

## Most commonly plant exposures and intoxications from outdoor toxic plants

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### Abstract:

Over the past two decades, there has been an increased recognition of the importance of wild plant used as food and as source of micronutrients and plant secondary metabolites. Non-cultivated plants are perceived as important and healthy food, because many adults are often unaware of the toxicity of certain plants, or may consume them as a results of mistaking them for alternative herbs. The Poison Centre of Milan does issue an annual report that includes all the analyzed exposures and intoxications. The genera and plant species described in this paper are related to the high frequency of exposures or intoxications registered, and they are related to the survey of the 1995-2007 period. After examining all the data and consulting with the botanic experts, it is possible to affirm that picking an wild edible plant *versus* a poisonous one is serious business. In order to avoid some mistakes, a morphological comparison of edible plant species [that people would like to use as food] *versus* toxic plants which produced the poisoning, was summarized.

**Keywords:** *plant poisoning, wild plants, secondary metabolites, foraging behavior*

### Introduction:

Wild edible plants are found in all climates and terrains. Although most people don't choose to eat wild plants, there is also a new trend known as "foraging behavior", where people called "fregans" search for wild edible plants, not to survive but to be green and environmentally friendly. But there are many toxic plants that cause serious harm, that's why the Poison Control Center, Niguarda Hospital suggests to use caution when choosing outdoor wild plants [1]. Plants are valuable sources of food because they are widely available, easily procured, and in proper combination, can meet the nutritional needs. The critical factor in using plants for food is to avoid accidental poisoning. We have to eat only those plants we can positively identify and we know are safe to eat. It is important to remember that mainly flowering plants (so-called Higher Plants) produce thousands of ergastic compounds, the secondary metabolites (alkaloids, glycosides, flavonoids, anthocyanins, tannins, saponins, essential oils, *etc.*), which can be either useful or very noxious for human health. Many people currently believe that all natural substances are inherently safe and useful for human health, because they are not

"real drugs". Because of this we have seen an increasing number of poisoning cases, starting from the mid-90s to date [2 – 6]. Presently the wild plants are searched not only as medicine but also as food. The term *Phytoalimurgia* (*phyto*, from Greek = plant; *alim* = food; *urgia* = urgentia, famine, from Latin) was coined in times of true famine in Italy and in Old Europe, when agriculture was underdeveloped [7]. At present, the *Phytoalimurgia* is a new, rapidly increasing approach which mainly attracts educated people. In order to eat fresh or cooked herbs and plants, mainly during spring and summer, some people prefer to spend their free time outdoors, picking up wild vegetables without having sure knowledge of plant identification.

Many exposures and intoxications were due to wild plant ingestion, and occurred at spring time, when some people go looking for the so called "purifying herbs". Eating young leaves or light green shoots growing wild, and self-collected seems to be very important at the end of winter, in order to "purify the cells" from residues and toxins accumulated over winter. A lot of plants are indicated having "blood purifying qualities". Internally "purifying herbs" include: dandelion (*Taraxacum officinale*), Yellow Dock root (*Rumex crispus*),

Burdock (*Arctium lappa*) and are defined as “blood cleanser that stimulate lymph flow to remove toxins”. Such “purifying herbs” don’t exist. Purification is an act or instance of purifying or of being purified. To purify is to make pure : free from anything alien, extraneous, corrupting, polluting, or damaging [8]. Many people think that the “purification” is one of the biological activities in the human body.

In a previous retrospective evaluation, regarding a hospital-based study over a 12 year period (1995 – 2007), we defined a general survey of all exposures and intoxications due to plant poisoning that were documented in Poison Control Centre of Milan, Niguarda Ca’ Granda Hospital, Italy [1, 9]. The aim of this study was to obtain an overview of the more common and more relevant exposures reported to the Center and due to the outdoor wild plant used as food in traditional recipes and according the social behavior.

#### **Material and Methods:**

Exposure and intoxication data are obtained from the examination of anonymous medical files concerning expositions and/or intoxications registered by the Milan Poison Center Niguarda Hospital between 1995 and 2007. During the monitored period, the total recorded number of 12,363 case related to plant exposures and/or intoxications was recorded [1]. According to the International Programme of Chemical Safety (IPCS) inside the World Health Organization (WHO) Guidelines [10], the Poison Centre is a specialized unit providing information on poisoning, in principle to the whole community. Its main functions are provision of toxicological information and advice, management of poisoning cases, provision of laboratory analytical services, toxicovigilance activities, research, and education and training in the prevention and treatment of poisoning. To provide an effective information service and help in the prevention and management of the deleterious effects of toxic chemicals on

human health and the environment, it is essential for Poison Centers to cooperate closely with a wide range of partners, particularly with other professional and social institutions that can contribute to the effective provision of information by Poison Centers. For example, specialists in fields such as botany and zoology can assist in the rapid identification of toxic plants or animal species. In all cases of exposures, drugs and ingested quantities are hypothetically known from patient or family report. According to the presumed drug ingested, the physician has to evaluate the initial severity and the potential toxicity to define monitoring and treatment. In case of exposure with a plant, the cooperation between the physician and the botanist is important in order to identify the plant: the intoxication can be confirmed (or not) by the presence of one or more clinical findings. Only in a few cases, it was possible to have a correct specimen of the entire plant, including the root. Usually the sample for the identification was a plant fragment either fresh, cooked, dried, frozen, conserved in olive oil, in aromatized wine or a fragments obtained from the gastric content of died or survived patients. Accurate and rapid identification of a poisonous plant is essential for the rational management of a poisoned patient. In some cases we performed a remote rapid identification of a plant using on-line transmission of pictures taken with cell-phone camera.

#### **Results:**

The typical example of exposures or intoxication by mistaken identification of an edible plant species is the misidentification of plant species containing alkaloids, cardiac glycosides or essential oils (especially when ingested). Plant intoxications vary according to the season. A few plants may cause severe toxicity. Among many others, significant clinical features can result, *e.g.*, from the ingestion of daffodil bulbs, foxglove, holly, mistletoe or *Laburnum* seeds or

pods, lupine, oleander, autumn crocus, lily-of-the-valley, poison hemlock, English ivy, deadly nightshade, English holly, and yew leaves or seeds. However, sometimes it may be difficult to establish what exactly has been consumed.

Then it is important to define which plant the intoxicated people has thought to collect and then to eat. In Tables 1,2 and 3 the morphological characteristics of some edible plants that have poisonous look-alikes were summarized. The mentioned plants are the most frequent reported intoxication cases during the period 1995-2007 at Milan Poison Centre Hospital. Botanical details referring the exact identification of toxic plant species are intentionally omitted in an effort to avoid potentially dangerous errors in the identification.

The difficult of the proper identification of “wild asparagus”.

There are many unrelated plants called “asparagus”, some of which are toxic. When picking edible wild plants it is crucial that people properly identify them, because many are similar in appearance to poisonous plants. The optimum time to ensure proper identification is when the plants are flowering, since most have a unique appearance of flowers and fruits. In spring the problem is related to the difficulty of correctly identifying shoots of plants, because the *habitus* of the young plant is very different from that of the adult plant (usually described in botanical texts). It is therefore possible that people confuse the shoots of wild edible plants with those of some toxic plants since shoots are not so easily distinguishable : a mistake which can be deadly. People are looking for shoots, because they are tender and more rich in vitamins : the people suppose.

The problem to identify the shoots of a plant species is more evident in the herbaceous plants than in shrubs or trees. The aerial parts of most of the herbaceous plants in the North hemisphere die in winter and in spring the new shoots

sprouts from their roots. Growth in plants occurs chiefly at meristems where rapid mitosis provides new cells. As these cells differentiate, they provide new plant tissues. In stems, the apical meristem of the shoot apex produces by mitosis cells that enable the stem to grow longer and, periodically, produces some cells which differentiate in leaves. Then we have the true aspect of the adult plant, which can markedly differ from that of the young plantlet. In spring young shoots, young leaves and buds which are collected to make fresh salad or to be cooked may be responsible of intoxications.

Young buds are searched as “wild asparagus”, but this name is used to refer to a lot of plant species, not necessarily only to the *Asparagus* genus. The most frequent unrelated plants called “asparagus” are reported in Table 1. During the spring in Northern Italy many people collect, as edible plant, the shoots of *Aruncus dioicus* “wild asparagus” or “mountain asparagus”, Rosaceae family. This plant is largely consumed, so the local Authority in 1996 decided to protect the “wild asparagus”. In 1997 the same local Authority, taking into consideration the local use of this plant and making an exception to the regulations, decided that it was possible to collect for one’s private use some *A. dioicus* shoots. Then we can affirm that the harvest of “wild asparagus” can be a problem if we are not able to recognise the young buds in open fields or in the underbrush.

Indeed in the considered period, 1995 - 2007, 31 patients presented clinical features of Aconite poisoning following the ingestion of young shoots and leaves, that they suppose “wild asparagus”. The most severe intoxications - 1 dead and 15 intoxicated people – were registered in Northern Italy in 2005, when unfortunately young aconite buds were gathered as *Aruncus dioicus* [and / or *Lactuca alpina* (*Cicerbita alpina*)] shoots and then eaten as “mountain asparagus”.

**Table 1:** Related and unrelated plants called “asparagus” or said “to be used as asparagus” eaten for their shoots, in comparison to similar species, misidentified, that caused illness or death

Latin name	Vernacular name	Shoot morphology	Possible use as food	Metabolites	Exposures 1995-2007 period
<i>Asparagus officinalis</i> <i>Asparagus acutifolius</i>	Asparagus	Straight shoots, turion	Edible	Glycosides, flavonoids	edible plant
<i>Humulus lupulus</i>	Hop	Climbing young shoots of a perennial herb	Edible	Resin containing humulone	edible plant
<i>Ruscus aculeatus</i>	Butcher's broom	Young shoot, adult stem very hard	Moderately edible Southern Italy	Saponins, glycosides (ruscogenine)	107 cases
<i>Clematis vitalba</i>	Evergreen clematis, Exotic vine, Old man's beard	Perennial vine with climbing woody stems, recurved shoots	Young shoots cooked & used like hop shoots ( <i>Humulus lupulus</i> ), caution due to toxicity : caustic & irritant	Protoanemonin and saponins	3 cases
<i>Dioscorea communis</i>	Black bryony	Herbaceous vine in the yam family, shoots bowed down	Shoots moderately poisonous	Saponins	3 cases
<i>Aruncus dioicus</i>	Goat's beard, mountain asparagus	Light green shoots, reddish at bottom	Only young shoots edible	Trace amounts of saponins, cyanogenic glycosides in shoots	no problems for young shoots
<i>Phytolacca americana</i>	Pokeweed Pokeroot	Light green shoots	Toxic plant	Saponins, proteins, phytohaemagglutinin	54 cases
<i>Cytisus scoparius</i>	Common Broom	Dark green shoots, cylindrical, hard	Heart toxicity	Sparteine alkaloid	2 cases
<i>Spartium junceum</i>	Spanish broom	Dark green shoots, cylindrical, hard	Heart toxicity	Sparteine alkaloid	66 cases
<i>Aconitum</i> spp.	Aconite, monkshood, wolfsbane	Young buds, in May or June, high mountain Alps from West to East	Letal	Diterpene alkaloid, like aconitine	31 cases

The clinical picture of aconite poisoning was related to aconitine alkaloids and it was characterized by neurological, gastrointestinal and cardiac symptoms. Within 10 – 30 min from aconite ingestion, patients developed a tingling, burning sensation in their tongue, lips and whole mouth, gradually extending to their arms and entire body, accompanied by a feeling of cold and of being very sick. Nausea, vomiting and diarrhoea were present and various cardiac abnormalities

and severe dysrhythmias have been reported, fatal for one patient.

Young buds of Common Broom, *Cytisus scoparius* syn. *Sarothamnus scoparius*, some weeks before blooming, were collected and eaten as “asparagus shoots”, despite the fact that they are very hard and woody. *C. scoparius* is a perennial, leguminous shrub from western and central Europe in the area that goes from the Iberian Peninsula to the southern part of the Scandinavian Peninsula.

**Table 2:** Shoots and/or young leaves of wild plants consumed as food and similar species, misidentified, that caused illness or death

Wild plant consumed as food	Use as food	Harvesting time	Plant misidentification	Exposures 1995-2007 period
Nettle <i>Urtica dioica</i> <i>Urtica urens</i>	Soup / omelette / rice	Early spring	It isn't liable to be confused	-----
Bears' garlic <i>Allium ursinum</i>	Soup / omelette / ravioli	Early spring only green leaves bloom in May	Lily-of-the-valley <i>Convallaria majalis</i>	29 cases
Bears' garlic <i>Allium ursinum</i>	Soup / omelette / ravioli	Early spring only green leaves bloom in Autumn	Autumn crocus <i>Colchicum autumnale</i> <i>Colchicum luteum</i> <i>Colchicum napolitanum</i>	11 cases
<i>Taraxacum officinale</i> s.l. / <i>Cichorium intybus</i> / <i>Cicerbita alpina</i>	Raw or boiled salad / vegetable material preserved in oil	Early spring	<i>Colchicum</i> sp.  Wolf's bane or Monkshhod <i>Aconitum napellus</i> <i>Aconitum neomontanum</i> <i>Aconitum vulgare</i> <i>Aconitum variegatum</i>	6 cases  31 cases
Borage <i>Borago officinalis</i>	Soup / omelette / ravioli	Spring	Foxglove <i>Digitalis</i> sp. <i>Digitalis purpurea</i>  <i>Mandragora autumnalis</i> (in Sicily, Southern Italy)	6 cases  50 cases
Sweet fennel <i>Foeniculum vulgare</i>	Fresh salad / cooked vegetables	Spring	Poison hemlock <i>Conium maculatum</i>	2 cases

It grows in sunny areas, with dry, sandy soil, and at low altitudes [11]. *C. scoparius* tops contain sparteine and cytisine, bitter alkaloids once used in cardiac arrhythmias and to raise blood pressure in hypotonia. These two alkaloids are cardiotoxic and block autonomic ganglia. Sparteine exerts a curare-like activity causing respiratory failure by paralyzing the respiratory muscles. Nowadays the clinical use of these alkaloids has been abandoned because of their high toxicity and of the fact that sparteine is not FDA approved for human use as an antiarrhythmic agent. Consequently, the ingestion of *C. scoparius* tops as "asparagus" shoots

endangers the heart functionality. Sparteine has well known effects on the electrical conductivity of the heart (similar to type 1A antiarrhythmic drugs such as quinidine) and can potentially cause dangerous heart rhythms or interact with cardiac drugs. Sparteine is also known to cause uterine contractions, and should be avoided during pregnancy [12]. It is important to remember that a lot of the leguminous plants produce toxic alkaloids related to these of *C. scoparius*: Spanish Broom (*Spartium junceum*) 68 cases registered, golden chain (*Laburnum anagyroides*) 42 cases, and alpine golden

**Table 3:** The most frequent misidentification of roots, berries, flowers and leaves that caused illness or death

Edible plant	Used part	Purpose	Wrong plant	Harvesting time	Exposures 1995-2007 period
Gentian <i>Gentiana lutea</i> <i>Gentiana purpurea</i>	Roots	homemade aromatic brandy & wine	White hellebore <i>Veratrum viride</i>  False hellebore <i>Veratrum lobelianum</i>	Autumn	4 cases
Bilberry ( short woody shrub) <i>Vaccinium myrtillus</i>	Blue / Violet berry	homemade aromatic brandy & “grappa”	Deadly nightshade <i>Atropa belladonna</i>	Summer	3 cases
Wild strawberry <i>Fragaria vesca</i>	Red fruit	fruit salad & cakes	Indian strawberry <i>Potentilla indica</i>	Summer	11 cases
Firethorn <i>Hippophaë fluviatilis</i>	Red fruit	fruit of the forest	Firethorn <i>Pyracantha coccinea</i>	Summer / Autumn	1 case (berries) 136 cases berries & leaves
Laurel <i>Laurus nobilis</i>	Coriaceous, hard, green leaves	to make aromatic meat	Cherry laurel <i>Prunus laurocerasus</i>	All seasons	147 cases
Elderberry <i>Sambucus nigra</i>	Flowers, fruits & seeds	jam, fritters	Wild elder <i>Sambucus racemosa</i> <i>Sambucus ebulus</i>	Summer	140 cases

chain *L. alpinum*, fresh lupine (*Lupinus albus*) and all the green parts of black locust *Robinia pseudoacacia*-(4 cases) and other similar plants are toxic.

Leaves of wild plants collected during spring for food purposes.

Bear’s garlic, *Allium ursinum*, growing wild in fens and river woods of Northern Italy and Central Europe, is used in local cuisines. In spring, its leaves are collected and used raw to flavour spreads based on cottage cheese, soups and sauces. Dried leaves usually have a very faint odour. In Italy and in other parts of Central Europe, bear’s garlic has increased dramatically in popularity within the last few years. While bear’s garlic was formerly known only to a few in eat-wild-plant-communities, today hardly any of the haute-cuisine-chefs will miss the opportunity to create new recipes

using this herb and offer them to their guests during the all-too-short season. Since bear’s garlic became widely and favorably known, many people have tried to pick the plant in the wild. Several cases of poisoning have been reported in the last years, since there are some toxic plants with roughly similar leaves (Table II), particularly the lily-of-the-valley (*Convallaria majalis*) (29 cases) and the autumn crocus (meadow saffron, naked ladies, *Colchicum autumnale*, Colchicaceae) (11 cases: 2 deadly ones). Both plants do not show even traces of garlic odour, and similarities are in the best of cases superficial, or even non-existent. The Lily-of-the-valley, *C. majalis*, contains convallarin and related cardioactive glycosides with physiological effects similar to those of the *Digitalis*, but

their concentration in the leaves is comparatively small, and, as a consequence, life-threatening conditions due to poisoning rarely occur. The situation is different when we consider the autumn crocus. All its parts are rich in colchicine, a highly toxic alkaloid. Colchicine poisoning very often takes lethal course.

Borage (*Borago officinalis*), starflower, is an annual herb originating in the Mediterranean region but naturalized throughout most of Europe and North Africa. Its leaves have been found to contain small amounts (10 ppm d/w) of the liver-toxic pyrrolizidine alkaloids. They taste like fresh vegetables and are used in salads and soups especially in spring and summer. One of the most known recipes with borage in Italy is the vegetable ravioli (Table 2). Of the calls relating to plant poisoning made to the Poison Control Centre of Milan over the years 1995 – 2007, 50 cases were of patients with toxic anticholinergic symptoms after accidental ingestion of *Mandragora autumnalis* family Solanaceae [the family of *Atropa belladonna* (116 cases inclusive of intentional ingestion), *Datura* s.l. (102 cases inclusive of intentional ingestion) and *Hyoscyamus niger*]. The patients unintentionally ate *M. autumnalis* leaves, mistaking this plant for the edible *Borago officinalis*. Both plants grow in sunny Mediterranean areas, have similar leaves and small, blue violet flowers with five lobes, but their stem and scape are different. In *B. officinalis* a flower stalk grows directly from the ground whereas, in *M. autumnalis* such stalk is absent and there are small rosettes of leaves near the ground. However, despite of such differences the two species may be easily confused by an inexperienced picker.

Some accidental intoxications (23 cases) occurred in Italy during the monitored period 1995 – 2007, due to *Aethusa cynapium* or *Conium maculatum* (poison hemlock) ingestion. *C. maculatum* leaves were confused and collected as

*Foeniculum vulgare* (sweet fennel), commonly used as spice /fresh salad / cooked vegetable in Italy (Table II). *C. maculatum* contains high concentrations of piperidine alkaloids very toxic for people: coniine, N-methylconiine, conhydrine, pseudoconhydrine and  $\gamma$ -coniceine. The intoxicated people had the first symptoms few hour after the ingestion : nausea, painful leg cramps, dilated and unresponsive pupils and dizziness.

Roots of wild plants used for aromatize home-made distilled products.

Some intoxications have been registered (2 cases) due to the presence of *Veratrum album* and / or *V. album* subsp. *lobelianum* roots inside a home-made distilled and aromatised brandy. In Northern Italy, mainly in the mountains, a distilled brandy named “grappa” is prepared by distilling a fermented grape pomace. This clear, or white brandy is usually very strong and pungent. Frequently it is aromatized by soaking medicinal plants in it, such as *Gentiana lutea* roots, otherwise known as gentian root or bitter root (Table 3). These roots have to be harvested in autumn, when the yellow flowers disappeared and its leaves go brown. In this period, unfortunately, the stem and the leaves of gentians are very similar to those of *Veratrum* species, plants containing toxic alkaloids, such as veratrine and veratridine [13]. Veratridine is a steroid-derived alkaloid that functions as a neurotoxin by activating the sodium ion channels. It binds to intramembrane receptor site 2 and increasing intracellular  $Ca^{2+}$  concentration. It acts by preferentially binding to activated  $Na^+$  channels causing persistent activation. *V. lobelianum* alkaloids have a paralyzing effect on the nervous system. The alcohol fraction of the brandy it is able to extract the toxic alkaloids from the roots and the “grappa” become toxic. The dried root has a faint, unpleasant odour, and a sweetish, bitter, and then intensely disagreeable, and permanently acrid taste, leaving the tongue tingling and numb. Several illnesses due to accidental use of

*Veratrum* in home-made gentian wine or grappa have been reported in recent years. *Veratrum* alkaloids act as a very violent and irritant poison. Vertigo, weakness, and tremors of the extremities, feeble pulse, loss of voice, dilatation of pupils, spasms of the ocular muscles, blindness, cold sweating, and mental disturbances are also produced. When it proves fatal, narcotic symptoms, such as prolonged stupor and convulsions, are evident. Gastro-intestinal inflammation has also been produced by it. When not fatal, distressing precordial oppression persists for some time, together with nervous and spasmodic symptoms and prolonged debility.

Frequently, the “grappa” is aromatized by the addition of blueberry berries (*Vaccinium myrtillus*). Unfortunately it happened that the berries of the *Atropa belladonna* were harvested as *Vaccinium myrtillus* (3 cases). *Atropa belladonna*, family Solanaceae, an herbaceous European plant with reddish bell-shaped flowers and shining blue/violet berries, contains tropane alkaloids hyoscyamine, atropine and scopolamine as main compounds (Table 3). If the *A. belladonna* berries are used to aromatise the grappa, the alcohol of the brandy is able to extract the toxic alkaloids. Toxicity symptoms include skin rash, skin flushing, mouth dryness and difficulty in urination, eye pain, blurred vision, and light sensitivity : the classic anti-cholinergic symptoms.

#### Conclusions:

Many edible plants have poisonous parts or some plants are edible when young, but become toxic later on. It is believed they evolved to produce poison to protect themselves from browsing animals and plant-eating insects. It is important to learn to identify poisonous plants in the house, yard, and neighborhood. The plants are everywhere: garden plants, wild flowers, spices, ornamental trees and houseplants. Foraging for edible wild plants constitutes a relaxing hobby, and on a more subtle level, introduces the hobbyist to an extraordinary range of new tastes and

textures. All people should feel secure in the natural environment. Knowledge of plants helps dispel ignorance and the feelings of helplessness which ignorance promotes. According to the Poison Control Centre of Milan Hospital survey [1] and the 2008 Annual Report of the American Association of Poison Control Centers [14] the plant exposures and intoxications are ca. 2.5 % of total cases. A few commonly grown plants are highly poisonous (e.g. castor beans, oleander, foxglove, hemlock, autumn crocus, monkshood), and many are moderately poisonous, but few plant poisonings have specific antidotes.

Accurate identification, of course, is the key to finding the appropriate plants and avoiding toxic species : it is essential for users to be certain of the reliability of identification and naming of wild food plants [15].

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