Beerworms: Rearing edible mealworms on spent beer brewing grains
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The past decade has seen a growing international realization that insects are a viable alternate food source to fill the growing gap in protein production needed to feed the estimated nine billion people by 2050. At the start of 2017 there were close to 200 startup companies worldwide developing insects as an alternate source of food.

Since July 2017, the Davidowitz lab has been developing the technology and protocols to rear insects as an alternate source of protein for human consumption. The College of Agriculture and Life Sciences (CALS) has invested over $100,000 to help get this off the ground. This initial support has allowed us to hire a full time technician, purchase equipment, and develop the infrastructure needed to mass rear insects. We have been extremely successful to date raising thousands of beetle grubs and caterpillars.

The purpose of this funding request is to develop the rearing of mealworms as an alternate source of protein for human consumption. In addition to rearing mealworms, we will also 1) develop a revenue generating stream that will make the program self sustaining, 2) pioneer a novel sustainability program, 3) provide hands on materials for undergraduate courses in edible insects, 4) provide research opportunities for undergraduates, 5) provide a platform from which undergraduates can learn about the entrepreneurial side of sustainability related startups.

This funding request is part of a larger program in edible insects being developed in the Davidowitz lab with our near-term strategic goal to make the UA the leading university in North America for edible insect research. We will be incorporating a startup company, HexaFeast, through Tech Launch Arizona (TLA) within the next few weeks. We can start production and commercialization of mealworms almost immediately as the demand for mealworms is much higher than supply. Revenue through HexaFeast will support future research of edible insects making this program self-sustaining in the near future.

Mealworms are larvae (juveniles) of the darkling beetle, Tenebrio molitor, and have become an increasingly sought after protein source for human consumption, but the supply is not currently meeting demand. Furthermore, this commercial growth is largely constrained to Europe. There is only one edible insect farm in North America (Canada) raising mealworms for food, and according to personal correspondence with them, they cannot meet the increasing demand. In 2016, 4000 metric tons of dried mealworms were imported into the US as chicken feed, primarily from China. Thus, the first novel aspect of this project is that HexaFeast will be the only producer of mealworms for human consumption in the USA. This is an untapped market, and could potentially generate an enormous income for edible insect research at the UA.

Second, we are developing the technology to use postconsumer spent beer grains as feed for the mealworms. Currently, spent beer grains are either composted, thrown in the landfill, or used to feed livestock. Our approach will produce a locally sourced and sustainable human food product from what is essentially food waste, which can be acquired at no or low cost. To our knowledge, no other company is doing this anywhere in North America.

Third, we are developing a 100 level for-credit course in edible insects. We will give each student mealworms to raise and at the end of the year have a gastronomy event where the students will cook, and eat, the mealworms they have raised. This event could potentially take place on the UA mall, which will increase the visibility of insects as food and the research being done on campus.
Fourth, this project will provide many opportunities for undergraduate students to gain valuable research experience and lab skills as well as “100% engagement” opportunities.

Fifth, together with Dr. Matt Mars in the Agriculture Education Department (AED), we will develop a separate for-credit course on the entrepreneurial aspects of sustainability related startups. Students will use data from our mealworm rearing facility as a test case of sustainable agricultural startups.

**Relevance to the Green Fund Rubric.** This project addresses the three tiers of sustainability: *environmental* in that it recycles waste streams as food for the mealworms, *social* as it is developing an alternate source of protein production to feed the growing human population especially in developing countries, and *economic* as we are working with Tech Launch Arizona to develop a startup company, HexaFeast, that will sustainably rear insects as food and hire UA students we train.

The edible insect project already involves both undergraduate and graduate students and this mealworm project will provide students additional opportunity for hands on training and research. We will also supply the “Insects as Food” booth at the annual Insect Festival that attracts over 6,000 visitors. Currently, we purchase mealworms for this booth from the Canadian supplier. If funded, we will be able to supply our own mealworms and will proudly display the Green Fund logo on our booth.

This project is part of a larger edible insect program on campus that creates a broad impact through experiential education. CALS has a strong interest facilitating this program as it aligns with their values and goals of increasing food production efficiencies and educating the community about sustainability. Our near-term goal is to make the UA the place in North America to come for research in edible insects.

We are taking a strategic approach to the edible insect program to make the UA the sought after university in North America for edible insects research. We will be incorporating a startup company (HexaFeast) through Tech Launch Arizona (TLA) within the next few weeks, that will not only train and hire UA students interested in this aspect of sustainability but will also serve as a platform for UA students to gain hands on experience in sustainability entrepreneurship. We have potential investors that have met with TLA and CALS Associate Dean for Research and will invest in HexaFeast once we show we can grow large numbers of grubs (hundreds of thousands). In our small pilot study to date we have grown about 4,000.

To our knowledge, The Green Fund has never funded research in edible insects.

We have gained a great deal of hands-on experience since starting the edible insect program in July 2017, and all aspects of this proposed project are feasible.

**Relevance to the Student Survey.** The edible insect program supports the following priorities of the student survey: On-campus job opportunities for undergraduate and graduate students (85%), Career-based experiential learning and leadership opportunities (81%), investing in student leadership and staffing to improve sustainability (71%), sustainability projects and initiatives (70%).

Insects use less water, produce fewer green house gases and are 12 times more efficient at converting feed into food than cattle, per gram protein produced. Thus, developing edible insects for nutrition meets the following sustainability priorities outlined in the student survey: water saving (85%), waste reduction (82%), energy savings (80%), reduced carbon footprint and greenhouse gases (75%).

Edible insects are the food of the future and Green Fund support can help propel the UA into a world leader of this industry worth an estimated $55 million in 2016 and expected to grow to $523 million within five years (2023).