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MECHANISMS OF THE TOXIC EFFECTS OF *DRACAENA* COMPOUNDS ON CATS AND THE CONCEPT OF THERAPEUTIC MEASURES (LITERATURE REVIEW)

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Summary. Due to their external characteristics, ability to reduce bisphenol A, formaldehyde, toluene, and xylene levels in the air, and lack of special growing requirements, *Dracaena* plants are used for interior landscaping in residential and office spaces. The most common species are *D. fragrans*, *D. surculosa*, and *D. sanderiana*. *Dracaena* is placed indoors in bright areas where cats rest. The presence of a pleasant, specific odor when the leaves or flowers are damaged, due to the presence of multicomponent essential oils that irritate the senses, promotes the chewing of plant parts by companion animals. Consequently, veterinarians have recently reported an increase in cases of cat poisoning caused by *Dracaena* species. The study aims to analyze scientific studies of the content of toxic substances in *Dracaena* and their toxicodynamics in the organism of companion animals. Dhar, Maji and Ghosh (2013), Julsrigival, Julsrigival and Chansakaow (2020) and Ye et al. (2021) report on the spectrum of chemicals found in the flowers of *D. fragrans*. Julsrigival, Julsrigival and Chansakaow (2020) used solid-phase microextraction followed by gas chromatography-mass spectrometry identification to isolate 30 chemicals from *Dracaena* flowers overnight. Only eight of these chemicals (benzyl alcohol, phenylethyl alcohol, cinnamaldehyde, 3-hydroxyl-4-4-phenyl-2-2-butanone, methylene glycol, α-bergamotene, α-farnesene, and tetradecanal) were found in amounts greater than 4%. The amount of each substance varied depending on the time of day. The plant synthesized most of the substances from 8 p. m. to 10 a. m. During the day, however, α-farnesene was dominant at 23.1–50.8%. It has a green apple smell, and the LD_{50} for rats when ingested orally is 1.5 g/kg body weight, and for rabbits when applied dermally is > 5 g/kg body weight. In general, all the substances identified by scientists have a local irritating effect and are low-toxic. In 2010, Calderón et al. reported that *D. fragrans* contains substances with anticholinesterase activity that excite M- and H-cholinergic receptors in animals. Therefore, the specific antidotes are acetylcholinesterase reagents or a 1% atropine sulfate solution administered subcutaneously. In the scientific articles by Zheng et al. (2004) and Rezgui et al. (2015), it was published that all species of the genus *Dracaena* contain steroidal saponins. Xu et al. (2010) identified six new representatives of angudrakanosides A-F in the stems of *D. angustifolia*. Steroidal saponins are irritating and cause lacrimation, vomiting, and diarrhea. They form insoluble complexes with proteins and binders. Therefore, the goal of antidote therapy for suspected *Dracaena* poisoning is to reduce irritation caused by essential oils and steroidal saponins, as well as to restore the functional state of M- and H-cholinergic receptors

Keywords: *Dracaena fragrans*, α-farnesene, acetylcholesterase inhibitors, steroidal saponins, essential oils

Introduction. Modern life is comfortable, and for additional coziness, many people grow indoor flowers and keep companion animals. Different types of *Dracaena* are nowadays often used for interior landscaping. The book 'Encyclopedia of Garden and Indoor Plants' (Anufriieva, 2013) contains its botanical characteristics.

Additionally, Mabberley (2017) published that *Dracaena* is an evergreen, perennial with lanceolate or elongated-oval leaves. A special feature is the different colors and arrangement of the leaves depending on the species.

Anufriieva (2013) notes that 40 species of plants are used in the *Dracaena* genus for growing in greenhouses and only 10 — for indoor growing.

Dracaena fragrans is of great interest to scientists and florists alike. According to Julsrigival, Julsrigival and Chansakaow (2020), this species is a common ornamental plant used indoors in Thailand.

Bos et al. (1992) highlight the distribution regions of *Dracaena* species, their cultivation features, and the detailed botanical characteristics of over 15 species. The authors write in particular about *D. fragrans* Compacta, which has internodes from 5 to 10 mm. Its leaves are elongated or narrowly elongated and leathery. They gradually taper from the middle to a sharply pointed apex and are sometimes bent downward to varying degrees. The surface is glossy, moderately glossy, or matte. The surface may have shallow furrows and longitudinal stripes in shades of yellow, white, green, or grayish-green. The inflorescence is unbranched or has heavily crowded short branches. The authors note that the standard variety, *D. fragrans* Compacta, is also known as *D. deremensis* Compacta or *D. deremensis*.

It is interesting to note that *D. fragrans* got its name due to the pleasant and extremely strong smell of freshly cut grass released from the leaves (Roslynnyi Dim, 2025).

According to the 'Encyclopedia of Garden and Indoor Plants' (Anufriieva, 2013), indoor plants should be placed on windowsills that receive plenty of light. The book describes several species of *Dracaena*, including *D. fragrans*, *D. fragrans* Compacta (= *D. deremensis*), *D. surculosa*, *D. sanderiana*, and *D. reflexa var. angustifolia* (= *D. marginata*) (Fig. 1a–e).

Dracaena Tornado (Fig. 1f) is a hybrid species of *D. fragrans*. The species got its name because of the appearance of the plant's leaves, which are long, curved, and twisted into a spiral.

Figure 1. *Dracaena* species: a — *D. fragrans*; b — *D. deremensis* (photo from fleurplants.com.ua); c — *D. surculosa* (photo from eliteflowers.com.ua); d — *D. sanderiana* (photo from thursd.com); e — *D. reflexa* var. *angustifolia* (= *D. marginata*) (photo from frondlyplants.com); f — *D. fragrans* Tornado (photo from floren.com.ua).

The dark green color of the leaves with a bright light green edge, glossy surface, and low maintenance make the bush attractive to people and used for interior design. This, in turn, increases the likelihood of cats contacting this type of dracaena.

Julsrigival, Julsrigival and Chansakaow (2020) report that *Dracaena* flowers very rarely. Thus, the Thais believe that the plant's production of an inflorescence is a harbinger of good luck and fortune for the owner. This belief led to the plant being called the 'plant of happiness' by the people.

The botanical characteristics, unpretentious growth, and presence of essential oils make *Dracaena* interesting to florists, interior designers, and scientists. Due to the plant's biological characteristics, owners of *Dracaena* species typically place them on windowsills or in sunny areas of their homes. These locations are attractive to cats, who like to relax there. This causes cats to damage the leaves, leading to varying degrees of poisoning, especially in cities. Therefore, on the internet and official clinic websites, veterinarians publish informative articles highlighting the possibility of *Dracaena* poisoning in cats. Considering the industrial need for scientific evidence of the toxicological significance of *Dracaena* species for cats, we conducted a literature analysis on the presence of toxic substances in the plant.

This study **aims** to analyze scientific research on the presence of toxic substances in *Dracaena* and their toxicodynamics in companion animal organisms.

Materials for the study were published articles and books reporting the results of scientific research on the chemical content of various parts of *Dracaena* plants.

Results and discussion. Julsrigival, Julsrigival and Chansakaow (2020) and Ye et al. (2021) inform about the chemical composition of *Dracaena* parts (inflorescences, leaves), which can be used as plant material for the development of new and improvement of existing cosmetic and medical products.

Lacroix et al. (2011) and Moshi, Otieno and Weisheit (2012) report that *D. fragrans* is a plant used in folk medicine, and Kamatenesi-Mugisha and Oryem-Origa (2007) and Lacroix et al. (2011) inform about its antimalarial effect.

Wolverton (1997) and Saiyood et al. (2010) reported that *D. fragrans* can reduce the content of bisphenol A, formaldehyde, toluene, and xylene in the air.

Considering the pharmacological effects of *D. fragrans* and its value in medicine and other industries, Lu and Morden (2014) performed a phylogenetic analysis of 95 *Dracaena*, *Pleomele*, and *Sansevieria* species. Their results, published in the paper 'Phylogenetic Relationships among Dracaenoid Genera (Asparagaceae: Nolinoideae) Inferred from Chloroplast DNA Loci', suggest that *Sansevieria* should be recognized as a species of *Dracaena*.

In other words, modern genetic research methods make it possible to establish the species affiliation of related plant genera, thus increasing the number of *Dracaena* species.

A distinctive biological trait of *D. fragrans* is its nocturnal blooming pattern, where its fragrant flowers only open during the nighttime hours. Dhar, Maji and Ghosh (2013) and Julsrigival, Julsrigival and Chansakaow (2020) report that the chemical composition of the flower fragrance varies throughout the day. Julsrigival, Julsrigival and Chansakaow (2020) studied the change in the amount of volatile chemicals from the flowers of fragrant dracaena during the day. The flowers were sampled every two hours. The researchers employed a method known as solid-phase microextraction, followed by identification through gas chromatography-mass spectrometry. A total of 30 volatile compounds were identified, grouped into eight categories: aldehydes (maximum accumulation in flowers at 6–8 a. m.), alcohols (maximum amount 6 p. m.–4 a. m.), esters (10 a. m.–4 p. m.), ketones (6 p. m.–4 a. m.), monoterpenes (12 p. m.–2 p. m.), sesquiterpenes (6–8 a. m.), phenylpropenes (12–6 p. m.), and other substances (10–8 p. m.). All groups of substances were detected in the samples during the day, with the maximum amount occurring in the hours indicated in parentheses.

Regardless of the time of day, the authors found that the flowers and buds of *D. fragrans* contained the following compounds: benzyl alcohol, phenylethyl alcohol, cinnamon alcohol, 3-hydroxyl-4-4-phenyl-2-2-butanone, methyleugenol, α-bergamotene, α-farnesene, and tetradecanal. Alpha-farnesene was the predominant compound in all sampling periods (23.1%–50.8%). During the flowering period from 6 p. m. to 10 a. m., the predominant compounds were 2-pentylfuran, β-ocimene, benzene aldehyde, linalool oxide, linalool, 2,6-nonadienal, 2-nonenol, and 2,4-decadienal. These compounds increased significantly at night, including 2-pentylfuran, linalool oxide, linalool, and 2-nonenal.

The maximum synthesis is from 6 to 10 a. m. (maximum 8 a. m.), with linalool oxide (4.8%) and linalool from 2 a. m. to 10 a. m. (maximum 10 a. m.) (3.1%). From the data presented in the article by Julsrigival, Julsrigival and Chansakaow (2020), some volatile chemicals (pentyl furan; 2,6-nanodienal, (E, Z)-; nonet-1-al; 2-nonenol, (E)-) were not registered in the samples from 12 a. m. to 6 p. m., at 6 p. m. a small amount of linalool was detected, at 8 p. m. — a twofold increase in linalool and traces of linalool oxide and 2,6-nanodiunal, (E, Z)-, at 10 p. m. — all these substances were synthesized with an increase in the amount of linalool and its maximum at 10 a. m.

Cinnamyl acetate was synthesized from 10 a. m. to 4 p. m., and 1-dodecanol was synthesized from 12 p. m. to 4 p. m.

Based on the results of scientific studies by Julsrigival, Julsrigival and Chansakaow (2020) regarding the presence of volatile substances in *D. fragrans* flowers and the chemical characteristics of available sources, we compiled a table (Table 1) on the degree of toxicity of some isolated substances whose content exceeded 4% at certain times of day. We also determined and substantiated their toxicodynamics.

α-Farnesene is the dominant substance in the flowers of *Actinidia deliciosa* (Nieuwenhuizen et al., 2009), *Lonicera japonica* (Schlotzhauer et al., 1996) and *Murraya exotica* (Raina et al., 2005).

Published data on the constituents of *D. fragrans* buds and flowers suggest the presence of synergistic effects among the substances present in the highest concentrations. After all, the published characteristics of the chemically pure compounds listed in the table for each substance indicate irritating properties. However, toxicological studies have only been conducted to determine the LD_{50} for oral administration to rats for a few of the dominant substances. It should be noted that all substances in the table in this article are marked with GHS07 (irritants) and are low-toxicity.

Calderón et al. (2010) reported that substances from *D. fragrans* may act as an acetylcholinesterase inhibitor. The toxicodynamics consist of blocking acetylcholinesterase in the intersynaptic clefts of the parasympathetic division of the peripheral nervous system. This is clinically manifested as nicotine and muscarinic effects. These findings can explain general depression, bradycardia, epigastric pain, and abdominal wall tension upon palpation.

Taking into account the toxicological characteristics of *D. fragrans* components, it is advisable to include medicines in the treatment regimen:

— enterosorbents form insoluble complexes with toxic substances and are effective at any stage;

— enveloping (mucous) or astringent agents, such as a decoction of oak bark, gray alder cones, or plantain, which reduce the irritating effect of substances identified by Julsrigival, Julsrigival and Chansakaow (2020) and slow the absorption rate of substances with anticholinesterase activity. These preparations can be prescribed if the animal is experiencing initial stages of poisoning (e. g., recent gnawing, depression, or vomiting, with a deteriorating but not critical condition). In cases

Table 1 — Description of the significant constituents of *Dracaena fragrans* essential oils from the flowers and saponins from the bark and leaves

Constituent	Localization in nature	Use	Toxicological effect	LD_{50}, oral
Benzyl alcohol	A component of the essential oils of jasmine, hyacinth, etc.	Flavoring agent for cosmetics, detergents	Pure — causes corneal necrosis (Kulkarni and Mehendale, 2005). Toxic doses cause respiratory arrest, vasodilation, hypotension, convulsions, and paralysis (Brühne and Wright, 2000)	For rats — 1.25 g/kg
Phenylethyl alcohol, $C_8H_{10}O$	Contained in rose and geranium essential oils. An important component of perfumes	Preservative in dosage forms for the eyes, nose and ears. It has bactericidal properties (Rybachuk, 2016)	—	—
Cinnamon alcohol, $C_9H_{10}O$	Only in combination with essential oils of hyacinth, Peruvian balsam	Flavoring agent for cosmetics, soaps, food products to create strawberry, lemon, peach, apricot, cognac flavors, intermediate in the synthesis of streptomycin, plasticizer for plastics	Skin and/or eye irritant; mutagenicity: DNA repair test: *Bacillus subtilis* 10 mg/disc (BDMAEE, 2024)	For rats — 2 g/kg; for rabbits — ≥ 5 g/kg; for mice — 2,675 mg/kg (BDMAEE, 2024)
3-hydroxyl-4-4phenyl-2-butanone, C_4H_8O	—	—	—	—
Eugenol	A component of essential oils of clove (80–90%), nutmeg, cinnamon, bay leaves, basil. It attracts males of the Euglossini species (NCBI, 2021)	It has a clove-like odor and is a flavoring agent in perfumes, cosmetics, and cooking. Vanillin is produced from eugenol. Dentistry. It has anesthetic and analgesic properties. It is eliminated from the body within a day	It is hepatotoxic (Eugenol (Clove Oil), 2019). Eugenol increases histamine release (NCBI, 2021). In case of poisoning: hematuria, nausea, diarrhea, dizziness, tachycardia, renal dysfunction (Heller and Zieve, 2010). Antidote — N-acetylcysteine	—
α-berga-motene	Component of essential oils of plants	Flavoring agent	—	—
α-farnesene	In the peel of apples, giving the aroma of green apples, in essential oils of orange, rose	Flavoring for perfumes, household chemicals	—	For rats — 1.5 g/kg; for rabbits dermally — > 5 g/kg
Tetra-decanal (myristyl alcohol)	Component of nutmeg	Component of cold cosmetic creams due to its emollient properties	Used on the skin — a consequence of a tumor. Symptoms are not described, only the LD_{50} is given	For rats — > 5 g/kg (Noweck and Grafahrend, 2006)
Steroid saponins	Components of foxglove purpurea leaves, less in lily of the valley (saponin conalarin), snowdrop, narcissus, snowflakes, Orobanche cumana, tobacco, jimsonweed, Mandragora, etc.	They have fungicidal and antitumor activity. The drug polysponin (made from *Dioscorea*) is used to treat atherosclerosis due to its cholesterol-lowering effect	Locally — irritation, after absorption, a hemolytic effect is possible	The minimum lethal dose of digitalis is 2.25 g. The actual LD of steroid saponins for laboratory animals was not found in the literature

of severe clinical conditions and depression, however, they will not be effective;

— intravenous blood substitutes and crystalloids can be used to have a diuretic effect because essential oils are mainly eliminated from the body by the urinary and respiratory systems and, to a lesser extent, the digestive system;

— in cases of anticholinesterase action, acetylcholinesterase inhibitors are effective. If they are unavailable, it is advisable to use atropine sulfate solution at therapeutic doses for the animal species. The active substance's pharmacodynamics will provide M-cholinolytic action and restore the physiological function of M-cholinergic receptors in the body.

In the scientific articles by Zheng et al. (2004) it is reported that all species of the genus *Dracaena* belonging to the family Asparagaceae contain steroid saponins. Xu et al. (2010) published data that new steroid saponins were isolated in the stem of *D. angustifolia*: angudrakanosides A–F (six in total).

Rezgui et al. (2015) reported that 15 steroid saponins were isolated in the study of chemical components of the bark and roots of *D. angustifolia*.

Rybachuk and Halatiuk (2022) report that consuming plants containing steroid saponins orally can cause vomiting and diarrhea due to irritation of the gastric and intestinal mucosa. Therefore, if such clinical signs appear after eating or gnawing on the leaves of various *Dracaena* species, it is necessary to administer antiemetics (such as ondansetron solution for injection in cases of debilitating vomiting) followed by protein solutions or astringents. Note that saponins form complexes with proteins, lipids, sterols, and tannins. If there is contact with the mucous membranes of the upper respiratory tract (e. g., coughing or sneezing) or the eyes (e. g., lacrimation), rinse with isotonic crystalloid solutions (e. g., sodium chloride solution at 0.9% or glucose solution at 5%).

If hemolytic effects occur, administer intravenous neohemodesis, detox, rheosorbilact, etc., as there are no specific antidotes.

Using dosage forms and drugs in the proposed complex therapy will quickly eliminate the toxic effects of *Dracaena* substances in an animal's body.

Conclusions. The flowers and buds of *Dracaena fragrans* contain low-toxic, locally irritating substances: benzyl alcohol, phenylethyl alcohol, cinnamon alcohol, 3-hydroxyl-4-4-phenyl-2-2-butanone, methyleugenol, α-bergamotene, α-farnesene, and tetradecanal.

The leaves and bark contain steroid saponins, which cause local irritation, as well as anticholinesterase substances that lead to overstimulation of parasympathetic synapses.

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