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Comparative *in vitro* evaluation of antioxidant, cytotoxic, antidiabetic, and phytotoxic activities of *Annona reticulata* L. plant parts

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Annona reticulate L (commonly known as custard apple) is well recognized for its traditional use in medicine; however, the comparative evaluation of its different parts has received limited scientific attention. This study investigated the antioxidant, antidiabetic, cytotoxic, and phytotoxic activities of methanolic extracts of leaves and seeds, as well as aqueous extracts of fruit pulp. Antioxidant capacity was evaluated by ferric reducing antioxidant power (FRAP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) assays. Cytotoxicity was evaluated by the brine shrimp lethality bioassay while antidiabetic activity was determined using α-amylase inhibition assay. Phytotoxicity was evaluated through a lettuce seed (*Lactuca sativa*) germination bioassay. Among the tested samples, the leaf extract demonstrated the highest antioxidant activity, with a FRAP value of 1254 ± 32 μmol Fe^{2+}/g, which was nearly comparable to the standard antioxidant Trolox (1261 ± 11 μmol Fe^{2+}/g). It also exhibited moderate DPPH radical scavenging activity (IC_{50}: 132.6 ± 3.94 mg/L), compared with the positive control, ascorbic acid (IC_{50}: 7.90 ± 0.10 mg/L). In the cytotoxicity assay, the leaf extract showed substantial activity (LC_{50}: 0.5239 ± 0.2418 mg/L) and moderate phytotoxic effect, with 48.09% root growth inhibition at 1000 mg/L. The seed extract showed the strongest cytotoxicity (LC_{50}: 0.0610 ± 0.000 mg/L), exceeding that of the positive control. It also displayed moderate antioxidant potential (FRAP: 574 ± 8 μmol Fe^{2+}/g), but showed lower phytotoxicity compared to the leaf extract. The fruit pulp extract recorded the lowest antioxidant activity (FRAP: 274 ± 25 μmol Fe^{2+}/g) and exhibited mild cytotoxicity, with only 10% lethality at 1000 mg/L. It showed moderate α-amylase inhibitory activity (13.45 ± 4.76%), which was lower than that of the standard antidiabetic agent acarbose (59.82 ± 4.10%). In summary, the leaf extract showed notable antioxidant and moderate phytotoxic potential, making it a candidate for antioxidant and allelopathic research. The seed extract may be valuable in therapeutic or anticancer research due to its high cytotoxicity. The fruit pulp extract, though weaker overall, shows mild cytotoxic and antidiabetic activities. These findings support the need for further isolation and characterization of bioactive compounds from different parts of A*nnona reticulata* for pharmaceutical and agricultural applications.

Keywords: *Annona reticulata α-amylase inhibition, antioxidant activity, cytotoxicity, medicinal plant extract, phytotoxicity*