The evolutionary explanation of the tendency of plants to enclose the seed in the fruit

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Abstract. The current work synthesizes a scientific answer of interest to plant enthusiasts, an answer that uses sources of information from the fields of plant physiology, plant anatomy, plant morphology and evolutionism. How can the evolutionary tendency of plants to coat the seed in the fruit be explained? The evolutionary tendency of plants to coat seeds in fruit can be explained by the selective advantage it provides in terms of seed dispersal, protection from predation, optimal germination conditions, reduced intraspecific competition, and the promotion of genetic diversity. These adaptations contribute to the reproductive success and survival of plant species in diverse environments.
Key Words: evolution of seed, fruits, dispersal agents, chemical protection, wind.

Introduction. The seed habit is the most complex and successful method of sexual reproduction in vascular plants (Linkies et al 2010). The seed plants (Spermatophyta) comprise two major groups: the Acrogymnospermae (also referred to as gymnosperms; about 800 living species) and the Angiospermae (also referred to as angiosperms; about 250.000 living species) (Cantino et al 2007; Linkies et al 2010).

The evolutionary tendency of plants to coat seeds in fruit is a key adaptation that has evolved to enhance the dispersal and survival of their offspring. This strategy provides several advantages for the plant species, contributing to their reproductive success. We will present below some explanations for this evolutionary tendency.

Seed dispersal. Dispersal can be facilitated by animals or wind.

Animals as dispersal agents. Fruits are often attractive to animals due to their taste, aroma, or color (Figure 1). By enclosing seeds within a fleshy and nutritious fruit, plants entice animals to consume the fruit. The seeds are then dispersed away from the parent plant through the animal's digestive system or by dropping seeds during movement (Morales & Moran Lopez 2022).

Wind dispersal. In some cases, plants have evolved to produce lightweight fruits that can be carried by the wind. The fruit coat helps in achieving aerodynamic shapes and structures that aid in wind dispersal (Kim et al 2022).

Protection from predation. Protection can be physical or chemical (Carvajal-Endara et al 2020; Jackson et al 2022; Aguirrebengoa et al 2021).

Chemical defense. The fruit coat can contain chemicals or compounds that deter herbivores from consuming the seeds. This protection ensures that a sufficient number of seeds survive to germinate and grow into new plants.

Physical protection. The fruit coat provides a physical barrier against environmental factors, such as desiccation, pathogens, and microbial attack, increasing the chances of seed survival.

Figure 1. Papaya fruit and seeds (*Carica papaya*) grown in Venezuela, called lechoza by the locals. The black seeds are edible and have a spicy taste. Sometimes the seeds are ground and used instead of black pepper (original picture).

Germination timing. Germination timing means delayed germination. Some plants have evolved to delay seed germination until specific conditions are met. The fruit coat can act as a protective layer, preventing premature germination and ensuring that seeds germinate under favorable conditions (Chaban et al 2022).

Competition and genetic diversity. Here we have to point out two aspects: reduced intraspecific competition and genetic diversity.
Reduced intraspecific competition. By dispersing seeds away from the parent plant, the offspring are less likely to compete directly with each other for resources. This helps in reducing intraspecific competition and enhances the overall survival of the plant population.
Genetic diversity. Seed dispersal contributes to genetic diversity by facilitating the colonization of new environments. This diversity can enhance the adaptability of a plant population to changing environmental conditions.

Resource investment or, in other words, energy efficiency. Plants invest energy in producing fruits to protect and disperse seeds. This energy investment can be more efficient than producing many small seeds that may not survive or germinate in suitable locations.

Conclusions. The evolutionary tendency of plants to coat seeds in fruit can be explained by the selective advantage it provides in terms of seed dispersal, protection from predation, optimal germination conditions, reduced intraspecific competition, and the promotion of genetic diversity. These adaptations contribute to the reproductive success and survival of plant species in diverse environments.

Conflict of interest. The authors declare no conflict of interest.

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