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Inquiries of Entomophagy: Developing and Determining the Efficacy of Youth-Based Curriculum

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Introduction

Entomophagy is the human use of insects as food. This practice is exhibited around the world by a variety of cultures with densities highest in the continents of Africa, Australia, and South America. However, entomophagy is not commonly practiced in the United States and as a result many Americans lack the knowledge necessary for understanding, appreciating, and using this practice. As the value of finite natural resources and impacts of food production are recognized by Americans, entomophagy has become a more socially-viable alternative food source because its environmental benefits allow consumers to justify their interest and adoption of the practice. As acceptance of entomophagy improve, so do the opportunities and means to practice entomophagy in the US, but they are still limited. Despite improved access to insect - based products, development of consumer markets for insects in the US has been slow. One reason for this is a lack of useable and accessible information about the benefits and means of adopting entomophagy. Our aim is to improve access to information about entomophagy by designing youth-specific curriculum which can be used in classrooms and science centers to introduce children to the practice of entomophagy and facilitate normalization of this practice.

The process of harvesting, producing, and eating insects provides insight into various cultural experiences and traditions around the world. As entomophagy has increased in popularity in recent decades, more attention has been given to the distribution of its adoption and what drives individuals to consume insects. There are marked differences use of insects as a food source in western cultures compared to cultures which traditionally consumed insects. Achieving sustainable use of insects as a food source will differ depending on the regulatory framework present in each country and the method of collection and production used.

Despite logistical challenges global insect production industry has reached an all-time high. Efficient methods of farming insects have been developed and a variety of insect-based food products are available to consumers, yet entomophagy still struggles to compete with the trade of traditional protein sources such as chicken, beef, and pork. This is in part due to consumer rejection of insects as a food source. A problem stemming from cultural norms which recognize insects as pests rather than food and associate insects with strong emotions such as fear and disgust. Commonly known as the “yuck-factor”, this cultural barrier must be broken down if entomophagy is to become more widely accepted in western countries. By engaging children and exposing them to the concept of entomophagy early in their lives, we can make aware of entomophagy at an early age, helping to normalize this practice and improve common perceptions of entomophagy. T we will create a set of comprehensive curricula centered around the education of youth specifically with the goal of exposing youth in Montana to the concept of entomophagy. By focusing our curriculum on experiential learning opportunities which actively engage students and allow them to explore entomophagy independently, we hope to improve their knowledge and awareness of entomophagy as an alternative protein source, and as a means to mitigate issues of environmental quality and food security, while allowing them to decide whether or not entomophagy is viable in their own lives. To understand the impact of our curriculum on student perceptions of entomophagy we will ask 1) how does student knowledge of entomophagy improve after exposure to entomophagy focused curriculum? 2) Do student attitudes towards entomophagy change after exposure to entomophagy focused curriculum?

Literature Review

From our interaction with the literature, we have observed the potential for substantial improvements in water conservation, land use, and a decrease in carbon emissions from insect use as compared to conventional, highly-industrialized monocrop and meat- centered agriculture. In addition, the majority of studies conducted on insect nutrient quality conclude that insects are excellent sources of protein, fats, and amino acids and could be incorporated as a regular part of a healthy human diet. Yet, the beneficial effects of entomophagy are hindered by a lack of awareness and education concerning the practice in western culture despite varying forms of entomophagy around the world.

Cultural Value

Globally there are around 2 billion people who consume insects as a primary source of food (Ekesi and Niassy, 2017). Entomophagy is inherently valuable to the communities that practice entomophagy as it has the potential to provide these communities with a sustainable and nutritional food source. Eating insects, while providing nutrition and food security for societies located in areas of limited food production capabilities, also represents a cultural tradition of cooking and eating. Entomophagy is widely practiced throughout Africa, with numerous communities containing valuable traditional information on seasonal harvesting, preparation and cooking. In Zambia, there is a clear connection between eating insects and social beliefs and community values. For example, insect desirability often parallels tribe class. In Kazoka, Zambia, the termite is the most desirable insect, but is associated with upper class individuals and men, and is considered a delicacy across Zambia, whereas beetle larvae and cicadas are among the least desirable and often associated with lower class individuals (Stull, et.al 2018). Examining the cultural value of entomophagy within indigenous communities around the globe, can help us to gain a better grasp of the cultural value of food—preparation, gathering, and consumption—and in turn allow us to have a deeper cultural understanding of traditional and indigenous communities in general.

There have been a number of societies across the globe that have practiced entomophagy. The preparation, harvesting and consumption of the insects is bound and rooted in tradition in many communities. This traditional knowledge is imperative for us to understand, if we are to attempt to incorporate entomophagy into a western context in a culturally sensitive manner. For example, termites are a commonly harvested insect for food consumption in the region of Uganda, as well as other locations in Africa. In Uganda, termites are harvested by using a wet grass blade and inserting them into the holes of termite mounds and then are collected during the first rains of the season using light traps and water buckets suspended over basins (Neshifhefhe et. al 2018). In the same article, a study was conducted in the area of Uganda where termite consumption is common, illustrating that termites are prepared in a number of different ways and with a variety of spices and other ingredients (Neshifhefhe et. al 2018). In the majority of the cases, women of the village are the harvesters as well as their children, therefore women contain the most traditional knowledge about how to collect edible termites, as well as being able to tell the difference from one termite to the other, which is indigenous information that has been passed down through the generations (Neshifhefhe et. al 2018). There is insurmountable value in this traditional and ecological knowledge concerning the successful implementation of entomophagy in communities around the world. Western societies wherein entomophagy is not widely practiced or understood can learn from this knowledge and can successfully implement entomophagy if the goal is to maintain the community-based and ecologically-specific nature of it. It is clear that there are differing values, scales and reasons for consuming insects, western societies wishing to develop and incorporate entomophagy can learn from indigenous knowledge but must develop culturally specific methods to ensure its success.

As we can see from the literature, there is value and cultural significance to entomophagy, and it is practiced all over the world. Therefore, it is reasonable to assume that such practices could be implemented in western societies such as Montana. However, in order for this implementation to be successful, traditional and indigenous knowledge must be used in a way that avoids delegitimizing the cultural context from where it came, especially if implementation is going to be done in an ecologically conscious manner. There is limited example of communities capitalizing on entomophagy, and if implementation occurs in a western context, we must also be wary of capitalizing on such practices. The capitalization of traditional knowledge for the purpose of economic gains could be potentially problematic. For example, wild honey bee gathering is common in certain indigenous forest communities in the Philippines, however this historically subsistence-based practice has recently been commercialized and the ecological effects on the forest and the people is not negligible (Matias et. al 2018). There is a direct reliance on the forest by the indigenous people, so damage to the forest due to commercialized, non-sustainable harvesting techniques is inherently damaging to the people and their culture (Matias et. al 2018). Although entomophagy in a western context would not rely on out-sourcing insects, the example illustrates the importance of an ecologically conscious and localized implementation strategy. Therefore, although there is much to learn and gain from indigenous people and their knowledge of entomophagy, there is also cultural and traditional significance to this practice, and implementation and collection of knowledge must be done in a culturally specific and mindful way.

Environmental Impact

As our global population continues to rise, the conflict between agricultural land use and the protection of forests and natural areas will only continue to increase. Global population is expected to increase to 9 to 11 billion by 2050 (Roos et al., 2017). Current predictions indicate that the earth's available cropland will not provide sufficient food for this population without increases in yield. Going into the future, the intensification of livestock production or a change in diet will be needed to sustain a population this large (Roos et al., 2017). Many people have eluded to both of these potential solutions in entomophagy; reducing the need for large scale livestock production while changing diet to a more sustainable resource. Entomophagy has been practiced for thousands of years by gathering or slightly altering the environment to yield a higher number of a certain species of insect. The large-scale cultivation of insects to reduce environmental impact is somewhat of a new idea on the global scale (Ramos-Elorduy, 2009).

Insects have a greater energy efficiency than conventional livestock (Tabassum-Abbasi et al., 2016). It takes ten times more plant resources to produce meat than it does to produce an equivalent amount of insect protein. Insects have a higher edible weight proportion in comparison to other meat producing animals. Where almost the entirely of an insect can be eaten, only 40% of beef and 58% of chicken can be consumed. Insects are efficient at converting energy directly into production, as seen with low waste when consumed and short life cycles. This energy efficiency is partly due to the poikilothermic quality of insects. Their internal body temperature closely follows the ambient temperature of their surroundings, meaning that less energy is spent on maintaining body temperature unlike traditional livestock which are classified as endotherms (Tabassum-Abbasi et al., 2016).

Insects require a much smaller minimum essential space in comparison to conventional livestock practices. Livestock production uses 30% of the earth's total land. Not only do livestock need physical space but additional cropland through the production of food for livestock is utilized as well (Premalatha et al., 2011). For every one hectare needed to produce mealworm protein, 10 hectares are needed for the equivalent of beef (Tabassum-Abbasi et al., 2016). While this is a stark contrast between cattle and insects, other smaller animal proteins such as eggs, pork and poultry meat are all relatively comparable. Crickets and mealworm larvae require slightly less pasture or cropland than these other animal proteins (Alexander, 2017). Insect land use efficiency has the potential to be decreased even further if by-product and waste products are used as feed (Alexander et al, 2017). Lastly, direct carbon emission from insects is much lower than their macro-livestock counterparts. Rumpold and Schluter (2013) claim that "livestock was found to be responsible for 9% of CO2, 35–40% of CH4, 65% of N2O and 64% of NH3 productions of all anthropogenic greenhouse gas emissions." Much research is lacking in the exact amount in which insects contribute to carbon emission, yet it is known that they contribute less than pork and significantly less than cattle. Carbon emission from insects is of course variable between species and life stages.

The environmental benefits of practicing entomophagy on either a direct scale (in which only humans consume this product) or on an indirect scale (in which insects are used as a holistic or complementary food source) are numerous and contribute to less stress to the environment that many aspects of conventional agriculture often depletes. In respect to water use, it should first be noted that water must not only be defined as clean, treated water from a faucet, but also recognized as green water (found naturally in soil), grey water (water that usually contains pollutants and is not intended for human consumption), and blue water (found in rivers and aquifers) (Flachowsky et al., 2018). All of these types of water are used for agricultural and horticultural practices. By expanding the definition of water, one is able to understand how much of these water sources are directed and redirected for the purposes of producing the largest and best potential product of a given crop in a given season. The use and manipulation of these sources quickly adds up when considering all these different types of water and their roles in agricultural production. A study comparing the water footprint between mealworms and livestock demonstrated that: mealworms use 4341 $m^3$of water/edible ton, pigs use 5988 m^3/ton, chickens use 4325 m^3/ton, and beef use 15,415 m^3/ton (Miglietta et al., 2015). It is, of course, important to note here that chickens do use less water. However, as also noted in (Miglietta et al., 2015), chicken tend to produce 127 grams of protein/edible kilogram of meat, while mealworms produce 186 g/kg followed by beef at 138 g/kg and pigs at 105 g/kg. Therefore, the nutritional value of water usage in comparison to the amount of protein produced can be compared to that of domestic, industrially-produced chicken.

Yet, water cannot be the only method of comparatively analyzing the ecological benefits of entomophagy as food and feed. The agrochemicals (pesticides and fertilizers) often used in plant production that may result in direct human consumption or as animal feed is the largest input of energy into these crops (Flachowsky et al., 2018). These agrochemicals used for the maximum production of one or two plants, primarily limits phosphorus in the soil, which inhibits the production of other plants (Flachowsky et al., 2018).

Nutritional Value and Health Risks

When it comes to entomophagy there are many questions the average person would want answered before considering this unique diet. What are the nutritional and health benefits to eating insects, and how does that compare with other food sources? Does eating insects have a significant health risk, and if so, what is it? Most people have no idea what the answers to these questions are and don't know where to find the resources to educate themselves. With human diets there are five main nutritional values considered: proteins, fatty acids, fibers, dietary energy, and minerals/vitamins (Van Huis et al., 2013). In several studies' scientists found that the food choices made by many people were influenced by the nutritional value of the food (Glanz et al., 1998, Worsley, 2002). Additionally, people who had some basic nutritional knowledge were more likely to choose nutritious foods. Around 57% of adults regularly use the nutritional fact panel when making food related decisions (Todd, 2014). This lack of US education in regards to the nutritional/health pros and cons of entomophagy is potentially one of the main reasons why entomophagy hasn't caught on in the US.

Entomophagy is an emerging field of science. Currently, there are relatively few studies conducted on insect nutrition. This is mostly due to the plethora of different insect species around the world. With so many different species all living in different ecosystems it becomes hard if not impossible to fully understand how nutritional values differs between all the groups. The current scientific consensus in regards to entomophagy is that insects are very nutritious and could provide a healthy diet for humans (Bukkens, 1997, van Huis, 2016, Van Huis, 2013). In one study by Rumpold and Schlüter (2013) they looked at the nutritional value of 236 different insect species (such as cockroaches, grubs, flies, ants, butterflies, and more). They concluded that while nutritional value wildly varied from family to family and between species to species, insects overall are mainly composed of protein and fat. Many insects also showed high fiber, amino acid and micronutrient levels. In another study by Latudne et al. (2016) they looked specifically at the mineral content of four insects (Grasshopper, Crickets, mealworms, buffalo worms). All the species had high enough mineral (Fe, Ca, Cu, etc) levels to support a human diet when cooked and portioned correctly. They also found that crickets had 180% more iron content than sirloin steak, showing that crickets could be used as a superb source of iron in diets. Lastly, they explained how minerals provided from insects were more soluble than minerals provided from sirloin steak, allowing for easier mineral uptake in humans. On average, insects contain about 60% protein (Van Huis, 2016). In many cases the amino acid concentration in insects is significantly higher than in many grains and legumes (Bukkens, 1997). The fat content found in some grubs and larvae (67%) exceeds the fat content found in beef, milk, chicken and eggs, and contains more poly-unsaturated fats (Van Huis, 2016). Just 100g of African Palm Weevil provide the daily-recommended iron, copper, zinc, magnesium, and manganese intake for an adult human (Ekpo & Onighinde, 2005). Additionally, a large portion of these insect species (crickets, cockroach, ants, buffalo worms, etc...) can be found in the United States and could be easy to access. Overall, all of these studies provide strong evidence that including insects into your diet provides more than sufficient nutrient density needed for a healthy diet.

While entomophagy might seem like a great alternative to meat-based protein and vitamin diets, there are some downfalls. First of all, not all insects are created equal. Nutritional value is usually tied directly to what foods the insects are eating (Bukkens, 1997). Even insects of the same species can have significantly different fat, mineral, and protein loads depending on their food source. This makes it hard to consider insects as a reliable source of nutrients. Additionally, while most insects are particularly rich in protein, insects can be harder for humans to digest than other food sources. A large amount of insect protein is found in chitin (compound in insect exoskeletons), which most humans lack the digestive enzymes to metabolize (Van Huis, 2016). In Indonesia, people who ate scarab beetles had chitin build up so much in their gut that it had to be surgically removed (Van Huis et al., 2013). However, there are conflicting studies in regard to the digestibility of chitin by humans, with some studies suggesting that humans could digest 77-99% of chitin found in insects (Bessa et al., 2017). Another concern in regard to insect food safety is allergy risk. In China the consumption of silkworm pupae has caused many allergic reaction cases with ranging severity. Reactions are severe enough to cause around 1000 cases of anaphylactic shock a year (Ji-km et al, 2008). Insect induced allergic reactions are comparable with some crustacean allergies as they share similar proteins. People with crustacean allergies are advised to avoid eating insect products (Bessa et al., 2017, Ribeiro et al.,2018). However, the few studies done on allergic reactions caused by insect consumption concluded that insect allergies don’t pose a significantly higher risk than other types of common food allergies (Testa et al., 2017, Ribeiro et al., 2018). The microbial load found in some insects is another health risk associated with entomophagy. Currently, there has been little to no testing conducted on the health risks involved with insect microbial load. Many insects are carriers for bacteria, fungi, viruses and more (Van Huis et al.,2013). While many pathogens that infect insect are harmless to humans, unless collected, cooked, stored and transported correctly, dangerous pathogens can easily thrive and grow on insect matter at levels unsafe for human consumption (Bessa et al.,2017, Testa et al.,2017, Van Huis et al., 2013). Additionally, insects exposed to pesticides, herbicides, heavy metals, and other toxins can have high chemical concentrations making them too toxic for human consumption (Testa et al.,2017, Rumpold & Schlüter, 2013).

Due to the lack of awareness around entomophagy in the US, most people are uninformed of the pros and cons of incorporating entomophagy into their lives. Based on this research, almost all scientists agree that, while insects won't be completely replacing chicken and beef anytime soon, there is enough evidence to support that humans can and should start supplementing insects into their diet in small amounts (Bukkens, 1997, Raubenheimer et al., 2014). Unless people become better educated about the nutritional and health factors that entomophagy provides, there is no real driving reason for them to start considering alternative protein sources.

Food Security/Access

Traditional anthro-entomological knowledge regarding the consumption and harvest of insects varies as widely as the species consumed. Recognition of insects as a food source has made them useful as a supplementary element in the diets of human populations around the world with roughly 2000 species of insect consumed currently and historically on every continent known to support a human population (Halloran et al. 2015, 739-746; RAMOS-ELORDUY 2009, 271-288; Yen 2009, 667). Where entomophagy is practiced it is normalized and accepted as a common element of sustaining oneself from resources available on the surrounding landscape. But western agricultural development and perspectives on food have begun to change the way entomophagy is practiced in communities where it was culturally accepted and historically common. Individual preference for insect preparation has shifted depending on social and economic standing with insects consumed for sustenance in rural settings and for delicacy in urban ones. (Manditsera et al. 2018, 561-570). This aligns with the idea that food in general has multiple dimensions including economic, physical, social, and psychological, security, and comfort (RAMOS-ELORDUY 2009, 271-288). While western perspectives on food have influenced the cultural relevance of entomophagy in some places, it is the hope of modern insect cultivators that western culture can adapt utilizing indigenous knowledge of insects and recognizing them as a food source.

Resistance to entomophagy in western culture is present as many reject the notion that insects are food and deep, cultural ties to meat production persist, impeding the transition to more sustainable sources of food, especially protein. Animal agriculture currently provides the majority of protein in western diets but the formation of more insect farming organizations and a subsequent increase in the domestic production of edible insects is providing feasible alternatives to western sources of protein, fats, and vitamins without the severe impacts of traditional protein production (Stoll-Kleemann and O'Riordan 2015, 34-48; Nadeau et al. 2015, 200-208; Looy, Dunkel, and Wood 2014, 131-141). Comparative studies of western neophobia to entomophagy have identified that using entomophagy to address issues of sustainability and localizing insect-based food offerings may be a viable method to popularize entomophagy (Barsics et al. 2017, 2027-2039; Campbell-Arvai 2015, 279-295; Lensvelt and Steenbekkers 2014, 543-561). Upon normalizing and adopting entomophagy into western culture the market for insect-based products can grow and begin to address issues of food security and access (Yen 2009, 667).

Normalization of entomophagy and growth of the insect production market is necessary for entomophagy to reach a scale at which it can address food security and food access issues. Currently many insect products cost as much per unit weight as beef (Rumpold and Schlüter 2013, 1-11), reducing demand for the products in places and cultures where insects are not a normal food source because consumers are unwilling to spend more money on a fringe culinary trend. Consumers will validate their purchase of insect products when they are familiar with, accept, and appreciate ecological and nutritional advantages of entomophagy (Lensvelt and Steenbekkers 2014, 543-561). Reducing the price of insects for general human consumption is an ongoing process which requires careful consideration of the insects being cultivated and regulation and advancement of the technology used to produce and process insects (Rumpold and Schlüter 2013, 1-11). The insects must be nutritionally worth the energy invested into their production, containing high levels of vitamins and useable protein. Improvements in the removal of chitin from insects can increase the quality of the protein derived from insects and therefore improve their nutritional quality. Additionally, rearing, harvesting, sanitation, disease monitoring, packaging, and distribution can be automated if entomophagy is scaled to a level of production which is profitable under high levels of regulation (Rumpold and Schlüter 2013, 1-11). Once this occurs, more people are likely to trust insect products because they are produced in a system that they are familiar with and can afford. At lower prices per unit weight insect products will be more accessible and consumers can then take advantage of their nutritional benefits as solutions to nutrient deficient meals in households without the means to purchase other sources of vitamins and proteins. Reliance upon traditional animal agriculture is also reduced in this scenario as consumers wishing to reduce the ecological impact of their diet are no longer conflicted between buying a quality source of protein and contributing to the production of meat.

Economic Viability

The economic implications of insect production and consumption are also important to consider when making the case for a western market and for the importance of educating western consumers. Since 2014, insect products and farming have generated $124 million worldwide. Of this, $119.8 million has gone to insect farming operations while $4.2 million has gone to companies creating consumer products for human consumption (Cosgrove, 2017). In 2015 alone, the insect global market industry reached $30 million. By 2022, it is expected to surpass $750 million, or possibly even $1.1 billion (Cricket, 2018). The leading international insect farming startup is a Netherlands-based company called Protix. They have raised a total of $50.5 million in equity and debt funding, however, their insect production is predominately focused on animal and aquaculture feed (Cosgrove, 2017). The leading startup for insect production of human consumption is an American company called Exo Protein, which produces protein bars made from cricket powder. In 2016, their first round of funding efforts raised just over $4 million demonstrating an interest in using insects as alternative proteins (Cosgrove, 2017). On a global scale, the movement toward alternative protein through use of insects seems to be a growing trend with many opportunities for economic gain on the consumer market. In the US alone, consumers have taken an interest in insect food products such as cricket tortilla chips from Chirps and mealworm snack packs from Don Bugito. These companies are the primary consumers for insect farms such as Coalo Valley Farms in Los Angeles and Rocky Mountain Micro Ranch in Denver (MacNeal, 2017). With innovative products and ways of processing insects, western consumers seem to be slowly overcoming the “yuck” factor of consuming insects.

Even as these seemingly mainstream products are growing in popularity, we need to take a step back and honestly consider the reality of insect production and where this alternative protein would take us in the future. It might be helpful to ask whether more industrial agriculture, even that which is focused on insects, "good" for North America and its consumers? Is local or regionally-focused, small-scale agriculture more in line with the future of food production and security? It is also important to consider the viability of small-scale insect production in the U.S.

Consider the Austin, Texas - based American start-up known as Aspire. The CEO Mohammed Ashour noticed the outrageous price of cricket powder selling for $20 a pound at wholesale, whereas a pound of cheap protein powder only cost $10. He explained this price stems from the high cost of production for cricket farming. In 2014 he won the $1 million Hult Prize to start up his edible insect plant that now uses robots to feed millions of crickets 24 hours a day in a 25,000 square-foot R&D center (Peters, 2017). In order to keep insect products in the hands of any consumers besides the elite upper-class, it seems they must be produced on an industrial scale. Tiny Farms out of Oakland, California is another example of a start-up building a model for industrial cricket farming, with the hope of making bugs as accessible as chicken (Peters, 2015). At the present, insect farming is heavily operated by man-power. Tiny Farms believes the only way to produce insects at scale to replace some meats is by reducing the human labor required and augmenting technological manufacturing (Peter, 2015).

On a local scale, Cowboy Crickets in Belgrade, Montana has operationalized insect production and is actively trying to scale up. Cowboy Crickets already boasts the largest area of cricket farming space in the US and their operations continue to grow in scale. They are developing automated systems that will allow for even the most novice farmer to efficiently raise crickets for human consumption without the large labor expense that has been seen in traditional insect farming. The automated bins are planned to cost less than $300 each and allow for easy and affordable scaling of a farm within their website-controlled internet portal (Cowboy Cricket, 2018). This innovation will essentially allow for anyone to take part in cricket farming without the investment of a full-time occupation. Conversely, Cowboy Cricket Farm has motives behind the cheap and efficient technological improvements. They plan to purchase all of the crickets that their partner farms can produce and hope to reach 1,000 farms by 2020 (Cowboy Crickets, 2018).

From the examples discussed, it appears that the only way of making insect farming economically feasible is through technological innovation to reduce labor costs. Most farms and product producers are focused on industrializing to maximize profit and production. Cowboy Crickets is the most locally focused by providing opportunities for community members to participate in small-scale production, which can then be combined through an intermediate company for larger production. These facts are useful for American consumers interested in food-centered entrepreneurial endeavors as well as those interested a better understanding of the economic viability of entomophagy in the U.S.

Education

Many people automatically perceive insects to be pests and nuisances, yet, an entomologist would say quite the opposite. They provide many ecosystem services like pollination, pest control, and nutrient cycling. So why is it that people become uneasy when insects become the topic of discussion? Literature, film, and everyday exposure has trained us to squash spiders and trample ants. Shows like *Fear Factor* and *Survivor* have capitalized on these attitudes (Looy & Wood, 2006). In addition, they have become irrelevant and understandable in our everyday lives:

> Insects are tiny, multitudinous, with little recognizable emotions or individual consciousness, they do not easily register as objects of moral obligation or as agents of ethical change. Insects seem doubly other - other than humans and other than the animals that we eat as well (Loo & Sellbach, 2013).

We have removed bugs from our consciences and given them undervalued statuses. Much of this stems from the lack of education on entomology at early ages. A study in 2002 found that elementary students have limited understanding of insect characteristics. Only five of the 56 students they studied were able to note that all insects have three body parts with six legs (Barrow, 2002). The most noted attributes of insects were their ability to bite and sting (Burrow, 2002). The students had many misconceptions about a bug's life cycle, explaining they have never studied such topics in their science classes. None of the students were able to report on insects' impacts on humans (Burrow, 2002). These poor understandings only multiply and become more misleading as children grow older.

Introducing such topics to young adults takes more phycological reasoning. Another study conducted in 2006 invited junior high, high school, and university students to participate in a paper-and-pencil questionnaire reflecting on their attitudes toward invertebrates. Next, the students received a presentation on entomophagy as well as a banquet for bug tasting. Afterwards they received a post-test questionnaire (Looy & Wood, 2006). The university groups experienced shifts in attitude toward more ecological, scientific, and aesthetic appreciation for insects. The junior high and high school students' attitudes barely shifted at all in either direction (Looy & Wood, 2006). In the end, all the participants did report changes in their awareness of the role of invertebrates, the possibility of using them as food, and a willingness to consider changing their behavior under appropriate circumstances (Looy & Wood, 2006). However, actually implementing change will take more than one presentation and banquet on entomophagy.

Due to these findings, more exposure to insects and their impacts on the world will be impactful on students. The earlier they are exposed, the more likely the students will be thinking about such topics and considering them in their own lives. Introducing curricula to elementary students will be an effective way to expose our youth to invertebrates in a positive way, leaving a lasting interest in the topic while also expanding their environmental and worldly views.

Methods

The academic literature on entomophagy reinforces what we have experienced personally as young adults growing up in the United States: entomophagy is not something that the average American encounters, either through an academic experience or in popular culture. Only in the last few years have products containing insects appeared on the market for mass consumption in the form of protein powders and insect chips. Despite a growing concern in the U.S. of the environmental and health impacts of consuming animal protein, insect consumption remains a niche interest and market. Given the opportunities presented by entomophagy – its potential to provide animal protein with a significantly smaller environmental footprint, the potential for market growth of mass production of insects like crickets – we believed that exposing youth and adults to entomophagy could prove to be highly beneficial. Our research and outcomes sought to do just this. By designing academic curricula targeted at children ages 9 to 11 and working closely with educators from Missoula, Montana to deliver useful lesson plans, we hoped to increase children's awareness of and interest in entomophagy. As with many topics that children explore in school, we also anticipated that students would share some of what they learned with their parents and families, making further dissemination of the pros and cons of eating insects a secondary outcome of our work.

A broad exploration of entomophagy and its potential to impact food system sustainability included content on the cultural value of entomophagy and how it varies globally as well as the environmental impact of insect production and traditional animal agriculture. Our lesson plans balance the positive and negative elements of entomophagy by explaining gaps in the literature and areas left to explore, ultimately framing entomophagy as an evolving social trend in western societies which adapts its scale to the level of consumer participation and potentially offers ecological and socially responsible pathways for consuming protein. Our goal was to increase children's awareness of entomophagy, leaving them with a sense of its global scale and encouraging their investigation of its place in their own lives.

To this end, our team met with community partners and mentors capable of guiding and facilitating the development and integration of our curricula. From our local community network, we gained insight into the pedagogy of environmental education and had opportunity to practice teaching our lesson plans. These opportunities ensured that we created and implemented an effective and engaging curriculum which provides information on alternate protein sources, with an emphasis on entomophagy, in a holistic, balanced manner. Our community network included Cowboy Cricket Company, University of Montana Professional Educators, Montana Natural History Center (MNHC), Missoula Insectarium, Missoula International School (MIS), and eNDVR Home School Coop. The following timeline reflects respective interactions:

Monday, 10/15 – Skype interview with James Rolin from Cowboy Crickets Company to learn about cricket farming in Montana including challenges they face, interactions they have, and impacts they leave on local communities.

Friday, 11/2 - First meeting with Dr. Fletcher Brown, Professor of the College of Education at the University of Montana, to introduce our topic and initiate a relationship for further collaboration on the design of our curriculum.

Monday, 11/5 – Second meeting with Dr. Brown to discuss what it means to teach children, how children learn, and the proper ways to design lesson plans for the most effective results.

Friday, 2/1 - Meeting with the Education Director Stephanie Pots, Community Programs Coordinator Christine Morris, and Distance Learning Coordinator Kellie Van Noppen at MNHC to outline the objectives and goals of our lesson plans to enhance our curriculum design.

Thursday, 2/14 – Meeting with Museum Educator Carolyn Wiley at the Insectarium to learn how they teach insects to children, gain further insight Next Generation Science Standards (NGSS), and make edits to the structure and contents of our lessons plans.

Wednesday, 2/27 – Initial teaching opportunity for our first lesson plan at MIS to measure to the effectiveness and relativeness of our curriculum in an education setting.

Tuesday, 3/5 – Third meeting with Dr. Brown to reexamine our curriculum and make edits in accordance with our results from the teaching opportunity at MIS.

Wednesday, 3/13 - Classroom observation at the Insectarium to advance our understanding of teaching lesson plans and acquire skills to keep children interested when considering insects.

Thursday, 3/14 - Second teaching opportunity for our first lesson plan at eNDVR to assess our curriculum content and make further edits from the MIS occasion.

Thursday, 3/21 – Third teaching opportunity at eNDVR to teach our second lesson plan to gauge the relativity to the first lesson plan and address faults/accomplishments in the overall curriculum design.

By the end, our team finalized the curriculum for entomophagy and condensed the material to fit into one fluid portfolio, including two lesson plans of 45-50 minutes and supplementary activities to adapt to needs of the program and educator. Once we were comfortable with our final product, we submitted our portfolios to the Insectarium and the Montana Natural History Center as well as posting online to Pinterest to make it accessible for future educational opportunities. It was our ultimate goal to make these lessons available to all educators within the Missoula county and beyond.

Findings & Analysis

In order to make our curriculum about entomophagy useful and applicable, we needed to learn about teaching children, constructing curriculum, assessing lesson plans, and making improvements to design. We started with interviews and meetings with educators from the Missoula community, discovering approaches used in youth education and the goals of youth education programs. These interviews and meetings allowed us to construct and adapt our lesson plans to align with programs that already exist in the community. Our initial encounter with the nuances of curriculum structure came from Dr. Brown. During these meetings, we discovered that students retain information best if lesson plans follow a comprehensive "learning cycle", which focuses on engaging the students, understanding their previous knowledge of the subject, and explaining and introducing new terms and ideas. During our meeting with educators from the MNHC, we compounded on these ideas, discussing that students engage best when their prior experiences and understandings are challenged, which leaves them with altered or even new knowledge about the topic. This format of teaching came to be identified as the "Five E's", which includes Engaging, Exploring, Explaining, Elaborating, and Evaluating. Our first drafted lesson plans were formatted to this learning cycle.

Through the structuring of our lesson plans to fit the "Five E's" format, we altered the trajectory of each teaching session to first introduce insects as a food, illustrate the global prevalence of bug-based diets, provide comprehensive reasons why an entomophagous diet is beneficial, and concluding with a discussion on how entomophagy could be incorporated into the lives of the students. For our pre- and post-tests, we decided it would be most attractive for students to draw or write out their feelings and understanding of eating bugs, first on individual sheets before the lesson and then afterwards together on a large sheet of butcher paper to be hung in the hall. The idea being that comparison of the two drawings would allow us to analyze changing reactions, what parts of the lesson worked best for the students, and what sections of the material stood out. After the design of our curriculum, we desired to attain further insight from an expert on teaching insects to children. Carolyn Weber from the Insectarium helped us to format our lesson plans to meet NGSS as well as provided meaningful feedback about the overall layout of the drafted lesson plans, instructing that our material needed more self-discovery for the students instead of teaching. Drawing Weber advice, we finalized our first lesson plan for the classroom.

During our first teaching opportunity at the Missoula International School, we sought to test the effectiveness of our lesson plan and make adjustments accordingly. To our surprise, many of the students were already familiar with the concept of eating bugs and some had already eaten bugs. During the engage activity, we had the students imagine a fat, juicy burger that was made of mealworms then asked them to draw or write their reaction on a blank piece of paper. A few students struggled with the vagueness of the question and did not keenly participate in the activity. Others were very engaged from the start, expressing their reactions aloud and asking questions. During the explore section, the students travelled around the world through a PowerPoint slideshow, investigating and discussing where people eat insects and what kind of insects are eaten. The students were enthused by the four-minute video of aborigines eating witchetty grubs and honey ants in Australia. For the evaluate section, again only some students were interested, but everyone was required to contribute one drawing or writing to the butcher sheet. Overall, the students had very intellectual questions and conversation, which we underestimated. We decided the lesson plans needed to be more challenging for the students.

To incorporate the notes from our initial teaching opportunity into our curriculum, we requested a third meeting with Dr. Brown. He guided us on reshaping our goals and evaluation portion to better fit each other, suggesting that our explore portion should also be restructured so the students come up with questions in the end. This will set the stage for further investigation, giving students the opportunity for self-discovery and prompt them to challenge their existing knowledge about eating bugs, which proved to be the most challenging aspect of developing our lesson plans. After an observation at the Insectarium, we were able to observe this student-led design firsthand, giving us clear vision for how to implement such teaching styles into our curriculum.

We next taught two consecutive lessons at ENDVR. Through the eNDVR program, we taught the first lesson plan, which focused on giving a brief overview of entomophagy and teaching students about what type of insects are edible. Given the active and loose nature of eNDVR classes, we focused on creating a very engaging lesson plan with multiple activities that got kids moving. To understand the student’s baseline attitudes, we once again had kids draw their opinion of entomophagy. While two students drew pictures showing they were already potentially open to the idea of eating insects, the large majority drew pictures of sad, vomiting, and other negative faces/picture. Additionally, many of the students were verbal about their opinions at the start of the lesson, making it very clear they thought eating insects was disgusting. The main activity involved having the students "forage" for paper insect cut outs that we had hidden around the classroom. After finding them, they then learned how to use a dichotomous key to identify the insects they had found. Overall, the students were very engaged and focused on the activity and seemed to have a lot of fun. After giving the students some time to identify the insects we went through the species as a class and asked them to tell us if they had learned if the insect was edible or poisonous. After finishing the lesson, we had the students once again draw their opinion of entomophagy. The large majority had now drawn a positive picture, most showing the kids either eating an insect, offering it to a friend, or just a happy face.

During or second session at ENDVR we focused on the global aspect of entomophagy. While about half of the kids had come to the first session, the other half were new faces. We administered a pre-test that involved having the kids color in the emoji face mood that best reflected their attitude towards several questions regarding entomophagy. The students who had joined us the week prior selected mostly "positive" to "neutral" faces, whereas the new students mostly choose "negative" faces. The majority of this lesson was a discussion format, where we asked kids certain questions about where they thought bugs were eaten and what the environmental impact of eating bugs was. Even though the lesson was spent mostly sitting the constant discussion kept the kids engaged and excited. At the end of the lesson we brought out edible mealworms and encouraged the kids to try them. Some of the students were initially tentative and required support from their peers. However, almost all of the students tried at least one mealworm, with the majority continually coming back asking for mealworms. Finally, we administered a final post-test, that asked the same questions as the pre-test. The results were overwhelmingly positive, and the students left excitedly talking about how tasty the mealworms were. In both lessons, we started off with mostly closed minded and negative responses to entomophagy, however, by the end the students exhibited a completely different attitude about entomophagy. This positive response indicated that exposing kids to entomophagy can successfully and significantly cause changes in attitude and leave them more open to trying insects. After including critiques and observations from our prior teaching opportunities, we finalized our lessons plans and prepared them for their future host sites.

Through these experiences, we were able to design intellectually challenging, yet easy-to-use lesson plans about entomophagy for 4th and 5th grade students that could be used by a variety of schooling programs across the Missoula valley. Our lesson plans on entomophagy have been tried and tested, resulting in many alterations to make them more user-friendly, timely, and thought-provoking. The observations and resulting success of our lesson plans strongly support our research question that exposing students to entomophagy-based curriculum can have a significant impact on their attitudes regarding entomophagy. The students engaged well with the topic and revealed that some children are more open to the idea of eating bugs than others.

Conclusions

Currently, there is a deficit when it comes to the average US citizens' knowledge of entomophagy (Burrow, 2002). This lack of knowledge and understanding may be one of the main barriers preventing the growth and popularity of entomophagy in the US. Many US citizens have no idea about the role entomophagy plays in a wide variety of cultures and lifestyles across the globe (Burrow, 2002). Entomophagy can add additional healthful and resource-conscious benefit to the average American diet. Insect cultivation offers a significantly lower carbon footprint than other sources of protein and is a very ecologically friendly practice (Tabassum-Abbasi et al., 2016). Entomophagy can be used to decrease and address food security concerns (Halloran, Vantomme, Hanboonsong, & Ekesi, 2015), and is currently a new and emerging business opportunity that could provide significant economic opportunities in the years to come (Cosgrove, 2017). Without more education on entomophagy in place, it is unlikely that the US public will change their preconceived perspectives of entomophagy. And, if consumers and potential entrepreneurs are not exposed this unusual opportunity, entomophagy may never reach its potential as a viable part of the American diet or business venture for those interested in re-designing and re-defining our food system.

To address the information gap that exists among US citizens on entomophagy, we designed and created educational lesson plans that focused on informing youth about the pros and cons of entomophagy and how it is used around the world. We hope that in producing these curricula and in giving it an educational "home" in Missoula, it will be used for years to come. The sponsor institution will be free to use the plan however it would be most effective and best used for them and, in doing so, continue the education of Missoula's youth on entomophagy. As Missoula's youth age, if they decide that an alternate protein source is something that they would like to pursue, they will have some background knowledge on entomophagy. This background knowledge may also influence their opinions of cultures globally, the environmental impact of the production of various protein sources, the diverse nutrition that entomophagy can provide, and food security within Montana.

The curriculum portfolio our team produced has the ability to impact our local Missoula community by exposing and encouraging students to see how their diet can have downstream effects on their local environment. The material we have shared with the Missoula Insectarium, Missoula International School, and the ENDVR homeschool co-op, provides only a small sample size. Yet, our combined material may have the most long-lasting effect on students' perceptions by way of sharing the information we have learned with these education centers as well as sharing our final product on an online forum that can be accessed by teachers for years to come. In this way, our curriculum can be a sustained stepping-stone and lesson plan for teachers in both private and public education to present their students with an alternative, sustainable food source as well as an alternative way to view the world.

From this experience, we accomplished our goal of providing a suitable avenue for entomophagy education in addition to learning how to engage and teach young students. When we began this project, our collective knowledge of how to build and implement a lesson plan was very limited. Therefore, it was our persistence in reaching out and establishing connections with multiple educators that allowed us to truly understand the complexities of curriculum building and classroom dynamics. With the help of Dr. Fletcher Brown at the University of Montana and Carolyn Webber at the Insectarium, we developed a curriculum that worked to meet the objectives set out at the beginning of the lesson and made sure the evaluation was a direct measure of those objectives. With their advice in mind, we met our goal and began introducing the topic of entomophagy to local Missoula children at the Missoula International School and the ENDVR homeschool co-op. From these experiences, we were finally able to interact with the kids, asking them questions about how they felt towards consuming insects and gauging their reactions by both observation and pre- and post-tests before and after giving them the option to consume mealworms. Finally, we shared our final curriculum portfolio with the Insectarium, Missoula International School, ENDVR co-op, and on an online forum, so a wide variety of both local and non-local students and educators could benefit from the material we have created.

While our curriculum initially may only be based through local partners, it will serve as a resource for other educational institutions and programs to use and enhance. Our curriculum will provide a base that others can modify to reach different age groups, inform class topics, and potentially grow to a much larger scale across the country. By educating our youth, we are educating the future. Currently, the resounding scientific consensus is that entomophagy will play a significant, if not essential, part in the decades to come on both a local and global scale. The longer we wait to catch up with the rest of the world, the harder it will become for people to accept entomophagy. By teaching our youth about entomophagy, we are taking some of the first major steps towards shifting the average US citizens perspectives surrounding the consumption of insects, and hopefully pushing them to a more open and welcoming understanding.

Reflection

In what ways do you feel your project represents a multidisciplinary effort? What were the challenges and benefits of working across disciplines?

Food systems and chains are a shared component of communities across the world's cultures. Analysis of these food systems and the ways in which we can alter such systems to perpetuate sustainable, healthy, and accessible food sources transcends all academic disciplines and professional sectors. Through our examination of an entomophagy food system, we have also examined nutrition, sustainability, natural resource consumption, social issues such as food security, food as a cultural expression, economics and marketing of food sources, and the educational value of learning about food systems. Our educational curriculum emphasizes this multidisciplinary focus by exposing students to all of the benefits of an insect-based diet, as well as illustrating the complexity and importance of understanding the impact that food plays on the body, the environment, and the people of the world.

Our group embodies the multidisciplinary nature of our project simply due to the fact that we all pursue different degrees and have different focuses in our personal education, none of which are in the College of Education. Not only did we lack a background in entomophagy, requiring us to start from scratch in our research, but we also had no background in professional education and curriculum development. It has been perhaps the most profound learning opportunity to learn what the educational process looks like. However, our lack of knowledge on the subject posed challenges for us as well. In order to teach students in an effective manner, we first had to build a foundational knowledge base of the subject of entomophagy, a process that proved difficult because of the multifaceted nature of the subject. We then turned our attention to learning the mechanics of curriculum development and the building of lesson plans. Our project led us to speak with professionals across disciplines in order to build this foundational knowledge base, and execute a project that required every group member to learn something new.

Understanding the complexities and nuances of a subject that has a multidisciplinary focus poses challenges, especially when attempting to convey such information to a group of young students who have often never been exposed to the concept of entomophagy. Information must be conveyed and taught in a way that allows them to grasp the subject completely, but also does not overwhelm with an information overload. Each section of entomophagy could have its own complete curriculum, for example, there could be a whole lesson focusing solely of the economic impacts of entomophagy. Devising individual curriculum for the specific discipline areas was not practical or realistic for our project resulting in more generalized curriculum. However, such complexity allows for future study, and provides a multitude of potential academic and professional focuses in the realm of entomophagy. Exposing students at a young age to the subject of entomophagy and conveying its multidisciplinary nature, allows for the prospect of study by the students in the sector that interests them the most, and thus perpetuates the study and understanding of entomophagy and its benefits, as well as the understanding of global food systems in general.

Explain the challenges your group faced in designing and carrying out the substance of the project. For example: How did you attempt to address these 3 challenges? How did the project change after the proposal stage? How might you do things differently?

After we had decided to pursue a topic involving entomophagy, one of our challenges was honing in on a specific research question. We spent multiple meetings trying to figure out what exactly we wanted to get out of our project. Did we want to try and convince US citizens to start incorporating entomophagy into their lives? Did we want to just expose people to the benefits of entomophagy and its uses around the world? The exact research question didn't truly come to light until after we had conducted a literature review for our proposal. Initially we had hoped to create a project that would change people's opinions on entomophagy, specifically young students who we felt were more susceptible to change and new information. After further reflection we realized we had no way to measure long term changes on how students would perceive entomophagy after teaching them and thus, due to time constraints, not be able to answer any long-term questions. This realization helped us mold our final research question, which involved exposing youth to entomophagy and seeing if attitudes changed after we taught them about it. We could easily measure attitudes with Likert scales and drawings. This research question shift allowed us to focus on a more specific topic.

Another challenge we faced was deciding what we wanted our curriculum to look like and where we wanted it to be used after our graduation. While we met with multiple teaching experts, they all came from diverse organizations that had diverse goals and needs. Should our lesson plans follow the Next-Gen-Science- Standards? How long should our plans last? What format should we use when writing them? What age group should we focus on? To work through this, we split our team into groups and each focused on creating a lesson plan based on the needs of one organization. The majority of the organizations willing to help us focused on younger students, 3rd - 5th grade. We decided to focus on those age groups out of convenience and support that those age groups are most susceptible to new information. While in our proposal we had initially wanted to cover the plethora of information we had learned in our literature review, we soon realized it wouldn't be feasible to cover so much. We choose the main topics we thought gave the best overview of entomophagy and removed all the other information. We additionally spent time researching pre-made lesson plans which helped us shape our plans into cohesive, clear tools that could easily be used in classrooms. Once our plans were made, we taught them at various organizations and recorded notes on how the students interacted with the lessons. The feedback from classrooms provided vital information that further let us improve our plans. After teaching our plans we decided that instead of our final project being multiple lesson plans, we should come back together and combine our work into one solid lesson plan with several extension activities that teachers could us optionally. While our lesson plan came together really well and we are proud of our work, if we could do it again, we would have liked to start working on our lesson plans earlier and asked for more feedback from actual educators.

An additional major challenge we faced was finding places that would allow us to teach our lesson plans. Initially, we contacted multiple schools and organizations around Missoula and faced little to no response. Given the lack of response to emails many of our members had to take a more direct approach when it came to scheduling meetings, through phone calls or impromptu visits. When we started to finally get responses, it was also difficult to schedule meeting and teaching times that worked for everyone. This ultimately left us with less teaching opportunities than we had planned in the proposal stage. While in the end everything worked out, it was frustrating for our team to be forced to wait and only end up with three teaching sessions, given how important teaching our lesson plans were, and the rapidly approaching deadline of UMCUR.

One of the last things we would have done differently was figure out a host place for our lessons plans. We got so caught up in making the plans, we lost track of where they would go after completion. Given how much work and energy we put into creating the plans we want to make sure they are used by other teachers and not just forgotten after we graduate. We are still finalizing where our lesson plans will go. Had we organized better we would have figure this out long ago. Finally, we wish we had more time to plan and host an entomophagy community day event to support our curriculum. The majority of our work was very passive and reaching a larger scale audience would have enhanced our project.

Overall, while our team faced some challenges and frustrations during our research project it was a great learning experience. As a whole, we all worked wonderful together and maintained a positive attitude through any hardships. In the end our close teamwork is what pushed us through many challenges, as we always had each other's backs.

Read the global context section above. How did considering the global context of the

problem your group identified influence your thinking, the project, and the complexity of your work? What challenges did you encounter and how did you resolve them? What would you do differently if you were to repeat this process?

Entomophagy fundamentally has global context. Our group was originally drawn to the idea of entomophagy because it is widely practiced in many countries around the world, yet most Americans are not aware of it. We conducted research on why this was, encompassing the different cultures around the world that do consume insects. As we were still formulating our question for the project, we knew that global cultures would have a very large role in our project as we looked to them as reference. In our research we learned that adults in the America and the West in general have a fear of eating bugs, otherwise known as the "yuck" factor. In the West insects are likely to be consumed in powders or flours, or disguised within food so that it is not obvious what is being consumed. We identified that the "yuck" factor, is one of the main barriers in America to entomophagy. Through research and personal experience, we knew that children would be much more welcoming to the idea of entomophagy instead of adults. Global context played a fundamental role in our project as we thought about why there is a lack of entomophagy practiced in America.

Once our question and project were solidified, our next steps were to begin formulating lesson plans and look for places within the community in which we could deliver our lessons. Most of us within the group, did not have much experience teaching children nor did we have many local contacts with elementary school teachers. Developing our lesson plans took some time as we consulted with Fletcher Brown and conducted interviews with local educators. Finding a school and educator to deliver our lesson plans took some time as well and was not as easy as we had originally hoped. Ultimately, we did not deliver our curriculum alongside as many educators as we envisioned. However, we took advantage of as many opportunities that we could, and did get into classrooms a few times over the semester.

We as a group identified quite a few challenges that we could have avoided over the course of the year. It took the group awhile in the beginning of our project to confirm a question around entomophagy and furthermore, decide what we wanted to do with it. The time it took to discuss our question set back the timeline for the rest of the project. If we could have developed the fundamentals of our project earlier on, we could have meet with educators and developed curriculum faster. This would have allowed us to reach out to more educators and develop a more comprehensive curriculum. As mentioned above, we did not anticipate the time that it would take to get into a classroom and present our lessons. We had to adjust our expectations of getting into several different teaching formats to what the reality was; two classrooms with two sets of students. Again, with our timeline, we did not anticipate how much time the development of lesson plans would require. In hindsight, if we would have completed the lessons sooner, we would have been able to acquire more guidance from faculty at UM and educators in the community. Something we still have yet to resolve is the need for future sharing of our lesson plans. Originally, we had assumed that we would be able to give our curricula to a local educator such as the Insectarium or the Montana Natural History Center. This expectation has been more challenging than first expected. We have discussed housing the curricula online, but have not come to a complete resolution as to how our project will be relevant into the future. Lastly, if we would have found more time within the year, it might have been effective to have held a community or campus event educating and bringing attention to entomophagy. In hindsight, one of our major challenges was the amount of time this project took. If we would have managed our time slightly better, there was potential to reach out to more people in the community to make our project even better.

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