining the effect of drug abuse, especially morphine and heroin on progression of the disease. The discovery of the association between two would certainly help in the treatment of both HCV infection and drug abuse. Morphine is also beneficial for immediate relief in reducing the symptoms of shortness of breath caused due to cancer and non-cancerous incident. Morphine is widely available in market as tablets, modified release-tablets, capsules, oral liquid and sachets of modified-release oral liquid, injections and suppository. There are however, many serious side effects of morphine which includes shallow breathing, slow heartbeat, stiff muscles, seizure (convulsions), unusual thoughts or behavior, severe weakness, constipation (Mishra *et al.,* 2013).

Cultivation: Generally speaking, poppies are all quite similar in culture. They love cool nights, and cool summers, which is rare in the US latesly, unless you live in Canada or the Pacific North West, most poppies can be challenging. Poppies require some basic knowledge to grow well, but I believe that if you are to bother at all with growing poppies, then start with annual expectations, for many poppies are true perennials or biennials, the cool growing forms can be started in early spring and treated as annuals, if you are lucky and the spring and summer stays cool. *Papaver somniferum* are the most impressive annual poppies to grow – follow directions, for one cannot be careless in sowing and cultivating these beauties. They take extra care and attention. Cool temperatures are best, which is why one sees beautiful stands of these poppies in Maine, and Canada, or in coastal England. These are tap-rooted, tender plants, and one can only grow these if the tiny seed is sown directly where they are to grow – in raked, tamped soil, sowing in March or April as thinly as you can. Do not cover the seeds, for light will help them germinate, and at first, they are tiny! Forget about transplanting seedlings, but I have done so when plants are very small, using a large shovel to carefully lift an undisturbed block of firm soil, to only slide the block of soil into a prepared hole without disturbing the seedlings. But such moves are risky, and failure is all but certain if any root damage occurs (Mattus, 2012). Remember, seed is small, so mixing seed with sand and then sowing will allow the seeds to be well spaced. Only a careful thinning will be required. Once seedlings are established, plants will grow with impressive speed, providing blooms in just two months on 4 foot plants, from a March sowing. True annuals, once the blooms fade, so too will the plants, so have a back up plan for poppies yellowing in the garden are not pretty. It will take some practice to learn what poppy seedlings look like, but with careful weeding, and editing of plant, these fleshy stemmed plants do require a little care. First, one might believe that due to their crunchy leaves and stems, that these plants might like water – but in fact, these are plants that prefer fast draining soil, and they will rot if they become too wet. That said, they also do not want dry conditions, so well watered soil, that drains quickly is best. Not as easy as it sounds, but I add sand to the soil where they are to be planted. Secondly, these plants like healthy, rich soil, but resist using high nitrogen fertilizer – a mistake many people make, since young plants look so tender, and weak, and they are fast growing, so one assumes that a liquid feed with Miracle Gro or 10-10-10 might seem smart – it is not. Use 2.5.5. fertilizer – higher in phosphorus and potassium is best (tomato fert.), and you should be fine. Once the weather begins to warm, in early July, the leaves will quickly take off into 4 foot tall monsters. Allowing plants to set seed (for there equally stunning seed pods) is not for the faint of heart, for the plants will need to yellow and will look awful for weeks in the garden, but the reward will be dozens of self seeded plants the following spring, as long as you don't mulch, or work the soil much. So as you can see, the ideal conditions are not always as ideal as we all imagine (Mattus, 2012).

Poppy is cultivated for the legal pharmaceutical use of opium latex in India, USSR, Egypt, Yugoslavia, Czechoslovakia, Poland, Germany, the Netherlands, China, Japan, Argentina, Spain, Bulgaria, Hungary and Portugal (Vesselovskaya 1976, Ramanathan and Ramachandran, 1977). Many European countries, however, grow poppy for its seed and seed oil. Poppy is also grown illegally for the narcotic trade and is categorized mainly in two groups:

- Golden Triangle (Burma, Thailand and Laos region)
- Golden Crescent (Afghanistan, Pakistan and Iran region)

There exist no records about the extent of illegal poppy cultivation and production (Pushpangadan and Singh, 2012).

Poppy can be cultivated in well-drained soil in open sunny locations in subtropical regions, being irrigated during dry spells. Direct sowing is better as transplanted ones do not grow well. It is a six-months crop and sowing is done mostly in autumn. In India sowing is carried out at the beginning of November and seed is harvested in April the following year. Poppy is primarily cultivated in India for opium as a rich source of morphine for medical use and for seeds and seed oil. There are a number of varieties of *P. somniferum* L. under cultivation in India. The races with white flowers are commonly grown in Uttar Pradesh. The races with red or purple flowers were common in Madhya Pradesh and Rajasthan, but now these too are replaced by white flower types. No comprehensive taxonomic treatment on the cultivars of Indian opium poppy is available (Pushpangadan and Singh, 2012). Broadly classified the races of opium poppy in Indis into 'Sabzadhari' (green, *i.e.*, non-waxy capsules) and 'Safaidhari' (white, *i.e.* waxy capsules) types (Pushpangadan and Singh, 2012). During the last two to three decades, there has been a great erosion of poppy germplasm in India and many of the races described earlier are no longer available today. To pinpoint the different races under cultivation in recent years, a detailed and classified investigation has been carried out (Pushpangadan and Singh, 2012).

Evaluated a large collection of germplasm from the various states which they categorized into basic cultivars. Not more than 20–25 basic cultivars could be recognized. India is one of the largest producers of opium alkaloids in the world. As well as meeting the domestic demand, India exports opium to other countries. Its production and distribution is controlled by the Narcotic Controller of Govt. of India. At present poppy is cultivated mainly in Uttar Pradesh, Rajasthan and Madhya Pradesh. The area under poppy cultivation is controlled by the Narcotics Department, Government of India who give annual renewable licences to the farmers. The area under opium poppy cultivation is divided into 12 (opium) divisions covering the districts of Faizabad, Barabanki, Barelly and Shajahanpur in Uttar Pradesh, Neemuch I and II, Mandsaur I and II and Ratlam in Madhya Pradesh, and Kotah, Chittorgarh and Jhalawar in Rajasthan (Pushpangadan and Singh, 2012).

The poppy flower is an annual (or a short-lived perennial). However its prolific self-seeding abilities give it the perseverance of a wildflower. Its crepe-like blooms look fragile, yet they easily withstand drought conditions, and grow in poor soil. Growing poppies is an easy task for any amateur gardener. They can be started indoors or sown directly into your garden or planter soil. Starting poppies indoors requires cool

temperatures and light to germinate. Start the seeds in a moist seed-starting soil and press gently into the surface, lightly misting to keep the soil moist. Once sprouted, thin to one seed per cell. When plants have a few leaves, harden off and carefully dig and replant them one foot apart to prevent overcrowding—taking care with the fragile roots. To avoid loosing the tiny seeds while planting, mix them with sand and use a large-holed salt shaker to sprinkle a layer of seeds over your planting area. You can also use nature's built-in shaker by saving the pods and simply shaking the seeds into your garden. Poppy flowers love full sun and well-drained soil, requiring little water once they have settled into the ground. Too much water can produce tall and spindly growth. Deadheading spent flowers, by removing blooms, encourages regeneration (Volpe, 2024).

The plants prefer rich, moist soil and much sun, and are often grown in succession to wheat and barley. The land is manured and ploughed in autumn, to ensure a fine tilth in spring. Sowing is done at the end of March or in April - according to weather - allowing 1 lb. of seed per acre, and drilling in rows a foot apart. The whitest seeds are preferred. Plants which are too forward are liable to be cut down by late frosts, while if the seed is sown too late, the seedlings may become dwarfed if dry weather sets in before they are well established. A light roller is sufficient to ensure the seeds being covered. When the plants are 3 or 4 inches high, cut them with the hoe into clumps about 6 to 9 inches apart, and afterwards 'single' them, leaving a solitary strong plant from each group. Weeding is necessary, and a dressing of soot may be given if support appears to be needed. Poppy heads of pale colour are most desired, but a week's rain, or even a few nights' heavy dew, may spoil the colour of the ripening fruit. High winds and heavy rains may cause much destruction, as the plants become top-heavy. The yield is very variable (Botanical, 2025).

The capsules are left on the stems after the petals have fallen, until they cease to enlarge. The stems should then be bent in the middle and the capsules left on the plant until they are firm, which will be about September. In India, when the flowers are in bloom, the first step is the removal of the petals, which are used in packing the prepared drug. After a few days, the imperfectly ripened capsules are scarified from above downwards by two or three knives tied together and called 'mushturs.' These make a superficial incision, or series of incisions, into the capsule, whereupon a milky juice exudes, which is allowed to harden and is then removed and collected in earthen pots. The time of day chosen for slicing the capsules is about two o'clock in the afternoon, when the heat of the sun causes the speedy formation of a film over the exuded juice; great attention is also paid to the weather, as all these causes modify the quantity, quality, or speediness of exudation of the opium. The capsules are submitted to two or three slicing processes at intervals of a few days, and the drug is ultimately conveyed to the government factory where it is kneaded into a homogeneous mass by native workmen. The capsules contain the principal constituents of opium, the most important of which is the alkaloid Morphine, which exists in combination with meconic and sulphuric acids. The seeds are free from morphine; their principle constituent is the pale yellow fixed oil, used as a drying oil by artists, as well as for culinary and various technical purposes. The action of poppy capsules is the same as that of opium, anodyne and narcotic, but much weaker. The crushed capsules are used as a poultice, together with chamomile (Botanical, 2025).

A syrup is prepared from the capsules, prescribed as an ingredient in cough medicine. Syrup of Poppy is often employed to allay cough and likewise as an opiate for children; in the latter case it should be used with great caution. Decoction of Poppy, made from the bruised capsules and distilled water, is not given internally, but is employed as an external application to allay pain and soothe. The broken capsules are sold at a cheaper rate, for making fomentations. The grey seeds are sold for birds' food, under the name of 'maw' seed, and are derived from the dark-red flowered form of *Papaver Somniferum*; the var. *album* having white seeds. On the Continent the seeds are much used in special poppy cakes and are sprinkled on rolls, as also in India, where they are used in the native pancakes or 'chupaties.' Anodyne, expectorant. The fresh petals are directed by the British Pharmacopceia for preparing a syrup, which may be given in 1 drachm doses, occasionally, as a mild astringent, but is principally employed as a colouring agent for mixtures and gargles (Botanical, 2025).

Poppies like sunshine. They are categorized as 'full sun,' meaning they like 6 hours or more of bright, direct sunlight. Choose a site with adequate drainage. These flowers won't appreciate a constantly wet or poorly drained site. Consider creating a raised bed or berm if your soil is heavy and compacted. Annual poppies can be planted in fall or early spring when there is still frost at night, but the soil is exposed. Planting in fall mimics the natural processes and makes one less thing to do in spring when you are already busy! Perennial poppy roots are often only available in autumn and should be planted in fall several weeks before the ground freezes. Perennial poppies are often purchased as started plants, but annual poppies are easily grown from seeds. Poppy seeds should be cold-stratified for several weeks. They also need light to germinate, so don't bury them in the soil. While they do best when direct seeded, they can be transplanted after germination in containers or cells. Use a biodegradable pot and plant the entire thing in the ground–pot, plant and all–to avoid disturbing the roots. If direct seeding an area, try mixing one part seed with four or five parts dry sand and then broadcasting across the site to be planted. An old jar with holes poked in the lid can work to sprinkle this mix around. Don't cover them up! Poppy seeds need light to germinate. If you are having issues with birds stealing your seeds, try barely covering them with a light, thin layer of straw. Essentially, dust them with bits that float down when you rub the straw together. You still want light getting to the seeds, so don't put it on like mulch. After sprinkling the seeds, press them down with your hand to provide good seed-to-soil contact. Then water well. Poppies need some cold. If you plant seeds in late spring, give them a chill in the refrigerator for a month to stratify them before planting. Poppy roots should be planted with the crowns about 3 inches deep in the fall. They may sprout a little greenery before the winter but then go dormant and return in spring.
(Wilcox, 2025).

Harveting

Poppies lend a beautiful hand in flower arrangements and should be cut at the cracked bud stage, just as the bud is beginning to split open, revealing a sliver of color through the green sepals. Once cut, the flowers will continue to open and can be enjoyed for 5-7 days in a vase. The large, dried pods are commonly used in home décor and are an ornamental favorite of florists (Volpe, 2024). After the flower petals have died and dropped off, the pods will dry on the stalk. Seeds are ready to harvest when the pod is fully dried and hardened and the seeds begin to rattle around inside. Harvesting seeds too early may inhibit germination. However, if you wait too long, the pods will split and scatter their seed to replant new poppy plants the following season. Clip the dried pods off the stalks and store in an airtight containter until the following season. Once ready to plant, simply snip the ends off and shake the seeds from the pods (like a peppershaker) over well-prepared soil in a sunny location (Volpe, 2024). The milky fluid that seeps from cuts in the unripe poppy seed pod has, since ancient times, been scraped off and air-dried to produce what is known as opium. The seedpod is first incised with a multi-bladed tool. This lets the opium "gum" ooze out. The semi-dried "gum" is harvested with a curved spatula and then dried in open wooden boxes. The dried opium resin is placed in bags or rolled into balls for sale (Museum, 2025).

Adverse Reactions

Immunoglobulin E–mediated allergy to poppy seeds is rare although case reports of anaphylactic reactions exist. The poppy seed commonly used in confectionary is thermostable. In some patients, it may need to be ground in order to be allergenic. Cross-sensitization with sesame seed, hazel nut, rye grain, kiwi fruit, and buckwheat has been reported. A case report exists of bowel obstruction due to consumption of large quantities of poppy seeds. Dependence requiring buprenorphine treatment has been documented in a 34-year-old man with a 5-year recent history of consuming poppy seed tea. His history included a 10-year overall history of opioid use disorder in which he transitioned from heroin to episodic use of pharmaceutical opioids, and ultimately the sole use of poppy seed tea for the last 5 years. Recovery was ultimately achieved with depot buprenorphine treatment (Drugs, 2025buprenorphine treatment (Drugs, 2025).

Toxicology

Opium is not very quickly absorbed. When a poisonous dose has been swallowed, the stomach should be emptied as soon as possible by the stomach pump and washed with a solution of potassium permanganate. Administration of nitrites and of small doses of atropine hypodermically maintain cardiac action, but the atropine must be used cautiously, as full doses are apt to intensify paralysis both of the heart and spinal cord. The lethal tendency is further combated by strychnine used hypodermically and by artificial respiration. Coma is prevented by giving strong coffee and stimulant enemata and keeping the patient moving. Tincture of gall and other chemical antidotes are of little avail. The leaves of *Combretum Sundaicum*, a plant native to the Malay Peninsula and Sumatra, have been used in the form of a decoction of the roasted leaves, as a cure for the opium habit among the Chinese (Botanical, 2025).

Oil is expressed by the cold process (Pushpangadan and Singh, 2012).
In India the oil is expressed by the cold process, the yield being about 90%.
In France, three stages are observed.
1. First cold expression – a very superior oil used for the table purposes and in the manufacture of very high quality paints
2. Second cold expression – lower grade edible oil also used for paints and illumination
3. Third hot expression – a much inferior oil to either of the others used chiefly in soap making.
The oil is rendered perfectly colourless by exposure to sun. Although both white seeded and black seeded are used for oil pressing, black seed is mostly preferred. Cold pressing seeds of fine quality yields 30 to 40% of virgin white oil, a transparent limpid fluid with a slight yellowish tinge, bland and pleasant to taste and with almost no perceptible odour. On second pressure with the aid of heat an additional 20% to 25% of inferior oil is obtained. This oil is somewhat reddish in colour and possesses a biting taste, and a linseed-like smell. Poppy seed oil has specific gravity (15º/25ºC): 0.924– 0.927, and refractive index 1.467 to 1.47, iodine value 132–142; sap value 188–196, and acid value 3.13%.

Food: In 2018, world production of poppy seeds for consumption was 76,240 tonnes, led by Turkey with 35% of the world total. Poppy seed production and trade are susceptible to fluctuations mainly due to unstable yields. The performance of most genotypes of *Papaver somniferum* is very susceptible to environmental changes. This behaviour led to a stagnation of the poppy seed market value between 2008 and 2009 as a consequence of high stock levels, bad weather and poor quality. The world leading importer of poppy seed is India (16 000 tonnes), followed by Russia, Poland and Germany. Poppy seed oil remains a niche product due to the lower yield compared to conventional oil crops (Wikipedia, 2025b).

Poppy seeds and oil: Poppy seeds from *Papaver somniferum* are an important food item and the source of poppy seed oil, an edible oil that has many uses. The seeds contain very low levels of opiates and the oil extracted from them contains even less. Both the oil and the seed residue also have commercial uses. The poppy press cake as a residue of the oil pressing can be used as fodder for different animals as *e.g*., poultry and fancy fowls. Especially in the time of the molt of the birds, the cake is nutritive and fits to their special needs. Next to the animal fodder, poppy offers other by-products. For example, the stem of the plant can be used for energy briquettes and pellets to heat. Poppy seeds are used as a food in many cultures. They may be used whole by bakers to decorate their products or milled and mixed with sugar as a sweet filling. They have a creamy and nut-like flavor, and when used with ground coconut, the seeds provide a unique and flavour-rich curry base. They can be dry roasted and ground to be used in wet curry (curry paste) or dry curry. When the European Union attempted to ban the cultivation of *Papaver somniferum* by private individuals on a small scale (such as personal gardens), citizens in EU countries where poppy seed is eaten heavily, such as countries in the Central-Eastern region, strongly resisted the plan, causing the EU to change course. Singapore, UAE, and Saudi Arabia are among nations that ban even having poppy seeds, not just growing the plants for them.[69] The UAE has a long prison sentence for anyone possessing poppy seeds (Wikipedia, 2025b).

Opiates: The opium poppy is the principal source of opium, the dried latex produced by the seed pods. Opium contains a class of naturally occurring alkaloids known as opiates, that include morphine, codeine, thebaine, oripavine, papaverine and noscapine. The specific epithet *somniferum* means "sleep-bringing", referring to the sedative properties of some of these opiates. The opiate drugs are extracted from opium. The latex oozes from incisions made on the green seed pods and is collected once dry. Tincture of opium or laudanum, consisting of opium dissolved in alcohol or a mixture of alcohol and water, is one of many unapproved drugs regulated by the U.S. Food and Drug Administration (FDA). Its marketing and distribution persists because its historical use preceded the Federal Food, Drug & Cosmetic Act of 1938. Tincture of opium B.P., containing 1% w/v of anhydrous morphine, also remains in the British Pharmacopoeia, listed as a Class A substance under the Misuse of Drugs Act 1971 (Wikipedia, 2025b). Morphine is the predominant alkaloid found in the cultivated varieties of opium poppy that are used for opium production. Other varieties produce minimal opium or none at all, such as the latex-free Sujata type. Non-opium cultivars that are planted for drug production feature a high level of thebaine or oripavine. Those are refined into drugs like oxycodone. Raw opium contains about 8–14% morphine by dry weight, or more in high-yield cultivars. It may be used directly or chemically modified to produce semi-synthetic opioids such as heroin (Wikipedia, 2025b).

Good Effects of Opiates: No other substance has been found to be as effective as opiates for the management of extreme pain. In addition to its analgesic qualities, it is a very effective cough suppressant, anti-diarrhea medication, and sleep-inducer (Museum, 2025).

Bad Effects of Opiates: The major drawback of opiate use is the potential for misuse and addiction. Effects include drowsiness, slurred speech, confusion, memory loss, pupil constriction, dilation of the blood vessels causing increased pressure in the brain, constipation, nausea, vomiting, weight loss, fatigue, hallucinations, sexual dysfunction, convulsions, and respiratory depression. Effects from using non-sterile needles and

adulterants mixed with opiates include skin, lung, and brain abscesses, endocarditis (inflammation of the lining of the heart), infected and collapsed veins, and diseases such as hepatitis and HIV (Museum, 2025).

The Heroin Molecule

Opium from poppy plants contains several natural alkaloids including morphine and codeine. All opiates share the same basic molecular structure, with just a slight change in the end molecules to differentiate heroin from morphine, codeine, oxycodone, and other varieties. After heroin use is stopped, symptoms like depression, abnormal mood swings, insomnia, psychosis, and paranoia remain. These brain scans show a reduction in dopamine receptors which control judgment and behavior. This reduction is a result of regular heroin use.
Heroin binds to receptors in the brain and produces feelings of euphoria. Its structure mimics that of a natural neurotransmitter and taps into the brain's communication system, interfering with the way nerve cells normally send, receive, and process information. This similarity in structure "fools" receptors and allows the drugs to lock onto and activate the nerve cells (Museum, 2025).

Legal Production of Opium

Legal growing of opium for medicinal use currently takes place in India, Turkey, and Australia. Two thousand tons of opium are produced annually and this supplies the world with the raw material needed to make medicinal products. Mallinckrodt, one of the pharmaceutical companies licensed to deal in legal poppy production, uses crates such as this to ship its poppy products around the world (Museum, 2025).

Heroin Drug Trafficking

Currently, there are three main sources for illegal opium: Burma, Afghanistan, and Colombia. Opium and heroin are ideal trade products–they are in great demand, are very profitable to produce, and the products take up little space. With modern transportation, opium and heroin can be moved from one country to another within days or a few weeks. Opium and heroin have an extensive and stable shelf life, allowing the products to be stored for long periods of time (Museum, 2025).

Capsule husk

Capsule husk is used in tea. Bonda Chai (Bonda tea), prepared by powdered capsules and then brewed with tea, has been prevalent in Punjab and Madhya Pradesh, mainly among truck and lorry drivers and farm labour. Poppy tea has been a common home remedy for many hundreds of years in Europe and is still practised in many of these countries. It is considered to be helpful in detoxing the heroin addiction (Pushpangadan and Singh, 2012).

Poppy Powder: To make poppy tea, after removing the seeds the poppy capsules are powdered in a coffee grinder or spice grinder into a fine powder. The powder is added to boiling water and stirred into a brew. The brew is left to cool while stirring occasionally and then filtered through a wire mesh strainer. The liquid thus obtained is bitter and taken with licorice or mixed with tea. Stem ground powder is also used to make poppy tea. The leftover pulp can be used again to make another cup of tea by adding boiling water (Pushpangadan and Singh, 2012).

Poppy straw: Poppy straw (unlaced capsule) has been made use of in Europe and other places as a source of morphine where it is cultivated mainly for seed and oil (Pushpangadan and Singh, 2012).

Poppy plants: Poppy plants are used in production of paper-pulp to make handmade boards. Poppy plants are sometimes eaten like lettuce leaves. It is grown as a pot herb in Iran (Pushpangadan and Singh, 2012).

Poppy flowers: The red poppy flowers are used in medicine for making syrup. The red and lilac flower contains a colouring matter and are suitable for use as indicator (Pushpangadan and Singh, 2012).

Poppy leaves: Poppy leaves were at one time in the French Pharmacopoeia. It contains morphine (0.03–0.2%) and other alkaloids in small quantities (Pushpangadan and Singh, 2012).

Poppy oil: Poppy seeds are rich in oil, though the oil content is highly variable and ranges between 33 and 53% DM. White-seed varieties have been reported to contain more oil than blue-seed varieties (40 **vs.** 33% as fed). There are large differences in the fatty acid composition of oils even in seed samples taken from the same region: the contents of lauric acid (0-13.4%), palmitic acid (7.8-30.66%), myristic acid (0-1.1%), stearic acid (1.4-10.9%), oleic acid (13.2-36.8%), linoleic acid (18.4-80.0%), and linolenic acid (trace-9.4%) are very variable. However, the seed oils generally have a high unsaturated fatty acid content (Tran, 2015).

Poppy seed meal and poppy seed cake: Poppy seed meal and poppy seed cake are generally rich in protein (30-40% DM) with a variable amount of fibre (up to 23% DM crude fibre). The oil content varies between 0.8-1.5% DM in solvent-extracted meal and 5-13% in the cake (Tran, 2015).

Seed: In some countries, such as Germany, only low-morphine poppy varieties are authorised for cultivation and are exclusively destined for the production of food or oil seeds. However, there is poppy seed production for food use from poppy varieties especially bred with high alkaloid content intended for pharmaceutical purposes. While poppy seeds do not contain alkaloids, bound forms may exist in the seed and the seeds can become contaminated with alkaloids as a result of insect damage, or through poor harvesting practices (Tran, 2015).

Cake: The pressed cake can be contaminated by capsule fragments, so it should be fed to animals with caution (Tran, 2015).

Risk: The symptoms of poisoning are excitement, constipation and excessive salivation. Although deaths are rare, the poisoned animals take a long time to recover. Poppy seed cake was once believed to cause drowsiness but this was not confirmed in early animal trials (Tran, 2015).

Products: Cultivated poppy (*P. somniferum)* has great economic value because of the opium latex and also for the edible seed and seed oil. The capsule is the major organ for the opium latex, but the alkaloids are also present in other parts of the plants like stem, leaves, roots. The

seeds do not contain any alkaloid, but are rich in edible oil of high quality. The straws of poppy also contain some alkaloids and are variously used in medicine (Pushpangadan and Singh, 2012).

Area: The world opium poppy cultivation covers 270.000–300.000 ha. The 5 largest producers are India, Burma (Myanmar), Afghanistan, Turkey and the former Soviet Union, representing two-thirds of all cultivated fields (Labanca *et al*., 2018).

Deseases and Pests: Some commonly found fungal, bacterial, viral and pest related diseases in opium poppy are summarized below (Mishra *et al*., 2013):

Downy Mildew: The causal agent for this most serious and widely spread disease of opium poppy is Peronospora arborescens. The symptoms include hypertrophy and curvature of the stem and flower stalks. The infection starts spreading upwards from the lower leaves and the entire leaf surface gets covered by brown powder. The plants dies prematurely as the stem, branches and even capsules are also attacked by this causal organism. In India, the disease appears annually on the crop from seedling to maturity stage mainly in the areas of Madhya Pradesh, Uttar Pradesh and Rajasthan. Capsule formation is also adversely affected due to infection causing significant reduction in opium yield. The primary inoculum of the pathogen is oospore which is present in infested soil and leaf debris introgresses through underground plant parts and infects the plant giving rise to stunting and chlorotic syndrome etc in the fields of opium poppy (34). The major control measures of the disease include disinfection and spraying of the seed beds with 0.5% Bordeaux mixture and different copper containing fungicides. Some other control measures include use of Bisdithane (0.15%) followed by Benlate (0.05%), Gramisan, dusting with Thiram (Mishra *et al*., 2013).

Powdery Mildew: This disease is caused by Erysiphae polygoni and causes severe losses in opium production. It caused severe damage to poppy in Rajasthan in 1972. The symptoms appear in late stages of plant growth with white powder on the surface of leaves and capsules. The control measures include field sanitation along with spray of Spersul (0.5%) and seed disinfection (Mishra *et al*., 2013).

Collar Rot disease: This is one of the most severe fungal diseases of opium poppy caused by Rhizoctonia solani Kühn. Decline in seed yield, premature death of infected plant appears with the progress of disease in plants (Mishra *et al*., 2013).

Seed borne diseases: Seed borne diseases are also a curse to opium poppy crop both in terms of production and yield. The major effect of seed borne disease is on capsules and seeds only, which results reduction in germination percentage and seedling delays. Some commonly spreading seed borne diseases have been discussed (Mishra *et al*., 2013).

Leaf Blight (causal agent - Pleospora calvescens): Symptoms include defused yellow spots followed by premature drying of infected leaves. During the course of pathogenesis, toxins are released by the parasites enabling it to assimilate the requisite nutrient. High temperature and heavy rainfall favors the disease (Mishra *et al*., 2013).

Seedling Blight (causal agents - Phytium ultimum and Phytium mamimmatum): Few studies undertaken on characterization of the disease revealed that the disease affects physiological process in poppy. However, no control measures could be found with total control effects (Mishra *et al*., 2013).

Leaf Spots (causal agent - Helminthosporium sps.**):** The main symptoms include dechlorosis of the leaves accompanied by curling. The disease is not of much importance, but due to correlation between opium alkaloids and leaf spot, it may be considered harmful. Several control measures to control the disease include seed disinfection or spraying of seed beds with 0.5% Bordeaux or any other copper fungicides, incorporation of lime as $CaCO_3$ at 285 kg/ha, Systox, Ogranol, borate and manganese superphosphate, germisan, Gramisan and spray of Bavistin (Mishra *et al*., 2013).

Wilt & Root Rot (causal agent - Fusarium semitectum): This is another major problem in poppy cultivation where plants in advance stage rapidly wilt due to desiccation. The infection appears at the stem base followed by damping of roots. The disease causes reduction in opium yield and can be controlled only by the removal of infected plants (Mishra *et al*., 2013).

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