Common buckwheat (*Fagopyrum esculentum* Moench) is the most economically important species of the genus *Fagopyrum*. It belongs to the knotweed family (Polygonaceae), but due to its cultivation technique and the chemical composition of its seeds, it is classified as a pseudocereal like quinoa (*Chenopodium quinoa*), amaranth (*Amaranthus cruentus*), and chia (*Salvia hispanica*). Buckwheat, along with these species, has been called a superfood of the 21st century because its seeds offer higher nutritional and health-promoting value than many other common cereals. The health benefits result from a high abundance of bioactive compounds, such as fiber, phenolic acids (e.g., chlorogenic, gallic, caffeic, and benzoic acids), flavonoids (e.g., rutin, quercetin, orientin, and vitexin), and vitamins (e.g., thiamine, riboflavin, pyridoxine, niacin, and tocopherol). Buckwheat seeds are also a source of numerous minerals such as magnesium, zinc, copper, manganese, iron, potassium, and phosphorus; additionally, they are gluten-free, making them a valuable food source for people with celiac disease, i.e., those intolerant to gluten. Due to the presence of many bioactive substances, buckwheat is used among others in cancer prevention, cardiovascular diseases, and inflammatory treatments. Despite its numerous advantages, buckwheat cultivation has decreased in recent decades, due to the low and unstable seed yield. In 2022 the global production of buckwheat seeds was estimated at 2.2 million tons, which was less than half of what it was 30 years ago (FAO). Buckwheat cultivation is not competitive compared to other cereals. The causes of the low seed yield of buckwheat are believed to be specific flower biology, i.e., the short lifespan of its single flower, heterostyly (production of flowers with different heights of pistils), and the resulting self-incompatibility and non-self-terminating flowering period. However, the most significant factors limiting seed yield are disturbances in the development of female gametophytes (embryo sacs) and very high flower abortion rates. It is believed that the causes of low seed yield can be traced to internal mechanisms that regulate the production of flowers capable of setting seeds.

Fagopyrins (FAG) are photosensitive compounds, found exclusively in the *Fagopyrum* genus. Their presence has been noted in *F. esculentum*, *F. tataricum*, *F. cymosum*, among others. FAG, belonging to naphthodianthrones, are structurally similar to the well-known hypericin (HYP), an active compound primarily found in the flowers of St. John's wort (*Hypericum perforatum* L.). It is known, that HYP are located in special dark glands, which most likely prevent the potential auto-toxicity of these substances. Due to its strong phototoxic properties, HYP is used in the photodynamic therapy of cancer cells, among others. FAG include seven compounds, marked as A-F, among which FAG F is the dominant form. FAG is most abundant in the flowers compared to all other parts of the plant. Our preliminary research have shown that over 75% of FAG F is located in the pistil among all parts of common buckwheat flowers. Using modern imaging technique for spatial metabolite distribution (MALDI MSI), the precise location of FAG F in the pistil was determined – around the ovary. Experimental studies have demonstrated the phototoxic properties of FAG. However, to date, FAG has not been studied in terms of its biological function in buckwheat. What role does FAG F play in the pistil? Could its localization around the ovary potentially disrupt the development of the embryo sac? Do these compounds participate in mechanisms that regulate the production of flowers capable of seed formation?

The main objective of this project is to conduct a comprehensive analysis of the activity of antioxidant enzymes and the occurrence of programmed cell death (PCD) in buckwheat pistils, along with the identifications of enzymes involved in this process. This analysis will focus on both: 1) the increased content of FAG F, induced by a specifically selected LED light spectrum, and 2) pistils at various stages of buckwheat flower development – in buds and open flowers. The collaboration established among three research centers – the W. Szafer Institute of Botany, the Institute of Botany at the Faculty of Biology of Jagiellonian University, and the Department of Pharmacognosy at Uppsala University – will enable a multidimensional investigation of this topic by combining the specialized expertise of the research team members with the methodological and instrumental resources essential for conducting the planned studies.