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The perception of entomophagy in Geneva and the opportunity for business

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Bachelor of Science HES in International Business Management

by

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Geneva, 3rd of June 2019

Sara DA SILVA FERRAZ

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Executive Summary

Edible insects for human consumption have been legalised in Switzerland in May 2017. The United Nations believe that entomophagy should be exploited as the food of the future. Since commercialisation of bugs is quite new in the county and the market is still a niche, there may be great businesses opportunities to explore.

This research provides an analysis of the perception of entomophagy and how it would be received as an alternative diet in Geneva. The objective is to make recommendations on how to introduce this alimentation of the future to the population in order to try and expand entomophagy as a successful business.

The methods used for the research include data collection through two sensory analyses composed of one blind sensory experiment and one sensory experiment run after a session of information on the benefits of entomophagy. Data is also collected through a free word association. The results are analysed with t-test statistics, and frequency tables. The aim of this research method is to understand how insects for food are perceived and whether there is a preconception bias. After analysing the demand side of entomophagy, a short interview with a Swiss company selling insect-based food products gives some insights about the supply side and the opportunities.

The results of the analyses show that the targeted population is not fond of entomophagy; when asked about their perception of insects for food, seventy percent of the sample relates to it as disgusting. However, the sensory experiments show a positive potential for the introduction of the practice. Indeed, the comments provided in the free word description show almost no sign of discrimination and the changes in means aren't significantly different from the blind to the non-blind sensory experiment. Nonetheless, there is a high volatility in the responses provided on the non-blind test in terms of overall liking scale. This result can be explained by a too small sample. The interview with the Swiss company shows that there is a rise in the market size, and the decrease in prices over time makes the business accessible to a broader public.

The recommendation that arise from the analysis is that, as Essento Food SA understood well, the market for insect-based food products is still very niche and there is a big opportunity to explore. More assertive and complete analyses should be run in order to confirm the viability of such business. It is important to keep in mind that the practice is novel for the population so extensive research are needed before starting a business.

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1. Introduction

This research aims to determine whether the population living in Geneva would be open to a change in diet, oriented towards entomophagy and whether there may be an opportunity to start and grow a successful business in this niche market.

Definition: *"Entomophagy: noun, the practice of eating insects, especially by people."*
OED, Oxford English Dictionary

Entomophagy is considered by some experts as the food of the future. There are different alarming factors that can make us question our consumption habits: currently, the world's overall exploitation of agricultural land for livestock is estimated at around 70%, there is an existing concern about overfishing in the oceans, and climate change represents a threat to crop production.

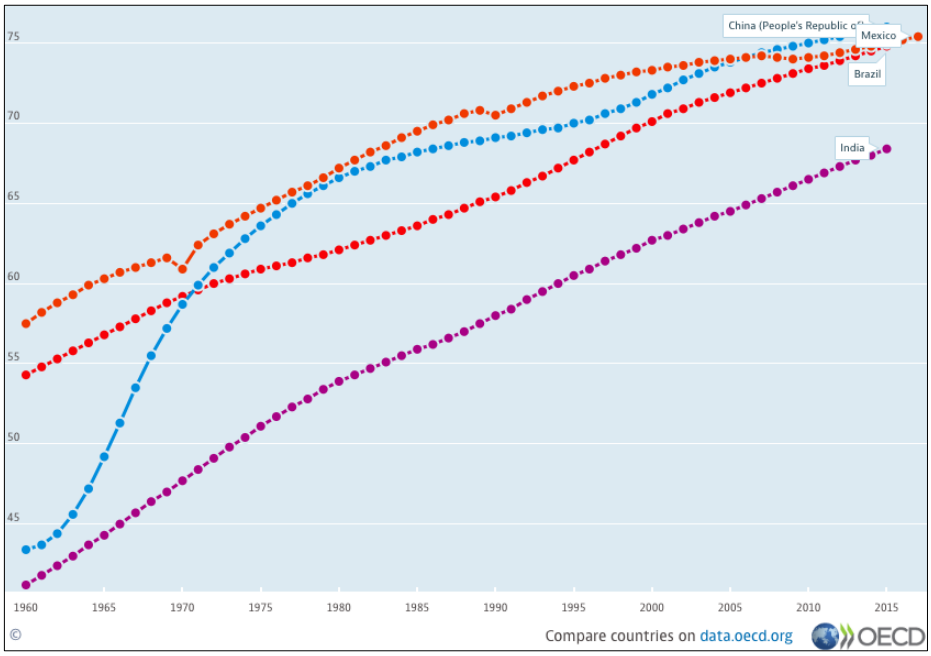
By 2050, the world's population is projected to reach 9.7 billion and most of that growth is occurring in developing countries. Such growth can be explained be the levels of living that are better, increasing life expectancy. The World Bank Group provides data about the evolution of life expectancy from 2016 to today. At a global level, in only forty years (from 1976 to 2016), the total life expectancy at birth has increased from less than 62 to more than 72 years old.

In figure 1, we can observe the rapid evolution of life expectancy over the years in some of the largest emerging economies such as Brazil, Mexico, India and China. The average increase in life expectancy for these four countries, from 1960 to 2015, was of 24.45 years.

At the same time, urbanization is developing and it is expected that 70% of the population will live in urban areas compared to 50% today. With that shift in living conditions comes increase in wages as well as an increase in demand for products of superior quality and a more diversified alimentation in those developing countries. To meet such demand in the future, twice as much food will be needed to keep feeding people around the globe. Thereby, environmental resources may most probably lack.

As we are talking about global trends, the increase in life expectancy particularly among emerging economies, and the threat of a growing population on the depletion of natural resources and on global warming, the question is why is this study focused on Geneva, Switzerland that is quite a small country with a population close to 8.5 million?

Figure 1 – Life expectancy at birth



Source: OECD (2019)

According to the Federal Department of Foreign Affairs (FDFA), there are 37 international institutions, organizations, bodies and secretariats, 179 states represented, 259 permanent missions, representations and delegations, and many members of organizations, international bodies, non-governmental organizations, permanent missions, representations, and delegations. All of this in Geneva. With these figures, we can understand that no matter how small of a country Switzerland is compared to the rest of the world, Geneva plays and essential role in terms of cooperation and multilateral diplomacy.

Moreover, the Canton is a recognized centre of expertise notably in the area of the environment and sustainable development, as well as in the area of health. Those are the two main areas of concern as far as the research subject. This symbol of recognition shows that researches and debates made in Geneva on such areas can make an impact at an international level, which justifies the importance of making this experiment in such region.

In addition to the Swiss Canton being recognized as the International Geneva, Switzerland is also a place of innovation. Indeed, for eight years in a row, the country has been named the world's most innovative country by the World Intellectual Property Organization (WIPO). According to an article by The Local, the environment that Switzerland provides for growing businesses and the nation's ability to transform resources into innovations are factors that put the country in the first position.

Thanks to globally renown universities such as ETH Zürich and EPFL, the country is home to a highly skilled and educated workforce and has sufficient resources to give opportunities to start and develop new, innovative businesses.

Finally, Geneva being very diverse culturally – with more than 40% of the Canton's population having a foreign nationality – people tend to be more open-minded and curious, which may have a positive impact on how they welcome change.

In other words, Switzerland, and particularly Geneva, is a very attractive place to develop a business, especially if it is innovative and that it treats environmental issues, contributes to the sustainable development and can potentially have benefits on health. Such business may potentially be recognized by one of the many international institutions headquartered in the Canton and obtain international acknowledgment.

For those specific reasons, the opportunities to develop a business related to entomophagy as an alternative to meat consumption for example, may potentially be attractive, if the results found by this study show that there is a potential for the population in Geneva to change its food consumption habits.

Indeed, one solution to fight against overproduction and saturation of agricultural land and that's an alternative to livestock consumption, is entomophagy. A spokesperson for Switzerland's food safety authority said that the country has been the first in Europe to authorise selling insects for human consumption. This is yet another argument proving that Switzerland is a good place to study how the Western society would welcome a change in eating habits, oriented towards entomophagy.

An issue with this alternative option is that insects are commonly considered as a nuisance and are not appreciated in Western societies. Although in many parts of the world – such as in Asia, Africa and Latin America – entomophagy is part of the diets, this practice is not popular among westerners and can even sometimes be seen as a primitive behaviour.

A paper on consumer acceptance of insect-based foods in the Netherlands analyses – beyond the level of acceptability of such products – factors influencing the likelihood of them being integrated as part of the diet. The different factors affecting repeat consumption are price, taste, availability, degree of fit with current eating patterns, household composition and family circumstances, and insects as an ethical source of protein. The study concluded that the practical factors had a greater influence on repeat consumption than more rationalised considerations about ethical position of insect-based foods. It said that repeat consumption required the successful interplay of all the

factors and that negative factors, led to “passive rejection” despite willingness to eat the product. The study made in the Netherlands is a valuable complement to this paper as it tests the factors influencing repeat consumption on a population that is already willing to integrate insects in their diets.

In order to answer the research question, this study proposes three qualitative experiments: the first one is a blind sensory experiment where participants of all ages living in Geneva will taste a selection of six cereal bars with similar ingredients, only that three of the six cereal bars will contain dehydrated insects that can be found in supermarkets for consumption in the city. The second test is a free word association. Finally, the third test will be a sensory experiment of the same products tested in the blind experiment and with the same participants that will have to do the same exercise of evaluating what they are tasting but this time knowing that three of the six cereal bars have insects.

Those qualitative tests will help understanding how entomophagy is perceived and received among the sample. The difference between the answers provided during the free word association and the grades provided during the non-blind taste test will also give answers on whether information about the current issue helps people accept entomophagy.

The paper is organized as follows: the first part gives existing information about the current situation and how is entomophagy accepted in Western cultures, it presents some history of entomophagy, gives some understandings related to western culture, discuss the environmental impact of agriculture and why finding a solution is important, and finally some details about nutritional values of common insects and why they are a great substitute for meat. The second part explains the methodology used for gathering the data, as well as the type of data collected. After that comes the analysis of the data collected where different hypotheses will be tested in order to provide the most accurate conclusion and discussion regarding the perception of entomophagy by the population in Geneva and whether it could be a profitable business. Finally, there will be a conclusion on the main findings, also explaining the limitations of the work and ways in which this project could be extended.

2. Entomophagy

2.1 The history of entomophagy

Eating habits are known to be influenced by culture, and the culture itself has been influenced by religion. Christian, Jewish and Islamic faiths all cite the practice of eating insects in the literature. In all of these religions, large majority of references are to locusts, mentioning permission to consume those insects (FAO, 2013). However, eating insects goes well before the apparition of modern religions. 500'000 years ago, Australopithecus used tools to dig into termite mounds and aliment themselves (van der Merwe et al., 2003). We can still observe the same pattern today among chimpanzees. The tool used is not the same but the technique remains unchanged. Maybe in part for that reason, the practice of eating insects is considered a primitive behaviour in Western societies today.

In his book "Insects as human food", Bodenheimer (1951) has well documented the history of entomophagy. Since the eighth century BCE, servants in the Middle East carried locusts arranged on sticks to royal banquets in the palace of Ashurbanipal. Eating cicadas was considered a delicacy in Greece, first country of reference to entomophagy in Europe. Indeed, the Greek philosopher Aristotle wrote how good this specie taste and when they taste best. Cossus was also a highly coveted dish in Ancient Rome and was spoke about by the author of the encyclopedia "Historia Naturalis" (FAO, 2013).

However, Western culture started growing familiar with entomophagy in the nineteenth century, with the exploration notably of tropical countries and the reporting of observations from such travels. Their observation was that people ate insects not only for their good flavour, but also as "a pleasant revenge on the ravagers of their fields" (Heinrich, 1857).

2.2 Why are insects not eaten in western countries?

Agriculture originated partly from the Fertile Crescent. From there, food production spread throughout Europe. Among a registered total of 148 species of terrestrial mammalian herbivores and omnivores weighing at least 45 kg, 14 of these have been domesticated. Those species don't only yield a large amount of meat, but also warmth, milk products, leather, wool, plough traction and means of transports. It is thought that it was because of the utility of these animals that the use of insects appeared much less attractive. (FAO, 2013)

On the one hand, agriculture became more productive and efficient, food could be stored and food supplies became more stable over time, triggering sedentism. On the other

hand, insects being seasonal, their nature was uncertain, which also contributed to the loss of interest in insects as food (DeFoliart, 1999). Moreover, sedentary agriculture may have resulted in the perception of insects as a nuisance and threat to food production. Urbanization has left people out of touch with nature and increasing urbanization will likely change insect consumption in developing regions of the world. (FAO, 2013)

People in most Western countries view entomophagy with feelings of disgust and associate it with primitive behaviour (FAO, 2013). Feelings of disgust are mostly triggered by the unknown and questions like “What is it?” or “Where has it been?” (Rozin and Vollmecke, 1986). The origin of disgust, more than a basic emotion, is rooted in culture, which defines the rules on what is edible and what is not. In other words, the acceptance or rejection of entomophagy is a question of culture (Mignon, 2002).

Insects are commonly more consumed in the tropics than in temperate areas of the world – with the exception of China, Japan and Mexico – for different reasons (FAO, 2013):

- Insects tend to be larger in the tropics, which facilitates harvesting,
- Insects often congregate in significant numbers in the tropics, so large quantities can be collected during a single harvest,
- A variety of edible insect species can be found year-round in the tropics
- For many insect species in the tropics, harvests are predictable

2.3 Swiss population eating habits

As the analyses of this paper will be performed on participants living in Geneva, it is important to have some understanding about the eating habits of the Swiss population. An article published by swissinfo.ch (2017) summarizes a study made by federal food safety and veterinary office on Swiss eating habits and gives us some insights about that.

Firstly, it says that while the government recommends eating 240 grams of meat a week, the results of the study show that men consume on average 980 grams and women 570 grams a week, which is four times and about two times more than recommended, respectively. Also, on average, the Swiss population consumes four times the recommended limits for sweets, salty snacks and fat, which include butter, margarine, creams and sauces. Patterns of consumption change between men and women. Among the population aged between 18-29, there are twice as much women consuming vegetables, fruit or salad daily as men. And this spread gets larger as the population gets older (see Appendix 1). The study counts 6,5% of women and 2,5% of men having a vegetarian or vegan diet. Eating habits also change depending on the region. The French speaking region consumes on average more fresh meat than Italian and German speaking

regions of Switzerland. The first conclusion from this study is that the Swiss population consumes an excessive amount of meat compared to what's recommended by the federal food safety and veterinary office, and their diet is on average mostly unhealthy.

Secondly, eating patterns are different during the week and during the weekend. For example, there's a higher percentage of the population preparing hot meals at home on the weekend compared to during work days. However, the study shows that the population spends on average 38 minutes in the kitchen to cook and that 35% of the population never prepares a hot meal for dinner.

Finally, the results from the study showed that almost half of the Swiss are overweight.

Thanks to this study made by the federal food safety and veterinary office, we now understand better the eating habits of the Swiss population. The latter study doesn't mention anything about eating insects. The practice has become legal in Switzerland in May of 2017, and the study has been made before that date.

There is another study made by researchers at the University of Bern on "price-based quality inferences for insects as food", conducted on German participants, and published in 2018, which suggests that the general belief that consumers associate higher prices with higher-quality products is also true with insect-based food. It also says that although government's subsidies to reduce the prices of insect-based products could have a positive effect in the short run, higher prices may have a more positive impact on the demand for such products in the longer term. Researcher Sebastian Berger also added that since lobster or crab is appreciated despite the insect-like appearance, the negative attitude towards eating insects could possibly change.

More details about the results of the study made by the federal food safety and veterinary office can be found in Appendix 1.

2.4 Environmental impact of agriculture and the opportunity for entomophagy

According to the Food and Agriculture Organization (FAO), livestock production accounts for 70% of all agricultural land use. At the same time, global demand for livestock products is expected to double by 2050, and meeting this demand will require innovative solutions. Fish production and consumption has similarly increased in the last fifty years. Consequently, the aquaculture sector now accounts for nearly 50% of world fish production. Large-scale livestock and fish production facilities incur huge environmental costs. If agricultural production practices don't change, increases in

greenhouse gas emissions, as well as deforestation, and environmental degradation are set to continue.

Jeffrey Sachs (2010) argued that the world needed new agricultural technologies and patterns of food consumption based on healthier and more sustainable diets.

Here are few of the advantages of consuming insects, according to FAO report:

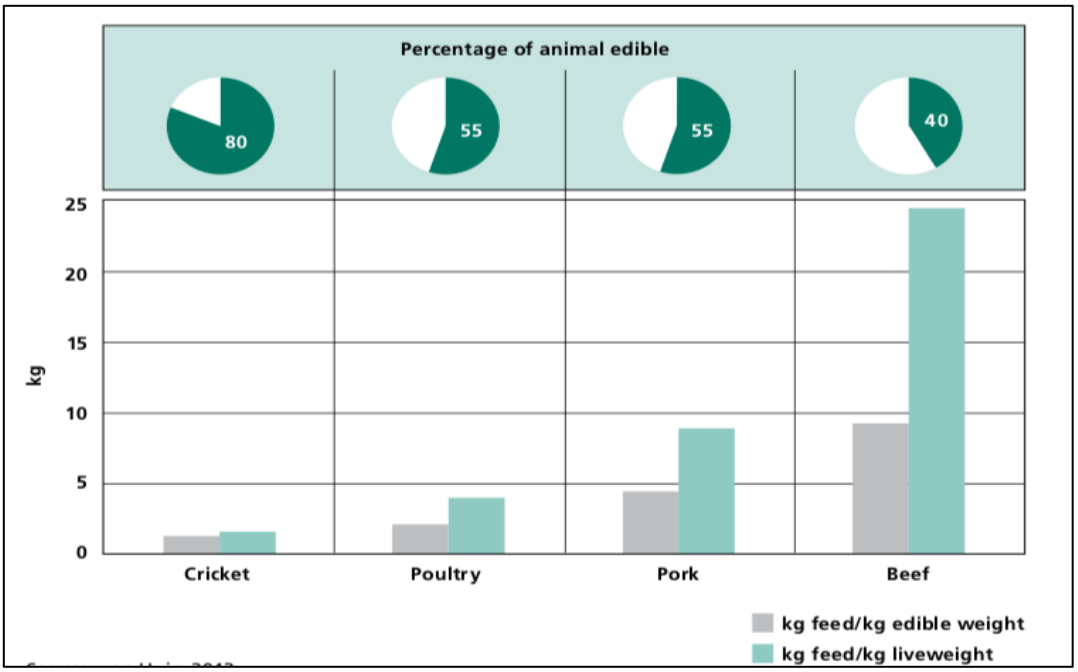
- They have high feed conversion efficiency.
- They can disputably be reared on organic side streams, reducing environmental contamination, while adding value to waste.
- They emit relatively few greenhouse gas (compared to livestock) and relatively few ammonia (emitted through the storing and spreading on manure).
- They require less water than cattle rearing.
- They potentially have fewer animal welfare issues.

Below, we will develop these advantages one by one in order to give a better understanding and have a point of comparison with other sources of protein.

High feed conversion efficiency: Insects demand less feed than other sources of animal protein. A study from Vaclav Smil (2002) and supported by the FAO affirms that for 1 kilogram of live animal weigh, chicken requires typically 2.5 kilograms of feed, 5 kilograms for pork and 10 kilograms for beef, whereas 1 kilogram of live animal weigh of crickets requires 1.7 kilograms of feed. In terms of edible weigh – according to a review by Arnold van Huis (2013), and still supported by the FAO – insects (in this example crickets) are even more rentable than the three other sources of proteins compared. It is estimated that 80% of a cricket is edible, while only 55% of chicken and pigs and 40% of cattle is edible. In other words, crickets are twice as efficient at converting feed to meat as chicken, four times more efficient than pigs, and twelve times more efficient than cattle. Figure 2 illustrates this assertion.

Organic side streams: Some insect species are known to be efficient at bio converting organic waste. They could collectively convert 1.3 billion tonnes of bio waste per year. However, crickets for example are fed with high-quality feed such as chicken feed because of legislations. The FAO believes that the substitution of such diets with organic side streams can help making insect farming more profitable. However, this argument has been contradicted in a research article published by Mark E. Lundry and Micheal P. Parrella (2015). This article defends a study that measured the biomass output and feed conversion ratios of house crickets (Acheta domesticus) reared on diets that varied in quality, ranging from grain-based to highly cellulosic diets.

Figure 2 – efficiencies of production of conventional meat and crickets



Source: van Huis (2013) cited in FAO (2013)

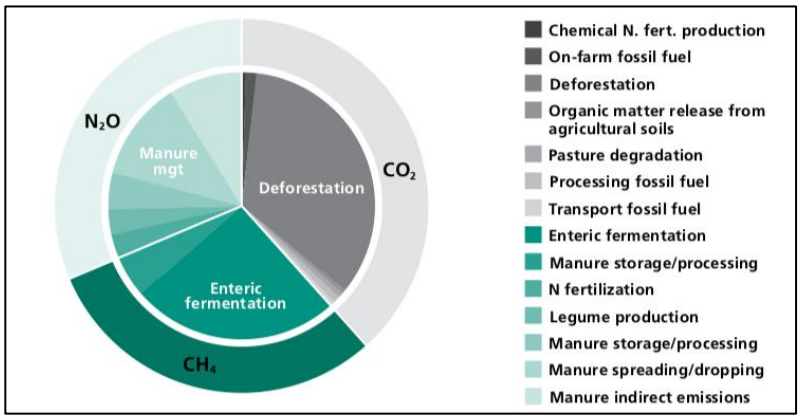
The following findings contradicted the arguments of the FAO report:

- Biomass accumulation was strongly influenced by the quality of the diet ($p<0.001$).
- For populations of crickets that were able to survive to a harvestable size, the feed conversion ratios measured were less efficient than those reported from FAO.
- Crickets fed minimally-processed, municipal-scale food waste and diets composed largely of straw experienced >99% mortality without reaching a harvestable size.

From this article we conclude that the potential for crickets to sustainably supplement the global protein supply will depend on capturing regionally scalable organic side-streams of relatively high-quality that are not currently being used for livestock production.

Greenhouse gas and ammonia emissions: Greenhouse gas contribution is present all along the livestock food chain. Livestock rearing is responsible for 14% of greenhouse gas emissions. The food chain doesn't only involve CO_2 but also methane (CH_4) and nitrous oxide (N_2O), which both have greater warming potential than CO_2. It is also important to note that of the insect species deemed viable for human consumption in Western societies, none produce CH_4. Figure 3 illustrates all the elements of the livestock food chain contributing to greenhouse gas emission.

Figure 3 – Relative GHG contributions along the livestock food chain



Source: Bonneau (2008) cited in FAO (2013)

Water use: Increasing demands of global water supply are a threat notably for food production. It is estimated that agriculture consumes about 70% of freshwater worldwide. 1kg of chicken requires 2'300 litres of water, 1kg of pork requires 3'500 litres and 1kg of beef requires 22'000 litres of water (including water required for forage and grain production) according to Chapagain and Hoekstra (2003) and supported by the FAO (2013). Some sources say that some insects don't necessarily need water as they get it from the water retained in food, but there is no assertive study on that matter, although we can assume that the levels are much lower.

Animal welfare: There isn't any existing studies on how insects feel pain. Therefore, this argument isn't viable to be compared with the pain endorsed by livestock during the whole food chain process. Other factors of welfare can be compared more easily, for example the feeling of discomfort which relate to crowding and the tolerance of certain levels of rearing densities. To ensure animal welfare, livestock and farmed insects should be provided with adequate space. As we know, in most of the times, it is not the case due to intensive process. However, the notion of space is not similar for livestock than for insects, as the latter naturally occur in high density and have tendency to cluster.

2.5 Nutritional value of edible insects

The nutritional values of edible insects can vary in function of their life stage (i.e. metamorphic stage), their habitat and diet, the preparation and processing methods, and also depending on the species (FAO, 2013). The main components of insects are protein, fat and fibre. In figure 4, we can see a table with nutritional values of most commonly consumed insects in the West as compared with common sources of proteins such as beef, pork and chicken. The nutritional intakes are for 100g of meat.

Figure 4 – Nutritional intake for 100g of meat

Common name	Cricket	Mealworm (adult)	Beef	Pork	Chicken
preparation	Fresh: blanched, inedible parts removed	whole raw, fasted	ground/ raw	ground/ raw	ground/ raw
moisture (%)	73.3	63.7	65.81	64.46	73.24
protein (crude measured as Nx6.25)	47.9	65.3	17.37	15.41	17.44
Fat (% crude fat)	21.3	14.9	17.07	17.18	8.10
fiber (a, acid detergent fiber; b, crude fiber)	13.5b	20.4a	0	0	0
Ash	9.4	3.3	0.86	0.79	1.17

Source: USDA National Nutrient Database (2015); Bukkens (1997); Finke (2007); Finke (2013); Ramos-Elorduy et al. (1997).

From this table, we can conclude that in terms of nutrition, insects are more beneficial than other sources of meat and are a healthy source of protein.

2.6 Summary

To summarize, we have seen that although insects can be considered a delicacy in some parts of the world, it is not the case in western societies. Since it has been observed in the nineteenth century, the practice has been reported as a form of revenge on those detrimental beings.

Apart from their nutritional aspect, insects don't carry much benefit, which makes them less rentable than other terrestrial mammalians. In addition to that, tropical climate is more suitable for insect rearing, which is another argument against their consumption in the West.

However, the adoption of insects in our diets could potentially limit the effects of agriculture on global warming, especially knowing that insects have high nutritional values which allow them to be a great contestant against regular meat.

We have seen thanks to the study made by the federal food safety and veterinary office that the Swiss population is a big consumer of meat, eating on average more than three times the quantity recommended by the government.

After acquiring some knowledge about the eating habits of the Swiss population, understanding how eating meat has a negative impact on global warming and on the depletion of resources, and why entomophagy could be a sustainable alternative to meat consumption, the purpose of the analysis is to try to determine if the population in Geneva would be willing to change its eating habits by including insects in its diet, and thanks to that, determine if there are some business opportunities around entomophagy.

3. Methodology and data

3.1 Methodology

“Sensory and consumer science emerged in the early half of the 20th century, mostly as a support tool to product development, to study perceptual reactions to ingredients, chemicals, and product modifications (Moskowitz, 2017). Sensory scientists were also interested in understanding consumer perception, and started measuring consumer acceptability, or degree of liking” (Ares & Varela, 2018)

This research paper was made using the basis of consumer science methods.

Sensory evaluation is a “scientific discipline used to evoke, measure, analyse and interpret reactions to those characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing” (Stone and Sidel, 2004).

“Information on consumer likes and dislikes, preferences, and requirements for acceptability can be obtained using consumer-oriented testing methods and untrained sensory panels.

In true consumer testing a large random sample of people, representative of the target population of potential users, is selected to obtain information on consumers' attitudes or preferences. Consumer panelists are not trained or chosen for their sensory acuity, but should be users of the product. For this type of testing 100 to 500 people are usually questioned or interviewed and the results utilized to predict the attitudes of the target population. Interviews or tests may be conducted at a central location such as a market, school, shopping mall, or community center, or may take place in consumers' homes. Because a true consumer test requires selection of a panel representative of the target population, it is both costly and time consuming. Therefore, untrained in-house consumer panels are commonly used to provide initial information on product acceptability and often are conducted prior to true consumer tests.

In-house consumer panels (pilot consumer panels) usually consist of 30 to 50 untrained panelists. It is advantageous to use as large a panel as possible. This type of panel can indicate the relative acceptability of products, and can identify product defects. Results from in-house consumer testing should not be used to predict product performance in the marketplace, however, because in-house panels may not be representative of the actual consuming population.” (Watts, 1989)

In this research, we want to evaluate the level of liking or disliking of a product. The method used for this evaluation is called hedonic or affective testing. It answers the question “How well are products liked or which products are preferred” and is made with untrained panelists.

To answer the question “How would the population in Geneva welcome a change in diet oriented towards entomophagy?” the method consisted of an analysis in three distinct but related parts as follows:

- Part 1: blind taste test
- Part 2: free word association
- Part 3: taste test after an information session on entomophagy

The three-part experiment consisted of inviting as many people as possible from all ages and living in Geneva. To do that, an invitation was shared over social network (see Appendix 3). The invitation included a section asking to share it among friends and family, to motivate people to come as a group and to extend the list of participants. To participate, the candidates had to be present at least to the blind and the non-blind sensory experiments that happened in two different dates with one-week interval and they could choose among two different time slots for each date. Once they registered for participation, a confirmation was sent by email with the location, date and time. The participants only knew that they were participating in a sensorial analysis in two parts and that they would be tasting cereal bars but they had no idea of the subject of the research, to avoid bias.

Getting a large amount of participants was expected to be a challenge compared to doing an online survey for example. However, this method was chosen for a question of preference and belief that information gathered through this research method are of higher quality and accuracy compared to questionnaires.

The whole experiment took place in a room at the HEG. Although formal taste tests happen in separate boxes, helping avoid communication between participants, it was a bit difficult to organise, so the candidates were not isolated.

Preparing the experiments: The two taste tests were made with the exact same sample of products which were a set of six cereal bars; three of them without insects and the other three contained edible insects. Of the products, two of those without insects were industrial (bought in a supermarket) and the remaining were homemade. In order to select a sample of products, healthy cereal bar recipes were found on the internet and

some ingredients were substituted with insects because insect-based recipes were hard to find. Once all of the recipes were gathered, they were first tested all once before the experiment, by a small group of people that wouldn't participate to the experiment, in order to taste the result and evaluate if they were well balanced in terms of ingredients and cooking.

The candidates would evaluate the products according to three criteria: firstly, they would evaluate them on a scale from 1 to 7, 1 meaning that they don't like it at all and 7 meaning that they like it very much, in terms of overall product appreciation. Secondly, they would give adjectives relative to the taste and finally they would describe the texture in their own words.

In the meantime, as the date of the experiment was approaching, the names, ages and gender of the participants were collected thanks to an online form that they had to fill-in. This would help during the analysis to sort the data demographically, if possible.

Finally, each product had a code number from 01 to 06 and each participant had a numerical code. The product code helped recognize which product the participant was evaluating, as they were disposed in a random order. The participants' code helped identify which participant evaluated which set.

3.1.1 Blind sensory experiment

The room was set up before the arrival of the participants. Each table disposed of the six samples of cereal bars in random order. The plate had a 4-digit code. The two first digits corresponded to the participant's identity and the two last digits were the product number. A cup of water for mouth rinsing, a napkin for spitting or cleaning, and napkins to cover the cereal bars were also disposed in each seat.

The participants waited outside the room until the time of the meeting and until they were all present. It was important for this first part that they all entered the room at the same time due to the "blindness" issue. Once they were all seated, they received the instruction to taste each product from left to right and evaluate them one by one. Tasting them from left to right was a matter of convenience as the products were already disposed in a random order. The participants also needed to rinse their palate in-between each product. For the evaluation, they had to use the product code and write it in the space provided for it (see Appendix 2). Noting the product code was essential in order to recognize which product corresponded to each description when running the analysis. Finally, they had to remain silent during the whole experiment in order to avoid bias for

other participants. Once the first part of the experiment was completed, they could leave the room and they weren't provided with any further information.

3.1.2 Free word association

As the participants arrived in the second day of the experiment – that happened one week later than the blind taste test – they were taken individually in a separate room and were asked to respond the first word that came to their mind when they heard the word "summer" (as a warm up phase) and then, in the same order the words "cereal bars", "proteins", "insect" and "insect in the plate". This interview was audio recorded for a matter of convenience and to re-transcribe the answers later. After all the participants answered individually, the third part of the experiment started.

3.1.3 Sensory experiment after an information session on entomophagy

The set-up of the room was the same than for the first part of the experiment and the same products were used. When the participants took their seat, they had a PowerPoint presentation on entomophagy (see Appendix 4). At the beginning of the presentation, the participants were all asked as a group if anyone knew what the word entomophagy meant. Nobody knew, so they were shown a picture of a person eating insects. The presentation was very short and simple and straight to the point. The first slide was about the increasing population, the second slide was about agriculture and its impact on global warming, then a comparison between how much resources are needed to grow insects versus beef, pork and chicken. Finally, the last slide was about the nutritional intake and the benefits for health. After this presentation, they were allowed to ask any question and finally they could remove the napkins to see what they were going to eat. From there, they were told about all the ingredients contained in each product, including the insects, and they could start tasting each product – not knowing that it was the same sample as the previous week – and grading them as they did for the first part. The participants that were not in measure to taste a product for any reason attributed the grade of 0 on the scale from 1-7. More details are provided on the protocol in Appendix 2.

3.2 Description of data collected

As explained in the methodology, the experiment intended to gather three types of data:

- Level of likeability of a product on a scale from 1 to 7
- Free description of a product's taste and texture
- Free word association

This data collected intended to: first, assess whether a product cooked with insects had a potential of being appreciated, even when the preconception bias is not affecting the degree of likeability, hence the blind test. Then, test if the preconception bias really affects the degree of likeability. The data collected in the free word association will help confirming, or not, whether the population has a feeling of disgust towards insects.

The analysis will be made using the following hypotheses:

- There is a significant difference in the mean levels of likeability of the same product from the blind to the non-blind taste test.
- There is a significant difference in mean levels of likeability between each product during the blind taste test.
- There is a significant difference in the mean levels of likeability between products with versus without insects in the non-blind taste test.
- A significant proportion of the population associates protein with meat.
- A significant proportion of the population considers insects as a source of nuisance.
- A significant proportion of the population isn't willing to taste a product containing insects.
- A significant proportion of the population considers that insects for food is disgusting.

Regarding the data gathered, the first two data had to be collected twice for each participant. As some participants didn't show up on the second day of the experiment, the answers they provided on the first day weren't collected because they would not be relevant for the analysis.

The free word association had to be preferably collected after the blind taste and before the taste test with information session. However, as this experiment required less resources to collect more data, other people from Geneva that didn't participate to the taste tests and that weren't aware of the topic were interviewed.

The purpose of doing a two-phase taste test was to compare:

1) The level of likeability when eating a product that contained insects without the preconception bias (i.e. blind test) versus the level of likeability when the candidates knew exactly what was in their plates.
2) The words employed when describing a cereal bar, without knowing the ingredients contained versus after seeing the insects present in the food.

The free word association helped understanding what people associate as a source of protein, how they judge insects, and how they welcome insects in their plate. It also helped differentiate how they react when they think of an insect in their plate versus how they welcome it after receiving some sensitization on the benefits for the environment and for the health.

4. Analysis

4.1 Free word association

The vocabulary analysis proceeded in the following steps:

- Make a list of all terms
- Reduce the list (lemmatization, categorization)
- Translate the answers from French to English
- Compute the frequency of occurrence of each term
- Make a frequency table
- Analyse and comment on the results and findings

Figure 5 shows the frequency tables for each term, excluding summer that was just a warmup phase and that is not relevant for the analysis.

The first observation is that the more specific is the term employed, the more there is an outstanding answer. In addition to this, on average contestants answered faster to the term “insect” and their response was even more straight forward when asked what they thought about “insect in the plate”. Unfortunately, no record of the time between each answer was kept but it could have added value to the analysis to compute an average answer time for each term interviewed.

Figure 5 – Frequency table

cereal bar	frequency	relative frequency
sweet/sugary	5	20%
chocolate/ toffee	4	16%
cereal	6	24%
food/ eat	4	16%
protein/ energy	2	8%
sport/ fitness	3	12%
good	1	4%
Total	25	100%

protein	frequency	relative frequency
sport/ fitness/ health	12	48%
meat/ white meat	8	32%
bean	2	8%
banana	1	4%
vitamin	1	4%
dislike	1	4%
Total	25	100%

insect	frequency	relative frequency
disgusting	11	44%
mosquito/fly/bee/etc.	10	40%
earth/ nature	3	12%
grilled	1	4%
Total	25	100%

insect in the plate	frequency	relative frequency
disgust/ not edible	18	72%
experience	5	20%
china	1	4%
weird	1	4%
Total	25	100%

Thanks to the lemmatization and categorization, we can more easily observe a pattern of response, and for each term we can retain two answers that occur in at least 20% of the answers.

The term cereal bar is the one where responses are more differentiated and there is less of an obvious opinion on the matter. However, the two words that come out at a frequency of at least 20% are sweet and cereal. Cereal is a word that is included in the expression cereal bar, so we can assume that the term didn't inspire much. One guess is that a cereal bar can come and is known in many different forms and there is a wide range of these products in the supermarkets, which can create confusion when trying to think about one.

Another interesting observation about this term is that no participant cited a brand name, despite many well-known and established ones for cereal bars here in Geneva. Indeed, the initial thought was that some brands are so powerful that people would associate a common product with their favourite brand. If this was the case, we could have assumed that for a company promoting the consumption of insects, the marketing and brand image would be important. But from these answers, the success of a cereal bar is more about the flavours or the purpose – we could also put energy and sport in the same category and it would serve as the purpose to get a source of energy.

Second, comes the term protein. If the term was "source of protein" instead of just protein, the answers could have been more precise as the aim was to find the sample's first aliment source of protein. We can still observe that among the aliments cited, meat is on top of the list and then comes beans. Therefore, the sample refers to traditional means of agriculture when it comes to sources of proteins. We can also observe that protein is strongly related to sports. So a little bit like with cereal bars, the term is associated to a purpose.

Then comes the term insect. There are two distinct elements of answer for this one. On the one hand, participants think of insects in a negative way and associate it directly with disgust or an unpleasant presence. On the other hand, there are the participants that think of specific types of insects. One explanation to why almost half of the sample answered "disgusting" when they heard "insect" is that, as discussed in the literature review, insects are commonly associated with a source of nuisance in Western culture and are not commonly welcome. Whether it be in homes or in gardens, people tend to reject them or even kill them when they can because they are perceived as annoying or dirty. For that reason, people might have had a feeling of disgust when thinking of an insect.

The other half of the sample thought of insects as an element of nature – in fact, all types of insects cited by participants and earth/ nature could also be categorized all together.

The answers provided for the third term were quite expected, with most people associating it with an element of nature and almost half that conveyed a negative thought on the subject.

The last term surveyed is similar but more specific than the previous one, because this time the aim is to know how insects are welcomed in the plate. Although this term is quite specific, it can be tricky and lead to confusion. Indeed, we can think of an insect in the plate as a mosquito or a fly that got in one's plate, still alive and dirty, which will most commonly – as seen earlier – trigger disgust. We can also think of insects in the plate as insects that are served in other parts of the world like in Thailand for example where Western tourist can see them on the markets and either be disgusted or be tempted to experience it for once. In those foreign markets, insects are often big and not dehydrated, unlike those that are starting to be sold in supermarkets in the West – notably in Geneva that is the market of study – which are small (crickets, mealworms) and dehydrated, so they aren't juicy nor particularly smelly. There may be other thoughts that come to mind when hearing about insects in the plate, but overall the general idea is about welcoming insect in one's diet.

For the large majority, the thought of insects in the plate triggers disgust and the answers were provided with no hesitation.

As the sample is quite small, categorizing the answers by age would not be possible in this case because more than half of the participants fell in the same age category between 20 to 30 years old, and the categories would have been too small to come to a conclusion.

4.2 Sensory experiment overall likeability

As explained in the methodology, the results were analysed only for the participants that were present both for the blind taste test (day 1) and one week later for the taste test after a presentation on entomophagy (day 2). In the following analyses, different levels of significance of the mean with different criteria will be tested.

4.2.1 Significance of the mean

By testing the significance of the mean, we can answer the question: “Do people agree on how much they like (or not) a product?”

Figure 6 – significance of the mean

*product 1 blind**	
Mean	3,407407
Standard Deviation	1,692955
Coefficient of variation	50%
Minimum	1
Maximum	6
Sum	92

*product 1**	
Mean	3,333333
Standard Deviation	1,901416
Coefficient of variation	57%
Minimum	0
Maximum	7
Sum	90

*product 2 blind**	
Mean	4,925926
Standard Deviation	1,567112
Coefficient of variation	32%
Minimum	2
Maximum	7
Sum	133

*product 2**	
Mean	4,074074
Standard Deviation	2,182552
Coefficient of variation	54%
Minimum	0
Maximum	7
Sum	110

product 3 blind	
Mean	4,851852
Standard Deviation	1,895414
Coefficient of variation	39%
Minimum	1
Maximum	7
Sum	131

product 3	
Mean	5,333333
Standard Deviation	1,037749
Coefficient of variation	19%
Minimum	3
Maximum	7
Sum	144

product 4 blind	
Mean	5,37037
Standard Deviation	1,497386
Coefficient of variation	28%
Minimum	1
Maximum	7
Sum	145

product 4	
Mean	5,259259
Standard Deviation	1,227649
Coefficient of variation	23%
Minimum	3
Maximum	7
Sum	142

product 5 blind	
Mean	5,703704
Standard Deviation	1,462738
Coefficient of variation	26%
Minimum	2
Maximum	7
Sum	154

product 5	
Mean	5,555556
Standard Deviation	1,154701
Coefficient of variation	21%
Minimum	3
Maximum	7
Sum	150

*product 6 blind**	
Mean	4,259259
Standard Deviation	1,318291
Coefficient of variation	31%
Minimum	2
Maximum	7
Sum	115

*product 6**	
Mean	3,851852
Standard Deviation	2,348546
Coefficient of variation	61%
Minimum	0
Maximum	7
Sum	104

*Products marked with a * contain insects*

Thanks to the coefficient of variation, we can compare the degree of variation from the blind to the non-blind test, and we can also compare the degree of variation between each product. We see that product 1 has a high ratio of variation on both days of the experiment. Thus, the data is too spread to assume that the mean is representative of the population's degree of likeability.

As for the other products, we can easily observe a change in the significance of the mean from the blind to the non-blind experiment. Indeed, from the coefficient of variation, we see that all the products (except n° 1) have quite a low degree of variation during the blind-test – resulting in the mean being significant. This level of significance becomes more interesting when we compare it between products tasted during the non-blind test. We see that the means of products without insects are very significant on the second day when the products were tasted non-blind and the participants knew the ingredients contained in the cereal bars. This low ratio means that there is little variation between the grades attributed by the participants, so the mean is representative of the average level of likeability. In other words, and to answer the question, people agree on how much they like products not containing insects when they are tasted non-blind. Oppositely, the means of products that do contain insects get a lower level of significance when they are tested non-blind. This result implies that independently of whether the mean of cereal bars get a lower or a higher score on the second day, the results aren't representative because people don't agree on how much they like this product. In order for the mean to have a higher degree of significance and be representative of the average level of likeability, the sample should be larger.

From this analysis, we can draw that when tasted blind, the mean is more representative of the level of likeability for all the products, irrespective of the ingredients contained. Also, when the participants know about the components of the cereal bars, they agree more on how much they like the same product when it doesn't contain insects, and they agree much less on how much they like it when it has insects.

This observation can have multiple explanations. Firstly, as they are biased by the information they receive on the components on the second test, the participants will evaluate the product according to what they are used to like or eat (for example: they know that they love chocolate so a cereal bar with chocolate will get a higher grade). Secondly, the fact that they don't like a product at all can influence them to attribute a higher grade to another product they like more. Although they are supposed to rate each product independently of each other, as they were asked to, it is a natural behaviour to evaluate by comparison. We see that the means of products without insects don't change

much from the blind to the non-blind experiment (see analysis of significant change in means in part 4.2.2 of the report) but they become more significant on the second day. When we look at the minimum and maximum grade for those products, we also see that the minimum grade attributed on the second day is higher than on the first day. Then, some participants might not have let their conception of insect influence their taste, and like the product just as much as the first day (although they didn't know it was exactly the same product). However, other participants did let their preconception influence their decision, even sometimes deciding not to try the cereal bar. The fact that some participants didn't try some cereal bars and attributed a grade of 0 also influences the level of significance of the mean, because the minimum grade of 1 meant "I don't like it at all" but in this case 0 implies that the product could not be evaluated, probably due to disgust (see adjectives used in figure 9).

Finally, to answer the question "Do people agree on how much they like (or not) a product?", we can answer that they do have pretty much the same level of likeability about the general taste of the cereal bars when they are tested blind (except product n°1), so the mean is significant on the first day. On the second day, the means of products containing insects are not significant and there is a lot of variation between the answers provided. On the other hand, means of cereal bars not containing insects become even more significant on the second day. So the people do agree on how much they like the cereal bars but are most likely biased by their preconception of insects, which results in higher degrees of likeability and of representativeness during a blind taste test.

To summarise, the mean doesn't always explain or justify the overall level of likeability of a product. We have seen that with the products containing insects, when the sample sees the cereal bar, the levels of likeability are very divergent, which implies that the results will be more spread and away from the mean. Oppositely, products without insects become more commonly appreciated, with results closer to the mean.

4.2.2 Significant change in means

The purpose of this t-test is to compare and determine if there is a significant difference in means between day 1 and day 2. Here, we want to test if the likeability of a product changes when information on the ingredients are provided, compared to the blind test. To do so, a t-test for paired samples was made as follows and the level of significance with the t-test formula was computed in Excel:

Null hypothesis (H0): $\mu 1 = \mu 2$ (There is no significant difference between the means)

Alternative hypothesis (HA): $\mu 1 \neq \mu 2$ (There is a significant difference between the means of day 1 and day 2)

Level of significance ($\propto$) = 0.1

Figure 7 – t-test: paired two sample for means

	product 1 blind*	product 1*	product 2 blind*	product 2*	product 3 blind	product 3
Mean	3,41	3,33	4,93	4,07	4,85	5,33
Level of significance	0,436		0,048		0,071	

	product 4 blind	product 4	product 5 blind	product 5	product 6 blind*	product 6*
Mean	5,37	5,26	5,70	5,56	4,26	3,85
Level of significance	0,359		0,230		0,185	

If $\propto$ is smaller than 0.1, then we reject H0 and it means that there is a significant difference of means.

In figure 7, the results highlighted in yellow imply that we can reject the null hypothesis and that the means are significantly different from day 1 to day 2, with 90% confidence interval. There are only two products for which the mean is significantly different. One of which contains insects (*) and the other not. As we can see from the mean results, on average, the participants have the same level of likeability over a same product regardless of whether it is tested blind or not. There are only two over six products tested that demonstrate a significant change in taste from one day to another. However, as seen in the previous test, the means are less significant on the second day for the overall likeability of the products containing insects.

From this analysis, it is difficult to draw a clear conclusion. We could say that the preconception bias doesn't have a significant impact on the degree of likeability of a product, but we have seen on the previous analysis that the mean is not significant when products are tasted non-blind. One assumption would be that there are two groups of people in the experiment. One group that would be open to entomophagy and one group that is not ready to eat insects yet, thus the reason why the data fluctuates so much. A lager sample would give more assertive data.

4.2.3 Test of equality of means between products

Figure 8 tests the equality of means between different products and is divided as follows:

- blue – both products compared contain insects
- green – none of the products compared contain insects
- orange – comparison of one product with insects versus one product without

Results highlighted in yellow indicate that there is a significant difference in likeability between two products tested, thus we reject the null hypothesis.

$$H0: \mu 1 = \mu 2 \qquad HA: \mu 1 \neq \mu 2 \qquad \propto = 0.01$$

Figure 8 – level of significance between products

Products compared	Blind test	Non-blind
Pr1* Pr2*	0,00	0,09
Pr1* Pr6*	0,02	0,19
Pr2* Pr6*	0,048	0,36
Pr3 Pr4	0,13	0,41
Pr3 Pr5	0,04	0,23
Pr4 Pr5	0,21	0,18
Pr1* Pr3	0,00	0,00
Pr1* Pr4	0,00	0,00
Pr1* Pr5	0,00	0,00
Pr2* Pr3	0,44	0,00
Pr2* Pr4	0,15	0,01
Pr2* Pr5	0,03	0,00
Pr6* Pr3	0,09	0,00
Pr6* Pr4	0,00	0,00
Pr6* Pr5	0,00	0,00

Firstly, the more noticeable observation is that when tested non-blind, products of the same categories aren't significantly different, while those that compare cereal bars with insect versus without insects have a significant difference in the average level of likeability. However, when tested blind, we can see in the orange category that products 1 and 6 have a significant difference in the mean level of likeability compared to the other products not containing insects. For that reason, we can say that there is already a change in means between products with and without insects even without the preconception bias. So maybe the ingredients used for the cereal bar with insects were not selected properly and the recipe should have resembled more to an industrial, sweeter cereal bar in order to obtain a higher level of likeability.

Secondly, the blue and green part – which compare cereal bars of the same type – show that when tested non-blind, the level of likeability is the same and we can't reject the null hypothesis. There is a clear preconception bias and we notice that the participants did the process of putting the different products in categories just like it was done for the analysis.

The behaviour they adopted in day 2 confirms that there is a preconception bias, also that a cereal bar containing insects can't be considered equal as a regular cereal bar despite the taste being very similar and the level of likeability being the same in half of the cases when tasted blindly.

Another interesting observation is that half of the products compared in the orange section, as mentioned, have a significantly different average level of likeability. This can be influenced by the comparison between industrial, sweeter and home-made, more natural products which is a mistake in the selection of the ingredients that should have been more alike. And the fact that there is only half of those products that have a significantly different mean on the first day compared to all of those having a different mean on the second day, also shows that the evaluation of the products tested non-blind was not based on the same criteria as the first day which was purely gustative.

4.3 Free product description

In this part we will analyse the vocabulary employed when describing the taste and texture of each cereal bar and compare the differences in the terms used when describing a product blind versus non-blind, as well as the difference between products.

The vocabulary analysis proceeded in the following steps:

- Make a list of all terms
- Reduce the list (lemmatization, categorization)
- Translate the answers from French to English
- Compute the frequency (freq.) of occurrence of each term and frequency over the total number of participants (27) to give the relative frequency (rel. freq.)
- Reduce the list by removing the terms that occurred at less than 10%
- Make a frequency table
- Analyse and comment on the results and findings

Figure 9 – free product description

Product 1* day 1

Taste			Texture		
Free decription	Freq.	Rel. Freq.	Free decription	Freq.	Rel. Freq.
savorless	9	33%	dry	9	33%
cereals	9	33%	soft	5	19%
not sweet/ no sugar	6	22%	cakey	5	19%
chocolate/cocoa	6	22%	pleasant	3	11%
bitter	5	19%	crunchy	3	11%
good taste	4	15%			

Product 1* day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
chocolate/cocoa	14	52%	soft	10	37%
insect/can't eat	5	19%	cakey	6	22%
cereals	3	11%	crunchy	5	19%
pleasant	3	11%	dry	3	11%
sweet	3	11%			

Product 2* day 1

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
chocolate	19	70%	soft	17	63%
fruity	9	33%	pleasant	9	33%
banana	6	22%	good taste	5	19%
tasty	5	19%	crunchy	5	19%
too sweet	4	15%	hard	3	11%

Product 2* day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
chocolate	17	63%	soft	12	44%
banana	8	30%	crunchy	7	26%
sweet	5	19%	pleasant	6	22%
insect	5	19%			
good	3	11%			

Product 3 day 1

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
fruity	18	67%	soft	15	56%
sweet	6	22%	pleasant	6	22%
good	6	22%	gelatinous	3	11%
tasty	5	19%	light	3	11%
raisin	4	15%			
cereals	3	11%			
acid	3	11%			
fresh	3	11%			

Product 3 day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
fruity	15	56%	soft	15	56%
apple	9	33%	cakey	3	11%
good	8	30%	humid	3	11%
sweet	7	26%	pleasant	3	11%
light	5	19%			
cinnamon	3	11%			

Product 4 day 1

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
sweet/sugary	13	48%	crunchy	19	70%
cereals	8	30%	pleasant	6	22%
good	5	19%	dry	3	11%
tasteless	6	22%	hard	3	11%

Product 4 day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
sweet/sugary	14	52%	crunchy	22	81%
cereal	9	33%	pleasant	3	11%
good	4	15%			

Product 5 day 1

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
sweet/sugary	13	48%	crunchy	16	59%
cereals	9	33%	dry	5	19%
good	7	26%			
tasteless	5	19%			

Product 5 day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
sweet/sugary	17	63%	crunchy	19	70%
cereal	7	26%	dry	7	26%
good	6	22%	pleasant	4	15%

Product 6* day 1

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
little sugary	11	41%	soft	17	63%
cinnamon	11	41%	pleasant	4	15%
tasteless	7	26%	hard to chew	4	15%
cereals	5	19%	not good	3	11%
banana	5	19%			
good	5	19%			

Product 6* day 2

Taste			Texture		
Free description	Freq.	Rel. Freq.	Free description	Freq.	Rel. Freq.
cinnamon	9	33%	soft	13	48%
little sugary	7	26%	crunchy bits	5	19%
tasteless	6	22%	cakey	5	19%
cereal	3	11%	pleasant	3	11%
fruity	3	11%	visually disgusting	3	11%
good	3	11%			

Those are the different observations drawn from figure 9:

- Products 1, 4 and 5 were described as tasteless in day 1 but not in day 2, whereas product 6 was considered tasteless both times.
- The notion of taste isn't likely to be related to the amount of sugar because products 4 and 5 are considered sweet or sugary by almost half of the participants and still nearly 20% found it tasteless.
- Products 4 and 5 have very similar description, it's only the frequency that varies slightly. From the terms used, they are almost the same product.
- The term that comes out the most is the notion of sugar or lack of sugar for product 4, 5 and 6 in both days
- Descriptions are very similar from day 1, when participants didn't know about the ingredients to day 2 when they knew.
- In day 1, they tried to guess the ingredients and they were quite accurate, which explains why the description doesn't change much in day 2.
- Description of products containing insects didn't become more negative in day 2 and the terms employed are pretty much similar. The only subtlety is that almost 20% of participants mentioned the term insect in the description for products 1 and 2 and over 10% described product 6 as visually disgusting.

Overall, we note that the comments don't become negative on the second day. Although some participants raised an observation about insects, there was no specific comment about the latter's taste nor any expression of disgust. It is true that some participants weren't able to taste the cereal bars due to the visual aspect but the taste didn't affect the adjectives used in the description of the products. This analysis proves positively that insects are not disagreeable in taste and it is more a concern about the visual aspect.

4.4 Summary of the analysis

The free word association experiment confirmed the argument that insects trigger disgust. As it is not common and not part of the culture to consume insects, they are more often seen as a being that belong on the outdoors and not at home, even less in the plate. When asked what they think about insects, the large majority of the sample finds it disgusting to have insects on the plate and think that insects are not edible.

The test of overall likeability provided different answers. When testing the significance of the mean, we could see that when tested blind, people agreed more on the level of likeability of products with insects, and the means showed that the products were more appreciated. While during day 2, the results had a high degree of variation, making the mean less significant. This analysis, combined with the free word association, helped us confirm the assumption that there is a preconception bias and the fact that the sample surveyed was disgusted by the idea of having insects in the plate influenced their level of likeability on the second day, but not homogeneously because there were some

outliers, like for example those who weren't able to taste the products and attributed a grade of 0, and those who were not negatively affected by the presence of insects and still attributed a very high grade, based on the taste. Testing the degree of significance of change in means from day 1 to day 2 allowed us to note that only two products' means changed significantly. One product whose mean decreased significantly at 90% confidence interval was one of the products containing insects. The other whose mean increased significantly at the same confidence interval was free of insects. These results show that entomophagy could be accepted because the presence of insects didn't affect the mean. However, we must keep in mind that the sample must be larger in order for the mean to be significant on the second day also.

From the last comment, it is also important to add that the experiments were slightly biased by social pressure. Indeed, although sensory experiments should normally occur with participants not being able to see each other, it was quite difficult to organise and in this case the participants were all in the same classroom with no separation between them, which allowed to see each other's reaction and be tempted to taste the products after a few minutes of hesitation, just because the person next to did it. Therefore, for this analysis to be the most accurate possible, the tests should be done in stricter conditions in order to limit such biases. When testing the equality of means between products, we saw that when products were tested non blind, there was a bigger gap in the means for all comparisons of products with versus without insects. This argument also comes to confirm the preconception bias but we have to keep in mind that the mean results were not significant on the second day for cereal bars with insects, which is explained by a large variation in the level of acceptance. This last argument implies that there may be a public that is not negatively affected by the presence of insects in their food and that there may be a market segment to target. In this case, further analyses and studies would need to be done to understand which type of public is open to entomophagy.

Finally, we have seen that the free product descriptions don't differ a lot from day 1 to day 2. The only noticeable observation is that for the three insect-based products, ten to twenty percent of the sample cited insects in the description, which was a visual observation and not an observation in the taste because dehydrated insects have no distinctive taste especially when mixed with many other ingredients, and if they did, the same people that mentioned insects could have mention "unfamiliar taste" or something similar during the blind test. Therefore, we can assume that for entomophagy to be more easily accepted, marketable insects can be mixed in order to remove the visual effect and attract a larger public.

4.5 Improvements

In the free word association, a record should have been kept of the time it took for the participants to provide an answer for each term. It would have been valuable to have a measure of how fast the sample answered when they heard the last term compared to the first one, and it would have reinforced the sentiment of disgust that won at a large majority (over 70% of the sample surveyed associated insects in the plate with disgust).

After gathering the data, it must be admitted that the second taste test could have been done differently, separating the group in two: one would get the information session before evaluation, while the second group would just see that there are insects in the cereal bars and would be asked to evaluate them without any more instructions or prior sensitization on the subject. This method would have allowed to determine whether the presentation on entomophagy had an effect on their perception of insects or not.

As mentioned in the summary of the analysis, with more resources, the taste tests would have been done separating each candidates so that they couldn't hear or see each other. It would also have been preferable to have more participants. The aim was to have at least fifty participants for the sample to be more representative but it was very hard to get volunteers, especially because there was no reward for their time, which would have given an incentive to participate. Moreover, with more participants there could have been demographic categories for a more complete analysis. However, if this analysis were to be made outside of academic context and for a new product marketing for example, the sample would need to be much larger and it would require more resources.

5. Discussion

As this market is still a niche and it is quite tricky from the analysis to draw a clear conclusion on whether our target population would be open to entomophagy in the near future, a complement to the analysis was made by contacting Essento Food SA – a Swiss start-up company that commercialises insect-based products – in order to know more about their strategy and how they succeed in selling their products in such a niche market. Here are the information gathered thanks to Mr Timothée Olivier, public relations and sales representative at Essento Food SA:

The start-up markets its products through different selling points such as restaurants, retail markets like Manor and Coop, and through their online shop. Their target customer is between 25 to 55 years old, mostly urban and sensitive to the environment, to ethics or curious of alternatives to current alimentation.

The company's slogan is: "insects are delicious, healthy and sustainable":

- Delicious: insects can be prepared and eaten in different forms – sweet, salty, roasted, cooked, raw, dry, dried, freeze-dried. The Swiss company does cooking classes around the country.
- Healthy: insects tend to be concentrated, we need vitamins, minerals (B12 vitamins) and unsaturated fats.
- Sustainable: insects are good for the environment

When asked if this market will remain a niche in the long term or if it will expand, the company responded: "We believe that the market will expand, that more and more people will be eating insects or insect products, products where insects are invisible. We have already noticed the changes since 2017: before, 30% of the population was ready to eat insects. Today, we are around 50% (our statistics during our events and tastings). Almost all people know what insects are, what they contain (proteins), but many have never eaten any."

One issue that may retain one's attention when shopping insect-based products is the price. Indeed, compared to a regular cereal bar, insect-based protein bars are relatively expensive. The company was asked if there is a way that products will become less expensive over time and align with the prices of other "regular" products.

This was the answer provided by Mr Olivier: "The prices of our products have already fallen over the last year. The new bio burger and dumplings are cheaper than the previous (non-organic) dumplings and burger. Protein bars are the cheapest on the market, with so many proteins, and most importantly, they are the only protein bars that are good in taste! Our prices for dried insects have dropped drastically since one year,

as have the prices for gastronomy. The kilogram of frozen mealworms costs CHF 64.- for a restaurant owner, which is equivalent to the price of good, local and organic meat."

In the light of the answers provided by the Swiss start-up, we can optimistically say that entomophagy is progressively starting to be accepted. In one of the answers, Mr Olivier says that almost 50% of the population is now ready to eat insects but this statistic may be biased by the fact that these are respondents that come to their events so they most likely have an interest for this practice and don't represent the whole Swiss population. However, it is still an optimistic figure that increased from 30 to 50%, which also shows that more people are curious and open about the topic.

If we relate the answers with the analysis, we have seen that the thought of insects triggers disgust among over 70% of the sample surveyed. However, we have seen that only one of the three products containing insects has a significant change on the average level of likeability. This can be explained by the fact that, as the start-up said, people have never tasted insects so they can only imagine their taste. It is a similar behaviour to that of children when they see a vegetable. It is not attractive but when we know about the benefits and get to taste it, we realize that it is actually good.

The information session on the second day is likely to have had an influence on participants' perception of insects as food. The candidates understood what was at stake which made them more sensitive to the subject. There was also a social bias, which can be considered when trying to market such products. Some articles say that it is easier to be influenced in a social setting, so that could give brands some ideas to attract new customers.

The two main recommendations drawn from the overall analysis is that firstly, information is almost mandatory to attract new customers, especially because we are talking about a niche market which implies that we need to raise awareness in order to attract a broader public. The population needs to know about the benefits and be sensitised to the cause and the reason why insects are the food of the future. Awareness campaigns can be a good way to sensitise the population, awaken curiosity and trigger interest. Secondly, exposing the subject during social settings could be a smooth approach to awaken interest and eliminate prejudice, as we have seen that the social pressure might have influenced some of the participants during the experiments, who overcame their fears and then realized that it was actually good and that other people were open to taste this unfamiliar product.

6. Conclusion

To conclude this project based on the information gathered, we can say that historically, insects are not welcomed as a dish in western culture. However, the analysis show that some information and sensitization on the subject and the concern about global warming can open the minds of a new population of consumers that were until today not familiar with the practice. Indeed, the thought of those beings triggers disgust and apprehension. There is a preconception bias in some cases as we have seen that the average level of likeability has decreased in significance when participants were discovering the insects in one of their cereal bars. But most of the participants were willing to try all the cereal bars. There was only one out of the twenty-seven participants that didn't try any insect-based product on the second day. Some participants were retained to taste all the bars because in some cases the insects were too visible.

Moreover, this decrease in significance implies that although a proportion of the population attributed lower grades, there is also another proportion that attributed high ratings of the cereal bars despite the presence of insects. This indicator may indicate that the marketing of insect-based products targets a certain segment of the population and further analyses should be made to determine what group of people would be open to entomophagy, and whether people are influenced by the information they receive.

Furthermore, the significant change in means happened only on one of the three cereal bars containing insects. And we have seen the contrast between the answers provided in the free word association that were very bad versus the answers and grades provided in the taste test that were not significantly worse compared to the blind test. This shows that the presentation on entomophagy could have had a positive influence on the consumers' perception of insects for food, but as mentioned previously, it should have been tested by separating the group in two on the second day in order to assess whether it was the presentation that had an impact or not. In addition, from the interview with Essento, we understand that there is a positive trend towards the consumption of insects and it is triggering the curiosity and interest of a broader public.

This analysis helped to understand that although the targeted population still has a negative perception of insects, the tests as well as the interview showed that it is open to discovering and trying alternative ways to current consumption. If we did the same experiment separating the group in two on the second day – one group with a presentation on entomophagy and one group without any information – we could have had a better understanding of the influence of information and campaigns. At this stage, this only remains an hypothesis but there is more to explore on the subject.

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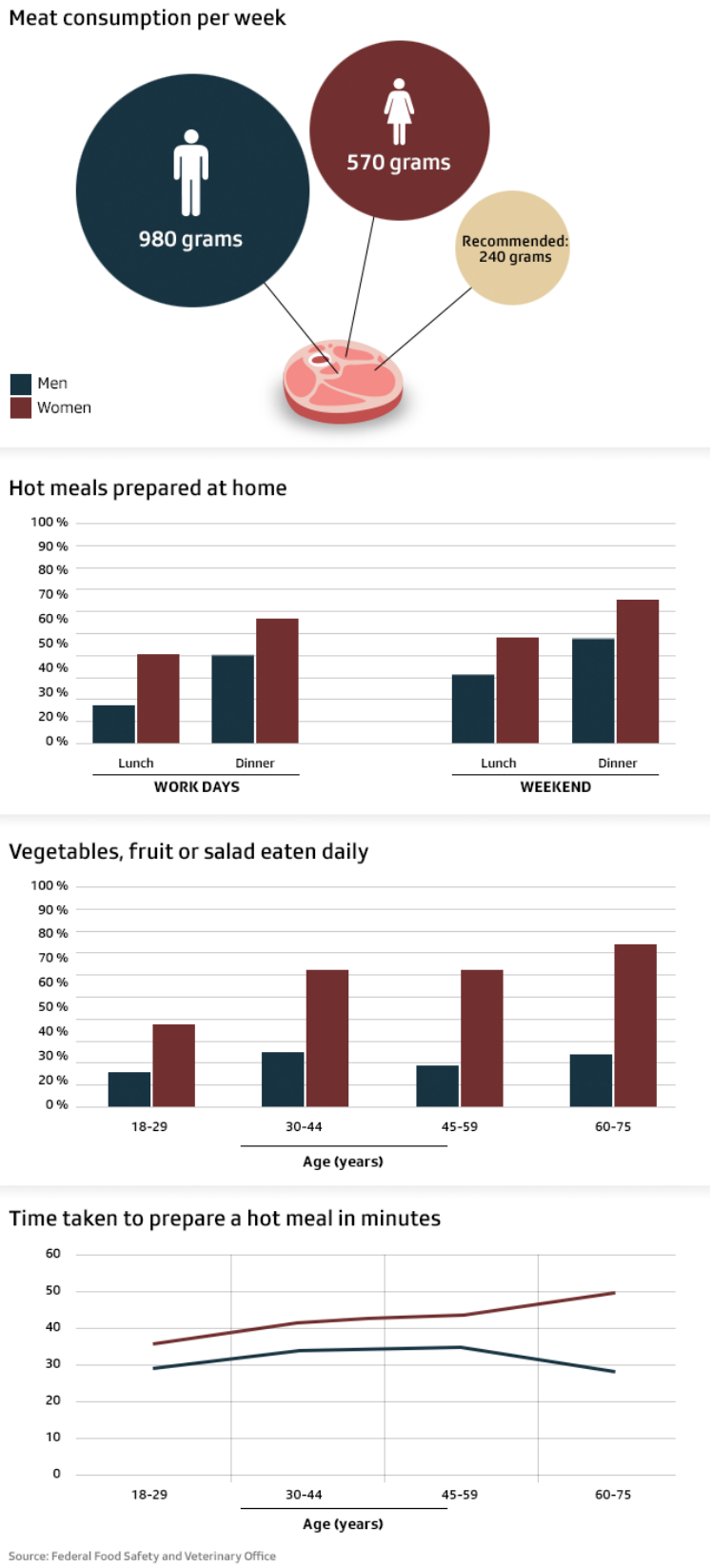
Appendix 1: Swiss eating habits



Source: swissinfo.ch (2017)

Appendix 2: PROTOCOL – insect for food tasting experiment

Effect of Geneva population's mental representation in sensory perception and acceptability of edible insects as substitute for other type of protein food.

Research by Sara Da Silva Ferraz – Haute Ecole de Gestion (HEG), Geneva

1. Aim

The experiment has for objectives: (1) to investigate the effect of the population's mental representation on sensory perception of insects for food tasted in the second part and (2) to evaluate the "objective" measure of likeability of a product when tested without any knowledge or information, as opposed to the "subjective" measure of likeability when the same products are tested after receiving some educational information on the ingredients, benefits on health and environment, and later determine the acceptability of insects for food by the population of Geneva.

2. Methods

Three tasks will be carried out: a free word association task (mental representation), a blind taste test (sensory perception is not biased), and a non-blind taste test (sensory perception is biased by preconception). The three tasks will be carried out within a period of 1 week, at the HEG in Geneva.

2.1 Free association task (mental representation)

2.1.1 Recruitment of participants

An invitation to participate to the whole experiment will be sent to residents of the Canton of Geneva. The aim is to obtain at least 30-40 positive answers, taking into account possible no-show or withdrawal from the first part to the second part. After accepting the invitation, each participant will fill in a form through the internet with his canton of residence, name, age, activity (employed, student, etc.), and allergies before coming to the first experiment. The free word association task can't only be performed before the blind taste test.

2.1.2 Procedure

Consumers interviews will be conducted individually, face-to-face. They will include a free word association task. As a warm-up phase, participants will be asked to give all the words or expressions that come to their mind when the experimenter says the inductor

words ***summer.*** After the familiarization phase, when participants will be comfortable with the procedure, the study directly begins: "*Tell me the first word that comes to your mind when I say* ***Cereal bar / Protein / Insects / Insects for food."*** All associations will be performed in French (official language of the Canton of Geneva). The task will last less than five minutes and will be audio recorded.

2.1.3 Data analysis

Firstly, all the words described by the assessors will be lemmatized and categorized. Secondly, the words will have to be translated from French to English.

2.2 Liking and description task

The experimental design will combine a liking evaluation and a description task. The treatments will be ingredients contained on the food (with edible insects and without insects) and information condition (blind and educated evaluation).

2.2.1 Assessors

As previously detailed, all the invitees that responded positively will be invited to join the evaluation. The assessors will be volunteers and will not receive any information about the aim of the experiment. The assessors will all be residents of the Canton of Geneva.

2.2.2 Foods

The sampling set will consist of 6 different products, homemade or industrial:

1. **Crunchy bar with insects, banana, honey and chocolate**

Ingredients: banana, honey, crickets, mealworms, crushed almond, dark chocolate 72%, oatmeal

2. **Energy balls with insects, chocolate and banana**

Ingredients: crickets, mealworms, banana, dried dates, hazelnuts, spelt mixture, oatmeal, date syrup, agave syrup

3. **Soft apple bar, oats and dried fruits**

Ingredients for the applesauce: golden apples, vanilla sugar, lemon juice, water, cinnamon

Other Ingredients: Dried Berry Mix, Dried Cranberries, Oat Flakes, Ground Almonds, Cinnamon, Agave Syrup

4. **Crunchy bars with whole grain oats and maple syrup**

Ingredients: whole grain oats (59%), sugar, sunflower oil, maple syrup (2%), honey, salt, molasses, emulsifier: sunflower lecithin, baking powder: sodium bicarbonate, natural flavouring

5. **Crunchy bars with whole grain oats and honey**

Ingredients: whole grain oats (59%), sugar, sunflower oil, honey (2%), salt, molasses, emulsifier: sunflower lecithin, baking powder: sodium bicarbonate

6. Soft bar with insects and cinnamon

Ingredients: oatmeal, almond milk, banana, egg white, almond puree, honey, cinnamon, crickets, mealworms

2.2.3 Experimental conditions

The samples will be placed in a small white plate and will be labelled with four-digit random codes. The food will be served according to a Williams Latin square design to balance presentation order. Tap water will be available for palate rinsing as well as napkins if participants need to spit. The sessions will be performed in two different days: During the first day, assessors will perform a blind sensory evaluation, while in the second day they will be given a short PowerPoint presentation on why the growing population and agriculture is directly linked to global warming, a description of entomophagy and why it is a good solution for the health and the environment. Finally, the ingredients on each cereal bar will be presented before they proceed to the tasting. The information will be provided as a short 5-10 minutes presentation before the test begins.

2.2.4 Procedure

In both sessions, participants will be invited to evaluate first their overall liking on a 7-point hedonic scale and then to carry out a description of the samples.

For the food overall liking evaluation, samples will be served one by one and will be asked to indicate how much they like each sample by ticking on a seven-point discreet scale anchored at the right end “J’aime beaucoup” (I like it a lot) and at he left end with “Je n’aime pas du tout” (I don’t like it at all).

For the free description task, after completion of the overall liking evaluation, participants will be asked to describe the item based on three criteria: Taste (goût) and texture

2.2.5 Data analysis

For the free description task, all terms will be listed, lemmatized and categorized, then translated from French to English. The frequency of occurrence of each term will be computed in order to make a frequency table before analysing and commenting on the results.

The taste test results will be analysed under different angles. Only the results from the participants that participated to both the blind taste test and the non-blind taste test will be analysed. For the overall level of likeability, the significance of the mean will be tested to answer the question “Do people agree on how much they like or not a product?”. This

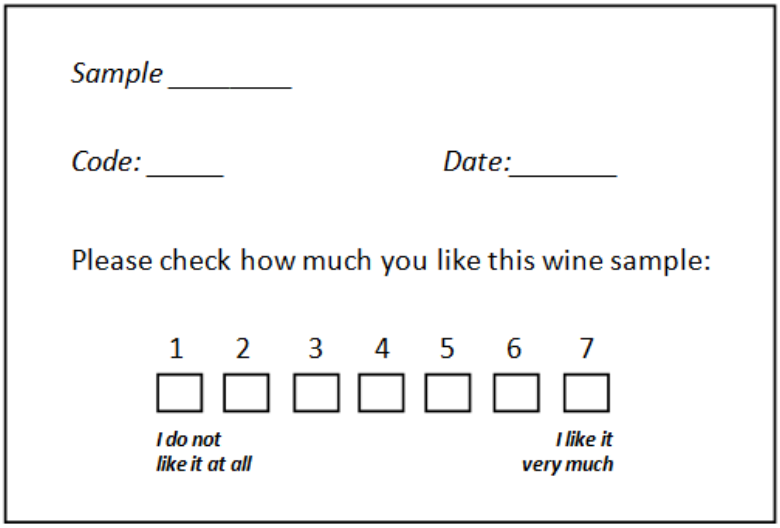
test allows to determine if the mean is representative of the sample's overall level of likeability.

Then, the level of significance in means from blind to non-blind taste test will be evaluated. This will help to assess if there is a significant change in the level of likeability and whether there is a preconception bias.

After that, there will be a test of equality of means between products. This will allow to assess if products have the same level of likeability between them and how it evolves from the blind to the non-blind taste test. It will also help to determine whether there is a preconception bias.

The last part of the analysis will be performed on the free product description. The aim is to analyse the vocabulary used to describe each product. All terms will be listed, the list will then be reduced, lemmatized and categorized. The answers will be translated from French to English. After that, a frequency table will be developed with the frequency of occurrence of each term as well as their relative frequency. This frequency table will help to observe and comment on the results and findings.

a) Overall liking scale



b) free description task

Sample: _____ Code: _____ Date:_____

You are invited to describe the sample by its taste, texture and cooking

Taste:

Texture:

Appendix 3: Invitation to sensory analysis of cereal bars

h e g

Haute école de gestion
Genève

Sensory analysis of cereal bars

You are cordially invited to participate to a research project

February 22nd and March 1st
17h30-18h15 or 18h45-19h30

Objectives

1) Tasting of different cereal bars, personal evaluation and appreciation
2) The test is purely academic. There is no commercial purpose involved

Task

1) First day: blind taste test of various food items, personal description and appreciation,
2) Second day: taste of a second selection of food, personal description and appreciation.

Confidentiality

The data gathered by this study are strictly confidential. Your confidentiality will be assured by a numeric coding. The sharing of the research results will not provide any information on the participants' identity.

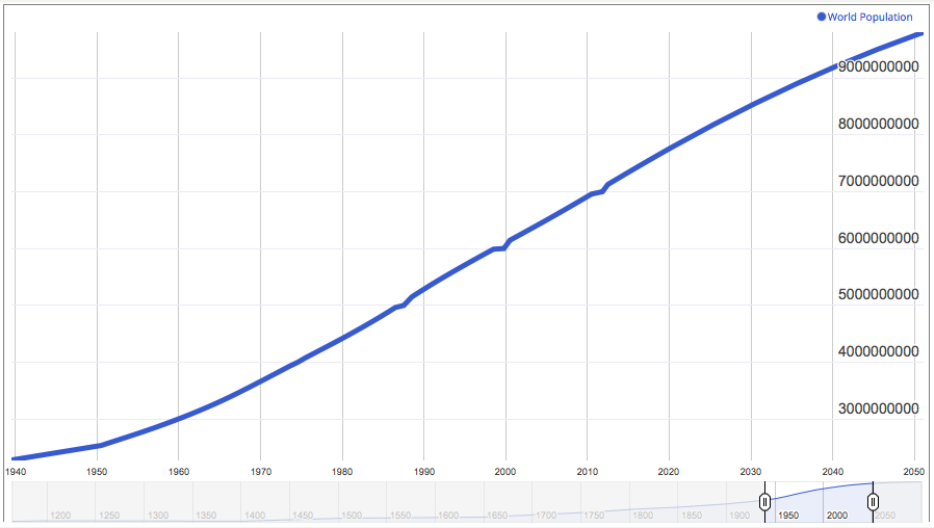
Please confirm your participation to the experiment by filling the following form: https://goo.gl/forms/mnJhuADL1IWN9r0x2

And don't hesitate to share it around you to potential participants!

Research by Sara Da Silva Ferraz, 3rd year student in the International Business Management program at the Geneva School of Business Administration

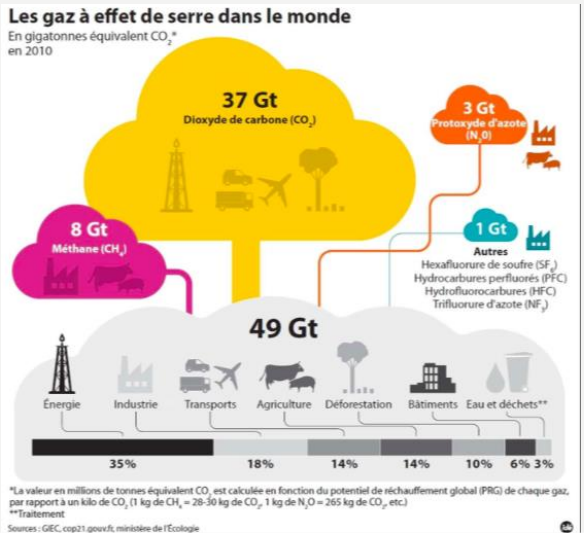
Appendix 4: Presentation on entomophagy

EVOLUTION DE LA POPULATION MONDIALE

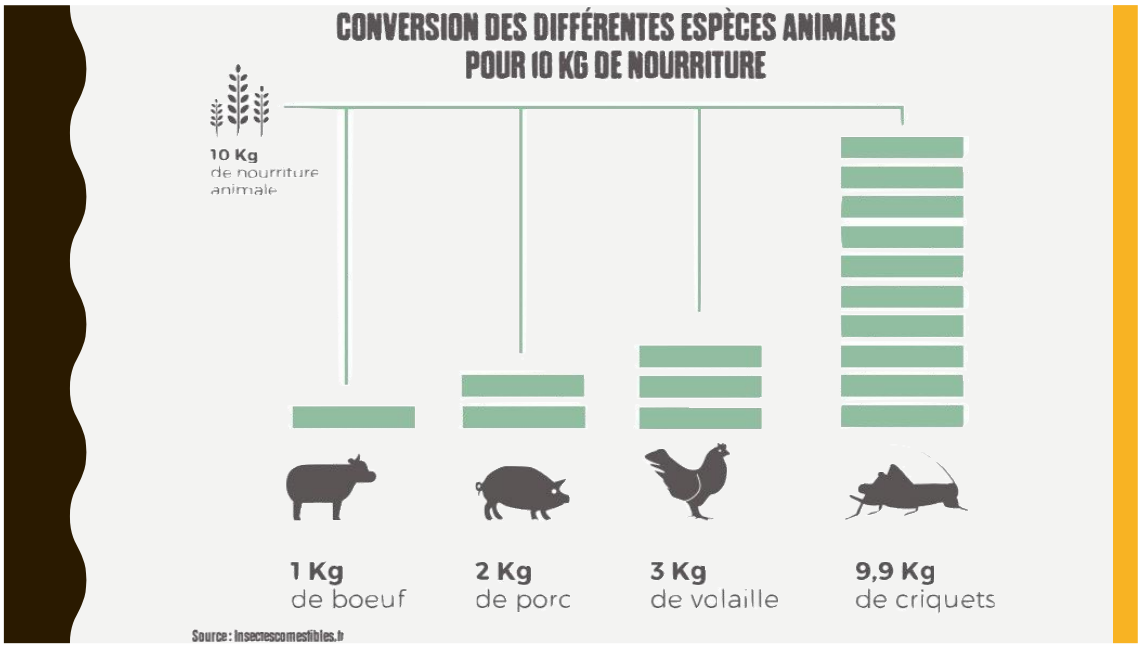


Source: United nations, (2019)

L'AGRICULTURE ET LE RÉCHAUFFEMENT CLIMATIQUE



Source: Futura-Sciences (2001-2019)



Source: Insectes Comestibles (2009-2016)

PROPRIÉTÉS NUTRITIONNELLES

	SAUMON D'ÉLEVAGE	OEUFS ENTIERS	CRIQUETS	VERS DE FARINE	BOEUF	TOFU
PROTÉINES	20.4g	19.2g	31g	16.2g	22.4g	24.6g
GRAISSES	13.4g	15.2g	8.1g	14.8g	11.2g	12.6g
GRAISSES SATURÉES	3g	4.8g	2.6g	4.9g	4.4g	2.7g
OMÉGA-3	2.5g	0.1g	1.8g	3.3g	0.04g	0.5g
FIBRES	0g	0g	7.2g	2.5g	0g	2.7g

Source: espace-musculation.com (2010-2019)