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Journal
Journal of Medical Toxicology, 17(1)

ISSN
1556-9039

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Publication Date
2021

DOI
10.1007/s13181-020-00805-4

Peer reviewed

Journal of Medical Toxicology (2021) 17:57–60
https://doi.org/10.1007/s13181-020-00805-4

ORIGINAL ARTICLE

Negligible Oleandrin Content of Hot Dogs Cooked on *Nerium oleander* Skewers

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Received: 7 July 2020 / Revised: 5 August 2020 / Accepted: 6 August 2020 / Published online: 14 August 2020

Abstract

Introduction The *Nerium oleander* plant contains cardenolides that may cause human poisoning when ingested. A long-standing belief holds that it is possible to be poisoned by eating hot dogs or other foods cooked on *Nerium oleander* branch skewers. Oleandrin levels in frankfurters cooked on fresh and dry *Nerium oleander* skewers were measured.

Methods Hot dogs were cooked separately on either dried or fresh oleander branch skewers using a disposable charcoal grill. The hot dogs were then frozen and transported to an analytical laboratory where oleandrin content was measured via liquid chromatography/mass spectroscopy (LC/MS).

Results The oleandrin content of hot dogs cooked on dried and fresh skewers did not exceed 343 ng and 701 ng, respectively.

Conclusion Hot dogs cooked on *Nerium oleander* skewers contain a negligible amount of oleandrin with respect to that sufficient to cause human poisoning. Reports of poisonings occurring in this manner are most likely the result of an urban myth.

Keywords *Nerium oleander* · Oleandrin · Cardenolide · Cardiac glycoside

Background

Nerium oleander is a flowering shrub that is highly prevalent in the Southern United States and is found in other subtropical and tropical locations. It is fast-growing and densely branched, which makes it a popular addition to many landscapes [1]. However, *Nerium oleander* is also highly toxic given the presence of many cardiac glycosides in its leaves, flowers, and branches [2]. Oleandrin is the primary cardiac glycoside present in *Nerium oleander* [3].

Common popular opinion and multiple sources in the medical literature report that poisoning may occur by consuming food cooked on oleander (*Nerium oleander*) branches used as skewers [2, 4–7]. As recently as 2006, the cardiac glycoside chapter in *Goldfrank's Toxicologic Emergencies* (8th edition) mentions poisoning due to consumption of food cooked on oleander as a possibility [2]. Modern case reports have demonstrated toxicity from purposefully ingesting oleander leaves or decoctions, including in teas and in regional stews [8–10]. The only published reports we could identify of alleged oleander toxicity via a skewered-food mechanism occurred in the nineteenth century and include few clinical details and no analytical laboratory results [11, 12]. The lack of any well-documented poisonings through cooking food on oleander branches suggests that the assumption such poisonings do occur contributes to an urban myth.

If the amount of oleandrin transferred into food cooked on *Nerium oleander* skewers is high enough, then poisonings might conceivably occur through this mechanism, whether well-documented cases exist in the medical literature or not. This study aimed to determine how much oleandrin is found in hot dogs grilled using oleander branches as skewers.

Methods

Eight hot dogs (Hebrew National Beef Franks, ConAgra Foods, Omaha NE) were skewered their full length on branches of freshly cut and dried *Nerium oleander* (4 each). A disposable charcoal barbecue (Instant Grill, Consumer

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Products Inc., Cartersville GA) was prepared and ignited according to manufacturer instructions. One non-skewered hot dog was cooked as a control, then the hot dogs on dried branches were cooked, and then the hot dogs on freshly cut branches were cooked; this order was chosen to minimize potential cross-contamination of oleandrin-containing material between samples and the barbecue grill.

The cooked hot dogs were placed in individual airtight plastic bags and frozen. A total of 9 samples were prepared: 1 control, 4 dried branch-cooked samples, and 4 freshly cut branch-cooked samples. The hot dogs were kept frozen during transport to the analytical laboratory (California Animal Health and Food Safety Laboratory, Davis CA). In the laboratory, the hot dogs were thawed, and each sample was individually homogenized. A portion of each homogenized sample was analyzed for oleandrin content (in ppb) by LC/MS, using analytical grade oleandrin (previously supplied by, but no longer available from, Sigma Chemical Company, St. Louis MO) as a standard. It should also be noted that existing LC/MS methodologies had to be amended due to the high lipid and pigment content of the hot dogs. This study did not require IRB review, as it did not involve any human subjects.

Results

The hot dogs cooked on freshly cut oleander skewers contained a mean of 7.0 ppb of oleandrin with a SD of 2.1 ppb (range: 5.2–10 ppb). The hot dogs cooked on dried skewers contained a mean of 14.3 ppb oleandrin with a SD of 8.8 (range: 7.5–27 ppb). The control hot dog contained less than 1 ppb oleandrin, which was the detection limit for this assay. Since the hot dogs weighed 49 g before grilling, the average oleandrin content of an entire hot dog did not exceed 343 ng in hot dogs cooked on a freshly cut oleander skewer and did not exceed 701 ng in hot dogs cooked on a dried oleander skewer.

The analytical lab noted that LC/MS analysis also detected trace amounts of additional cardenolides (e.g., nerigoside) in the hot dog samples, but these could not be positively identified nor quantified due to lack of analytical standards for these compounds.

Discussion

There was a difference in oleandrin content found in hot dogs cooked on dried versus fresh oleander skewers (14 ppb versus 7 ppb, respectively). This is likely due to the dilution of oleandrin in fresh branches by their water content, compared with the dry skewers in which the oleandrin was more concentrated at the time of hot dog cooking.

Each hot dog cooked on oleander skewers contained a fraction of a microgram of oleandrin. For the following calculations, it is presumed that serious toxicity from oleandrin and digoxin is closely related to Na^+/K^+-ATPase inhibition. Consider that oleandrin is 4.3 times as potent an inhibitor of Na^+/K^+-ATPase as digoxin [9] and that therapeutic digoxin doses are in the milligram range (parenteral loading dose = 8–12 μg /kg; 0.56–0.84 mg for a 70-kg adult) [13]. It would require consumption of 186–279 hot dogs containing the highest amount of oleandrin measured to produce a desired therapeutic effect, as in the treatment of rapid atrial fibrillation with associated congestive heart failure. While the therapeutic index of digoxin, and presumably also for other cardenolides, is low, it would require eating many further oleander-skewered hot dogs to produce a dangerous or lethal effect. Given that even champion eaters cannot consume more than 100 hot dogs in a sitting (the world's record is 73 hot dogs in 10 min) [14], it does not appear possible to become poisoned through this mechanism.

In addition, a few unexpected mechanical difficulties in cooking the hot dogs occurred that make the use of oleander branches as food skewers appear unlikely. First, the oleander branches have many leaves, sprouting in groups of three at regular intervals, which must be removed prior to use as a food skewer (see Fig. 1.) Secondly, the three-pronged nodes where the leaves emanate from oleander branches form a

Fig. 1 Triad branching orientation of *Nerium oleander*. Three leaves emerge, 120 degrees apart, at each node

Fig. 2 Triad branching along fresh oleander stems requires hot dogs to be skewered from wider base, rather than the narrower branch tip

physical barrier that makes skewering hot dogs difficult (see Fig. 2). Only the dried branches could be speared into the hot dogs skinnier end first, which is the self-evident way to use a branch as a food skewer. Also, only the thickest freshly cut branches (nearly 1 cm in diameter) were able to support the weight of a hot dog without bending so much as to be useless for grilling food (see Fig. 3). Potential hot dog grillers would probably use alternate sources of food skewers that were available, including other plants with less physical impediments to their use than oleander.

Limitations

Because only the oleandrin content of the samples was determined, additional consideration must be made to account for additional unmeasured cardenolides. The cardenolides found in horticultural and wild oleander strains include oleandrin, adynerin, oleaside, odoroside, nerigoside, and their gentobiosyl-substituted derivatives [2, 3]. While the relative amounts vary by strain, oleandrin represented 29.8% of the total detected cardenolides in a previously tested strain from California, where the oleander for this current study came from [15]. Another study determined that oleandrin accounted for 22.3–34.3% of the total cardenolides found in oleander stems [16]. If one allows that oleandrin represents only 10% of the total cardiac glycoside activity in *Nerium oleander* (an intentional underestimate, to maximize the likelihood that ingesting these hot dogs could cause poisoning), and again factors that oleandrin is 4.3 times as potent an inhibitor of Na^+/K^+-ATPase as digoxin [9], and further assumes that clinical effects from oleandrin and digoxin are closely related to Na^+/K^+-ATPase inhibition, then each cooked hot dog contained less than 0.0147 mg (freshly cut) or 0.0301 mg (dried) digoxin equivalents. The amount of Na^+/K^+-ATPase inhibition expected from eating oleander-skewered hot dogs is more than 2 orders of magnitude smaller than seen with digoxin doses expected to cause serious human toxicity, let alone fatalities [1].

The hot dogs in this study were also cooked on a disposable charcoal barbecue grill, rather than an open campfire, which would have better represented the scenario of impromptu use of oleander branches as hot dog skewers. A disposable charcoal grill was chosen so that the experiment could be performed safely in a suburban domestic setting, without potentially contaminating any existing grill used for other food

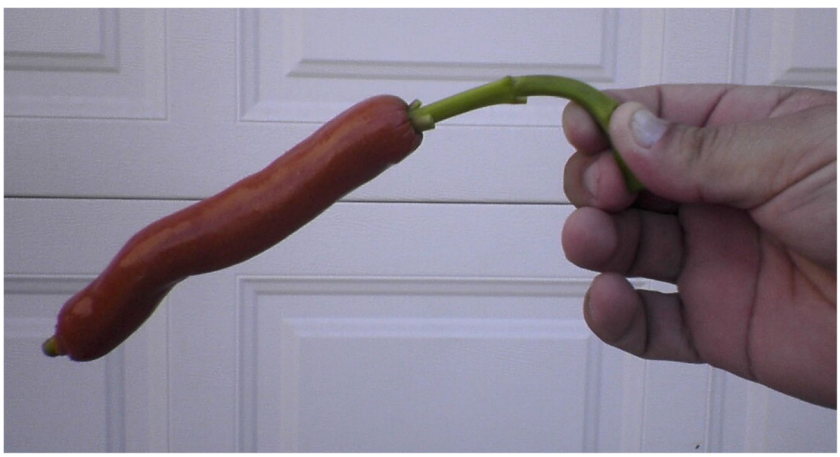

Fig. 3 Fresh *Nerium oleander* branches thin enough to use conveniently as skewers cannot support the weight of a hot dog, and are useless for grilling

preparation—a concern that was ultimately unsupported by our results.

Conclusion

Hot dogs cooked on *Nerium oleander* branch skewers contain a negligible amount of oleandrin. Poisoning by consuming hot dogs or other food items cooked on oleander branches is probably an urban myth. Future replication of this experiment may benefit from also measuring other cardenolides, such as nerigoside, that are also present in *Nerium oleander*.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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