methods have all been proposed as effective sporoderm-breaking approaches (Wang et al., 2017). The common technical target is high wall-breaking efficiency with minimal damage to active ingredients; reported methods include low-temperature vibration pulverization under protective gas, which achieved a 98% breaking rate without additives or obvious deterioration, and broken-sporoderm machine or ball-mill processing, both of which exceeded 95% wall breaking. In addition, fermentation with *Lactobacillus plantarum* achieved a wall-breaking rate of 52.38% after 48 h, suggesting that biological pretreatment can complement physical disruption where mild processing is desired.

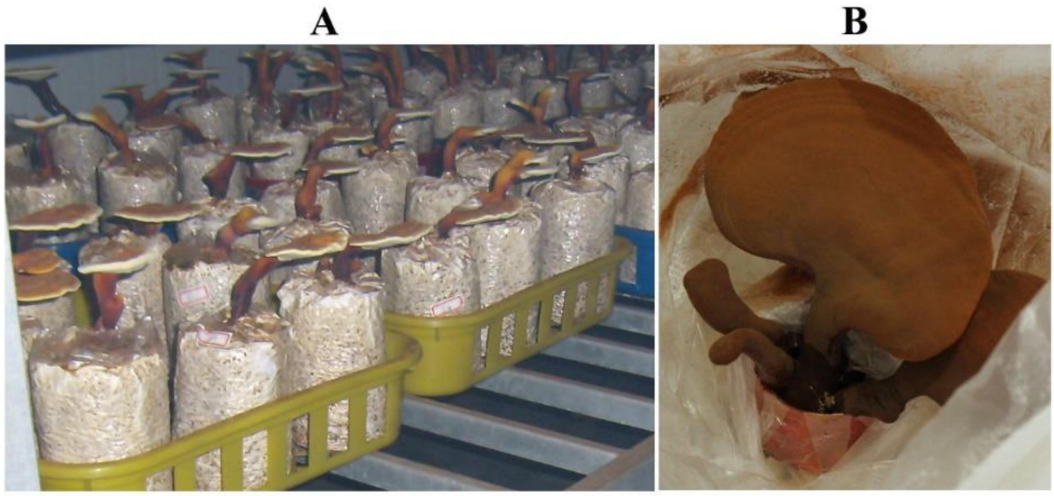

Figure 1 Fruiting of the 1st, 5th, 10th and 15th generations of the mutagenic strain UV119 (Adopted from Tang et al., 2023)
Image caption: (A): Fruiting situation of different generations of UV119; (B): collection of spores powder (Adopted from Tang et al., 2023)

Processing optimization should not be judged by wall-breaking rate alone, because different methods produce different nutrient release and bioactivity outcomes. In vitro digestion experiments showed that broken spores released substantially more polysaccharides and triterpenes than unbroken spores, and that bioaccessibility increased with specific surface area; after the intestinal phase, polysaccharide bioaccessibility rose from 29.52% in unbroken powder to 39.73~72.45% after room-temperature milling and 44.53~104.18% after low-temperature ultrafine grinding. Low-temperature ultrafine grinding also outperformed conventional milling in bioaccessibility despite a lower specific surface area, implying that structural preservation during processing can be as important as particle-size reduction (Qi et al., 2024). Studies comparing sporoderm-removal with ordinary sporoderm-broken powder found even larger differences: sporoderm-removal increased total polysaccharides by nearly 12-fold, yielded more abundant triterpenoids, and produced stronger antioxidant activity, while another study reported that broken spores extracted 3~4 times more bioactive compounds than non-broken spores. Therefore, spore powder collection and processing technologies should be built around clean collection, low-temperature drying, protective and efficient wall-breaking, and post-process quality evaluation based on release efficiency and active-component retention, so that the final product achieves both high yield and high functional quality.

4 Quality Control of Ganoderma Spore Powder

4.1 Evaluation of appearance quality and basic physicochemical indicators

The quality control of *Ganoderma lucidum* spore powder should begin with a combined evaluation of appearance, microscopic traits, and basic physicochemical indicators, because single-index assessment does not adequately capture source differences, processing status, or market adulteration. Early quality studies on wall-broken spore powder used character inspection, microscopy, physicochemical identification, and main-component assays together, and showed that these indices were stable and operable for preliminary quality valuation. Regional comparison further shows that spore powders differ measurably in color and physicochemical properties, confirming that appearance is not only a sensory trait but also a useful external reflection of internal quality