Why do plants possess laxatives?

The functional significance of fruit pulp in plants could extend beyond merely offering nutrient rewards for their dispersers. Murray *et al.*[1] showed that fruit pulp of *Witheringa solanacea* increases the passage of seeds through the gut of the avian disperser *Myadestes melanops*. They found that seeds encapsulated in the agar blocks treated with the pulp extract passed significantly faster through the gut of its disperser than those encapsulated in untreated agar. The seeds that passed rapidly through the gut germinated better and remained viable for a longer time than those that passed slowly. Murray *et al.*[1] proposed that reducing the seed retention time might increase the fitness of the plant and hence that selection might favour the evolution of laxative chemicals in the fruits so as to enhance seed passage rates. Thus seed retention time appears to be an important component of fitness in plants. Accordingly we predict that selection shall favour the evolution of laxative chemicals predominantly in fruits and seeds (in structures such as seed coat and aril) of the species that are especially dispersed by animals as opposed to those dispersed by wind, water or passive means; unlike animal-dispersed species, wind and passively dispersed species do not require such laxatives. Here we test this prediction by analysing the association between the occurrence of laxative property in plants and their respective dispersal modes.

Several traditional health care systems, such as Ayurveda and Siddha, predominantly use plant products for curing human ailments. These systems of medicine have been very popular in the Indian sub-continent and even today enjoy a substantial patronage. We surveyed three compendia of these health systems[2–4] for information on plant species and their parts exhibiting laxative property. Plants listed to serve as purgatives were considered to possess laxative property and the dispersal modes of these species (animal or wind or passive) were obtained from the *Flora of the Presidency of Madras*[5] and from our own data source[6]. We then tested for the independence of the laxative property of the species with their dispersal mode. For this we computed the expected frequency of the species with different dispersal modes based on the data provided by Lokesha *et al.*[6] on the dispersal modes of a set of 770 species of angiosperms. These frequencies were compared with those with the laxative properties.

Nearly 60% of the 114 species with laxative property in their seeds and fruits are dispersed by animals (Table 1). Significantly more animal-dispersed species exhibited laxative

property than would be expected by chance ($N = 114$ species, $\chi^2 = 19.42$, $df = 1$, $p < 0.001$; Table 1). There were fewer wind and passively-dispersed species with laxative properties than expected. Thus it appears that plants with laxative property are more likely to be dispersed by animals than by other means.

Fruits and seeds generally constitute a small proportion of the total biomass of the plants and range from 10 to 30% in annuals, and much less in perennials[7,8]. Accordingly, if the laxatives are randomly distributed in the vegetative and reproductive parts of the species studied, then the proportion (frequency) of species with the laxatives in fruits and seeds shall roughly correspond to these proportions. Our results showed that fruits and seeds together constituted nearly 58% of the plant parts having laxative effects (Figure 1). Thus as predicted, we found a strong association between the mode of dispersal and the laxative property of fruits and seeds and that seeds and fruits constitute predominant source of laxative chemicals in plants.

Table 1. Association between modes of dispersal of seeds and fruits and their laxative property†

Dispersal modes	Species	
	Observed	Expected
Animal	68	45
Others*	46	69

Plants listed to serve as purgatives in their seeds and fruits were considered to possess laxative property and the dispersal mode of these species (animal or wind or passive) were obtained from Gamble[5] or Lokesha *et al.*[6]. We then tested for the independence of the laxative property of the species with their dispersal mode. For this we computed the expected frequency of the species with different dispersal modes based on the data provided by Lokesha *et al.*[6] on the dispersal modes of a set of 770 species of angiosperms; these samples represent random collection of species from the world flora. These frequencies were compared with those with the laxative properties. $N = 114$ species; raw data from references 2 to 4. $\chi^2 = 19.42$, $df = 1$, $p < 0.001$.

*includes wind and passively-dispersed species.

†The list of plants and plant parts possessing laxative properties and their dispersal modes is deposited with the editorial office. Those interested in obtaining the list may contact the editorial office or the authors.

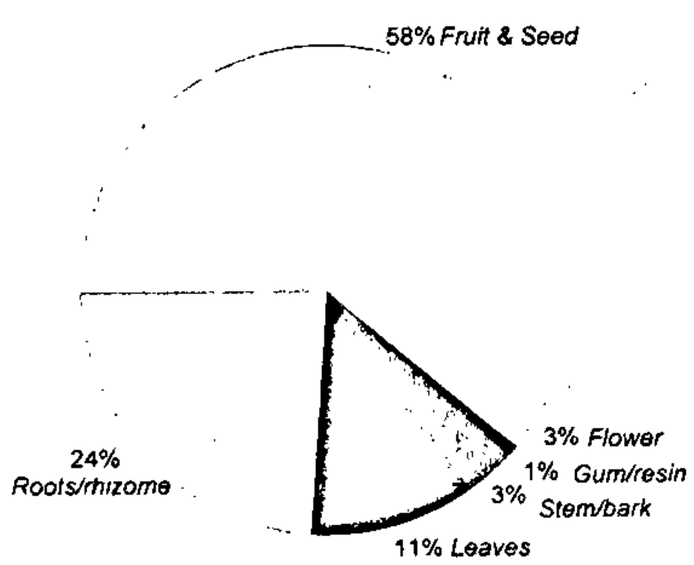

Figure 1. Percentage of various plant parts exhibiting laxative properties ($N = 112$ species, raw data from ref. 2).

Apart from the immediate function of enhancing seed passage rates, laxative in fruits may confer certain other advantages as well. Putz[9] argued that rapid passage of seeds would facilitate their deposition in a greater number of fecal clumps, probably leading to reduced post-dispersal competition. Further, frequent defecation also favoured a greater fruit consumption rate by birds, which may lead to greater removal of fruits from plants[10]. In fact Sorensen[11] found that feeding preferences of the European blackbirds (*Turdus merula*) were positively correlated with seed passage rates.

Plant products have been extensively used as curatives for a wide range of human ailments by both traditional and allopathic health systems. Yet the functional significance of these products to the plants themselves largely remains unaddressed. While it has been suggested that these products may constitute secondary plant metabolites, with no apparent function in the plants[12], it is also conjectured that they may have evolved as chemical defenses against predation or pathogenic infection[13]. Our study suggests that at least in some cases (in this study with reference to the laxative property), the acclaimed curative property of plants is an adaptive consequence to enhance their own fitness. Indigenous and allopathic health systems have apparently taken advantage of such selection of laxative chemicals in the fruits and seeds of animal-dispersed species to their own use as curatives. It is likely that several other curative properties of plants such as anti-helminthic may also have an adaptive basis.

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