POTECTO

Instant Mashed Potatoes with Cricket Powder

Background/Introduction

From 2010 to 2021, there has been a notable increase in the number of individuals in the United States who are actively engaged in working out, with approximately 20 percent of the population reporting that they regularly participate in physical exercise. This trend indicates that Americans are increasingly recognizing the importance of maintaining a healthy lifestyle, which includes regular exercise as a key component. Furthermore, the increasing popularity of fitness-related activities and the availability of a wide range of workout options, such as gym memberships, fitness classes, and outdoor activities, have made it easier for people to incorporate exercise into their daily routines. As a result, it is likely that this upward trend in exercise participation will continue in the years to come, with more and more Americans prioritizing their physical health and well-being.

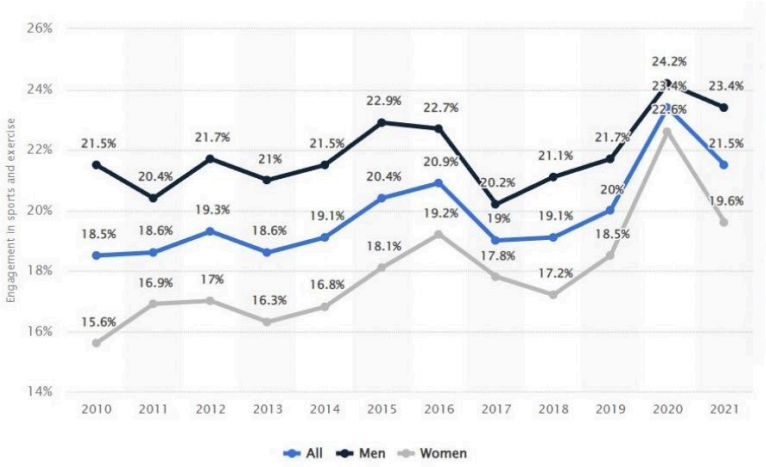

Figure 1. Overall workout rate in the United States from 2010 to 2021.

After exercising, it is crucial to fuel the body with the proper nutrients to promote muscle growth, replenish glycogen stores, and provide sustained energy. This is particularly important if people engage in strength training or high-intensity workouts, as the body requires adequate nutrition to support muscle repair and recovery. Protein is an essential nutrient for muscle growth, and consuming a source of high-quality protein after exercise can help stimulate muscle protein synthesis. Good sources of protein include insects, meats, fish, eggs, dairy products, and plant-based options such as tofu and legumes. In addition to protein, carbohydrates are also important for post-workout recovery which can help replenish glycogen stores in the muscles. This can be particularly important for endurance athletes or individuals who engage in prolonged exercise sessions. Good sources of carbohydrates include whole grains, fruits, and vegetables. It is also important to stay hydrated after exercise, as sweating during exercise can lead to fluid loss and dehydration. Drinking water can help replace lost fluids and minerals. Overall, knowing

what to eat after exercise is an essential part of a successful workout routine, it can help support muscle growth and recovery, prevent fatigue and injury, and improve overall performance.

Now, many people tend to get instant food or meal replacement products as a quick and convenient way to satisfy their needs after a workout. However, many of these products are often high in fat and sodium, which can have negative effects on their health. Also, some meal replacement products are also high in added sugars and have poor taste, which can make it challenging to maintain a healthy and balanced diet after a workout. This is where our product Potecto comes in, the sector of our product is instant food and meal replacement. The main ingredients for our product are Acheta domesticus and potatoes. Our product Potecto is designed specifically to meet the needs of busy exercisers who are looking for a convenient and nutritious post-workout recovery. Potecto is made from high-quality, all-natural ingredients that are carefully selected to provide benefits to people's body after a workout. With its unique protein source and carbohydrates, Potecto helps replenish glycogen stores in the muscles, stimulate muscle protein synthesis, and provide sustained energy. Our product is also incredibly convenient to use, just simply grab 45g Potecto and mix it with 50g hot water, then enjoy the delicious flavor and nourishing benefits. We decided not to make our product into a protein-shake. While protein shake is very popular for post-workout, it typically provides only protein and a lot of sugar, but lacks other important nutrients like carbohydrates. We understand that everyone has different preferences and dietary needs. While some people may prefer post-workout food that is high in sugar and has a sweeter taste, there are others who prefer a salty taste with less sugar.

Solution

As a unique and novel feature of the product - Potecto, our group will choose insects as the main protein powder source that is added along with the mashed potato flakes. Currently, there are no products in the existing market that use the same strategy as our group do which makes Potecto new and opportunity-rich. Based on research, It is noticed that crickets are optimal and could have the greatest performance to act as a protein source for consumption. Although **Figure 2** shows that honeybee contains higher nutrition values than cricket, cricket is still winning out because of the following three advantages.

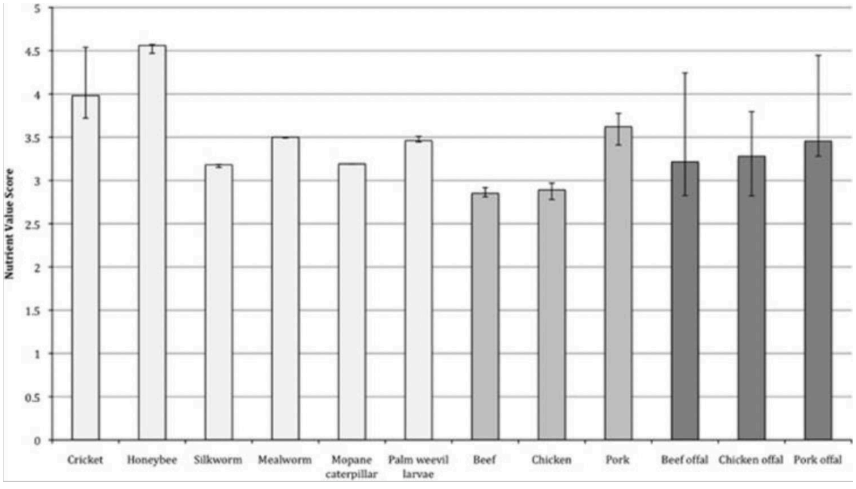

Figure 2. Bar graph showing the median values and inter-quartile range of Nutrient Value Scores (a higher score indicates a more nutritious food) for insects (light grey), meat (medium grey) and offal (dark grey). Higher scores indicate healthier foods.

First of all, compared to honeybees, crickets do not require a restricted living environment to raise which could provide a lower breeding cost. New hives, hive tools, and proper protective clothing are all extra purchasing besides individual bees. However, crickets are able to survive and thrive in simple containers with appropriate height to prevent hopping. Further, bees are naturally fed on nectars and pollens which are unusual materials to obtain compared to the crickets' diet. Crickets are omnivores so that a variety of seeds, fruits, and grasses can be selected and used for feeding. It will be easier for our group to boost cricket's nutrition fact by adjusting their meals as well. Second, the reproducing rate is not satisfying for honey bees because only one queen in each colony has the responsibility to reproduce. In contrast, each adult female cricket can lay 50-100 eggs every 2.5 days. A clear table of their efficiency in reproduction is shown in figure 3.

Generation	#Crickets	#Eggs Produced in 1 Month (29.53 days)
0	50	14,765-29,525
1	22,145	6,539,418.5-13,076,622.5
2	9,808,020.5	2,896,308,453.65-5,791,636,105.25

Figure 3. Estimated number of egg production in one month from a start-up of 50 crickets

As a result, raising crickets can help meet our production requirement better. Third, bees are too aggressive to handle. Stinging by one bee would lead to anaphylaxis which not only is dangerous for employees but also causes additional medical expenses. More importantly, the phospholipase A2 in bee venoms may trigger more-serious immune system reactions. Crickets, on the other hand, do not deliver venom nor transmit any kind of disease. Hence, we will use crickets as our main protein source through overall consideration.

Cricket's protein content is remarkable as well as other micronutrients like vitamins. Our group will focus on one species called Acheta Domesticus to be our main cricket powder ingredient because it contains the highest Leucine content. A branched-chain amino acid (BCAA) is an essential amino acid that the body uses for muscle repair and growth. Leucine is one of the three BCAAs and is the most important one because it is capable of enhancing strength performance and building muscle mass. From figure 4, it is obvious that Acheta Domesticus is particularly high in Leucine which is the best option for making post-workout food.

Amino acid	Cricket species						
	Tarbinskiellus portentosus	*Gryllodes sigillatus* nymph	*Gryllus assimilis*	*Gryllus testaceus*	*Acheta testacea*	*Gryllus bimaculatus*	*Acheta domesticus*
Essential Amino acids							
Valine	11.45 ± 0.98	5.20	4.62 ± 0.59	4.42 ± 0.00	3.44	3.20 ± 0.03	1.07
Isoleucine	3.03 ± 0.19	3.70	2.12 ± 0.73	3.09 ± 0.00	2.98	2.16 ± 0.04	4.45 ± 0.21
Leucine	ND	6.90	7.74 ± 0.64	5.521 ± 0.13	6.09	3.97 ± 0.05	9.75 ± 0.35
Lysine	6.10 ± 0.07	5.30	7.90 ± 0.64	4.79 ± 0.10	4.61	2.42 ± 0.01	5.40 ± 0.00
Threonine	3.81 ± 0.21	3.50	3.55 ± 0.63	2.75 ± 0.12	2.90	2.00 ± 0.04	3.60 ± 0.00
Phenylalanine	2.59 ± 0.13	3.10	0.72 ± 0.20	2.86 ± 0.06	NR	1.83 ± 0.01	3.00 ± 0.28
Methionine	2.42 ± 0.09	1.60	0.63 ± 0.20	1.93 ± 0.06	NR	0.27 ± 0.01	1.40 ± 0.14
Histidine	ND	2.20	1.32 ± 0.37	1.94 ± 0.01	1.54	2.50 ± 0.08	2.25 ± 0.07
Trypatophan	1.35 ± 0.23	0.90	0.95 ± 0.20	NR	2.44	NR	0.55 ± 0.07
Methionine	NR	NR	NR	NR	3.09	NR	NR

Figure 4. Essential amino acids comparison among common edible crickets' species.

As we have settled our cricket species, it is equally important to compare the essential amino acids content with other commonly consumed protein sources like beef, egg, and soybean. Figure 5 below shows a clear comparison among those protein sources. Acheta Domesticus is comparable and potentially better than beef or egg. Its 9 essential amino acids' content all largely exceed the recommendations for adult male, let alone females. As a result, our product will be competitive in the market.

Amino acid	***Acheta domesticus***	**Beef**	**Egg**	**Mature soybean seed**	**Recommendation for adult male**
Histidine	2.34	2	1.20	1.07	0.7
Isoleucine	3.64	1.6	2.43	1.76	1.4
Leucine	6.67	4.2	4.15	2.85	2.6
Lysine	5.11	4.5	3.33	2.39	2.1
Methionine	1.46	1.6	1.49	0.48	-
Methionine + cysteine	2.49	2.19	2.56	0.84	1.0
Phenylalanine	3.02	2.4	2.53	1.8	-
Phenylalanine + tyrosine	8.75	4.6	4.49	3.23	1.7
Threonine	3.11	2.5	2.13	1.59	1.0
Tryptophan	0.63	0.25	0.77	0.48	0.3
Valine	4.84	2	2.99	1.77	1.8

Acheta domesticus data: Finke, 2013; Traditional protein source data: USDA National Nutrient Database for Standard Reference (May 2016); daily protein recommendation adults: WHO, 2009

Figure 5. EAA content (g/100g dry weight) of the house cricket Acheta Domesticus, traditional protein sources and daily EAA recommendation per adult male (g/70kg)

What's more, Acheta Domesticus is rich in vitamins including Vitamin A, Vitamin B group, Vitamin C, and Vitamin D. These natural vitamins are able to save customers' money from supplements which can be an attractive selling point as well.

Vitamin	Cricket species		Recommended daily intake		
	Acheta domesticus	*Gryllus assimilis*	Children	Adult female	Adult male
	mg/100 g	mg/100 g	mg/day	mg/day	mg/day
Retinol (Vitamin A)	<67.00	2.90 ± 0.05	6	15	15
β carotene	<0.02	NR	NR	NR	NR
Thiamine (Vitamin B1)	0.04	NR	0.4	1.1	1.2
Riboflavin (Vitamin B2)	3.41	0.23 ± 0.08	0.3	1.1	1.3
Niacin (Vitamin B3)	3.84	NR	2	14	16
Pantothenic acid (Vitamin B5)	2.30	NR	1.7	5	5
Pyridoxine (Vitamin B6)	0.23	NR	0.0001	0.0013	0.0013
Biotin (Vitamin B7)	0.02	NR	0.005	0.03	0.03
Folic acid (Vitamin B9)	0.15	NR	0.65	0.40	0.40
Vitamin B_{12}	0.01	10.00 ± 0.00	0.004	0.0024	0.0024
Vitamin C	3.00	1.01 ± 0.63	15	65	75
Vitamin D	<17.15	NR	5	5	5
Vitamin E	1.32	30.00 ± 0.01	6	15	15
Vitamin K	NR	40.00 ± 0.00	0.03	0.065	0.065
Choline	151.90	NR	125	425	550
References	(105)	(62)	(128)	(121, 128)	(121, 128)

Figure 6. Vitamin content of two cricket species including Acheta Domesticus and recommended daily intake of each vitamin.

Overall, Acheta Domesticus is considered the best candidate for our Potecto.

Nutrition Facts
Valeur nutritive
Per average potato (150 g)
par pomme de terre moyenne (150 g)

Calories 110	% Daily Value* / % valeur quotidienne*
Total Fat / Lipides 0 g	0 %
Saturated / saturés 0 g + Trans / trans 0 g	0 %
Total Carbohydrate / Glucides 24 g	
Fibre / Fibres 2 g	7 %
Sugars / Sucres 0 g	0 %
Protein / Protéines 4 g	
Cholesterol / Cholestérol 0 mg	
Sodium 0 mg	0 %
Potassium 550 mg	12 %
Calcium 10 mg	1 %
Iron / Fer 1.5 mg	8 %
Vitamin C / Vitamine C 27 mg	30 %

*5% or less is **a little,** 15% or more is **a lot**
*5% ou moins c'est **peu**, 15% ou plus c'est **beaucoup**

As the main protein source being addressed, carbohydrate is another crucial ingredient needed for post-workout food because it can help the body to recover and rebuild. Post-workout carbohydrates also help the body release insulin, which then replenishes glycogen stores used during training. Potatoes are a well-known vegetable because of their dense nutrition value. It is low in calories, zero in fat, and a good source of complex carbohydrates due to the potato starch. A hundred grams of potato could have 20.1 grams of carbohydrate which makes it suitable for post-workout consumption. Also, potatoes are rich in Vitamin C, dietary fiber and potassium.

Figure 7. Nutrition facts of a 150g potato

Hence, our product Potecto — instant mashed potatoes with cricket powder is capable of offering busy gym people a combination of high-quality protein and carbohydrates within a short period of time. Since intaking the combination within 60 minutes is ideal for muscle building and repairing, our product is designed to be ready to eat by just adding 50 grams of boiling water to

45 grams of potato flakes. It is more time-saving than preparing a nutritious meal after an exhausting exercise. In addition, our product will be gluten free and dairy free. Gym people, people with celiac diseases, people that have lactose intolerance, and people who worry about the content lackness in plant-based protein are all our target customers.

Nutrition Facts

7 servings per container
Serving size **1 packet (30.25g)**

Amount Per Serving	
Calories	**110**
	% Daily Value
Total Fat 0.5g	**1%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 360mg	**16%**
Total Carbohydrate 16g	**6%**
Dietary Fiber 3g	**11%**
Total Sugars <1g	
Includes 0g Added Sugars	**0%**
Protein 11g	**22%**
Vitamin D 3mcg	**25%**
Calcium 94mg	**8%**
Iron 4mg	**25%**
Potassium 310mg	**7%**

*The Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

INGREDIENTS: Dehydrated Potato Flakes, Protein Blend (Soy Protein Isolate, Calcium Caseinate, Milk Protein Isolate, Pea Protein Isolate, Whey Protein Concentrate), Natural Flavors, Gum Blend (Cellulose and Guar Gums), Vegetable Broth Seasoning (Yeast Extract, Salt, Tomato Powder, Garlic Powder, Onion Powder, Spices, Sunflower Oil), Nonfat Milk Powder, Dehydrated Sour Cream, Egg Whites Powder, Garlic Powder, Soluble Corn Fiber, Onion Powder, Potassium Citrate, Vitamin Mineral Premix (Vitamin A Palmitate, Beta Carotene, Cholecalciferol, dl-alpha Tocopherol Acetate, Magnesium Oxide, Ascorbic Acid, Reduced Iron, Niacinamide, Zinc Oxide, Calcium Pantothenate, Pyridoxine Hydrochloride, Copper Gluconate, Riboflavin, Thiamine Mononitrate, Folic Acid, Biotin, Potassium Iodide, Cyanocobalamin), Salt, Disodium Inosinate and Disodium Guanylate, Spice, Sunflower and/or Soy Lecithin.

Contains Milk, Soy and Egg. Manufactured on equipment that processes wheat (gluten), peanuts and tree nuts.

Possible competitors in the market could be traditional instant mashed potatoes with whey and plant-based protein. HealthSmart High Protein Instant Creamy Mashed Potatoes is a potential rival. It has a protein blend from various sources like soy protein isolate, milk protein isolate, pea protein isolate, and whey protein concentrate. Non-fat milk powder and egg whites powder are in the product as well. Many other micronutrients are added as the vitamin mineral premix that is labeled in the ingredient list. These products use additives like tomato powder, garlic powder, onion powder and other species to provide better taste. Figure 8 beside shows an overview of the integral nutrition values of HealthSmart.

Figure 8. Nutrition facts and ingredient lists of HealthSmart High Protein Instant Creamy Mashed Potatoes.

In order to make a clear comparison between Potecto and HealthSmart, our group made a nutrition label for our product in figure 9. Because of the differences in serving size, It might be ambiguous. Figure 10 provides a further comparison of the three major macronutrients by setting the weight to the same which is 100 grams. It is decided that one glass jar of Potecto is 1000 grams in weight which contains 10% Maltodextrin, 37% potato flakes, 48% cricket powder, and 5% additives. Hence, there will be 100 grams of Maltodextrin, 370 grams of potato flakes, 480 grams cricket powder, and 50 grams additives. Within the 50 grams of additives, there is 20 grams of salt, 20 grams dehydrated kale, and 10 grams of species powder depending on the flavor. These ingredients all contribute to the nutrition table in figure 9 and 10. Since our group uses whole potatoes and whole crickets as ingredients, we largely reduce the waste from producing and boost the natural micronutrient value. Potecto is also able to exceed the protein content of protein blend by just using cricket as the main protein source which not only can save money from purchasing a variety of sources but also be able to be an eco-friendly and sustainable product.

Add Headings (Format > Paragraph styles) and they will appear in your table of contents.

Nutrition Facts

Serving size	**(45g)**
Amount Per Serving	
Calories	**200**
	% Daily Value*
Total Fat 6g	**8%**
Cholesterol 0mg	**0%**
Sodium 440mg	**19%**
Total Carbohydrate 19g	**7%**
Dietary Fiber 2g	**7%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 18g	**36%**
Vitamin D 4mcg	20%
Calcium 37mg	2%
Iron 5mg	30%
Potassium 27mg	0%
Vitamin A	2%
Vitamin C	4%
Vitamin E	2%
Riboflavin	50%
Niacin	4%
Pantothenic Acid	10%
Zinc	40%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Figure 9. Nutrition facts of POTECTO

Nutrition Fact Comparison per 100g product

	Potecto	HealthSmart
Total Calories (kcal)	444	364
Carbohydrate (g)	42	53
Protein (g)	40	36
Fat (g)	13	3

Figure 10. Macronutrient comparison of the two products at 100 grams.

Although Potecto contains a relatively high amount of fat that may cause customer concerns, there are benefits from it. Fats of Acheta Domesticus are all saturated fats. It is known that active gym individuals, especially bodybuilders and powerlifters, should intake 25-35% of the total fats from saturated fats. As a result, 6g of saturated fat per serving which is 8% of daily value can do no harm to the body. The main saturated fatty acid in Acheta Domesticus is pentadecanoic acid (C15:0) which is an essential odd-chain fatty acid that supports long-term metabolic and heart health.

Also, a huge advantage of our product is the price. Our group decided to purchase the first and the parental cricket source from Kenya because they offer the lowest price at 1.93 euro per kilogram which is 2.04 USD per kilogram. By using 0.95 USD per pound for our potato price, the two major sources' prices are settled. The average market price for maltodextrin is 2.96 USD per kilogram. Since the additives' amount in our product is little, the pricing will be negligible. Thus, our products are able to be presented to customers at a low price as 30.00 USD per kilogram of Potecto (one glass jar). Compared to 16.95 USD per 211.75 grams of HealthSmart, our product is more affordable and we have the nutrition values at the same amount.

Protein source	€/kg
Acheta domesticus (Thailand)	3.36
Acheta domesticus (Kenia)	1.93
Acheta domesticus (USA/Canada)	21.36
Beef, ground	6.80
Ham	5.56
Chicken, fresh, whole	2.78
Milk, fresh	5.37
Eggs, grade A	3.38

USDA, 2018, Dust and Hanboonsong, 2014

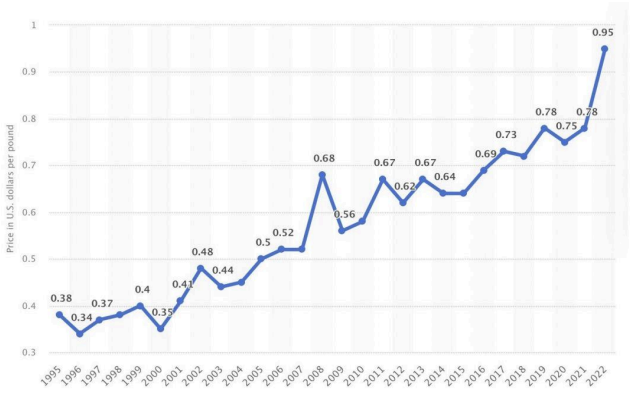

Figure 11 (LEFT). Retail price (€/kg) for Acheta domesticus and other protein sources
Figure 12 (RIGHT). Retail price of white potatoes in the United States from 1995 to 2022

The biggest reason why we choose insect powder, Acheta Domesticus powder, rather than animal protein or plant protein as the main protein source in our product is sustainability.

As for now, the global animal-based dietary protein production, which is the source of whey protein that is sold popularly on the market, is expected to reach 494 million tons by 2050, an increase of 206 million tons from 2013, if we want to satisfy the global need of dietary protein. (1) And the dairy and egg protein production is expected to reach 102 million tons by 2050. (1) And the plant-based dietary protein, which is extracted from wheat and soybean, is expected to increase the production by 60-110% of current production by 2050. The problem is that the global population will also increase to 9.6 billion by 2050. With the speed of growth of the global population, traditional livestock cannot meet the protein demand of the population with the growth, which might lead to chronic protein deficiency and protein energy malnutrition in the long run. (1) So it is considerate that we think about our future generations that we choose a more sustainable protein source: insect powder. There are many insect food products on the market already, such as the EXO protein bar that also uses Acheta Domesticus as raw material, Bugsolutely cricket pasta, and even some dog food brands contain insects like the Kind Earth Dog Food. Therefore, we came up with the idea of incorporating insect protein powder into mashed potatoes making a mashed potatoes product with high quality protein source, which has not been invented ever before.

Our main ingredient, Acheta Domesticus, has a high protein content percentage. On average, beef contains around 42% dietary protein per 100g dry weight protein and milk has around 22% protein per 100g dry weight milk. However, insects contain around 48% protein per 100g dry weight insect protein. And Acheta Domesticus has around 70% protein per 100g dry weight protein. (27)

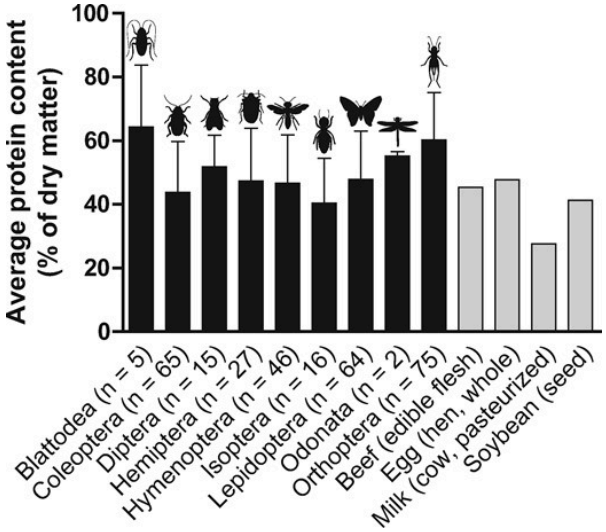

Figure 13. The protein content percentage of dry weight of insects, beef, and dairy and egg products mentioned in the article.

Thus, it has higher protein content than most of the other protein sources, which means we could use less amount of protein, but still satisfy our daily protein intake, 0.8-2.2kg per kilogram of adult body weight. More than that, rearing insects is more sustainable compared to raising livestock. Insects' feeding conversion ratio (FCR) is much lower than that of cattles. (4) FCR equals the weight of feed divided by weight gained by the animal. For example, a cow's FCR is 6:1, which means it takes 6 lbs of feed for a cow to gain 1lb of weight. (22) The FCR of cricket is 0.923-0.949 so it has a lower FCR and a higher livestock production efficiency. (4) Rearing insects also emit less greenhouse gasses and ammonia than traditional cattle raising. (5) Raising cattles plays a big part in the global GHG emissions. For example, fertilizing plants needed to breed cattles produces lots of carbon dioxide (CO_2), cattles' manure is fermented while raising them and it can produce methane (CH_4), and animals' manure and urine is where the nitrous oxide (N_2O) comes from. (5) Also, the process of raising cattles also releases ammonia (NH_3) which comes from microorganisms breaking down the waste of livestock. (5) Regardless, a certain amount of nitrogen fertilizes the soil, but too much ammonia leads to soil nitrification and acidification, (5) which damages the crops' ability of absorbing nutrients, and makes them more vulnerable to toxins, such as aluminum and manganese. (23) Based on research, the rearing of our main ingredient, Acheta Domesticus, emits less NH_3 than the NH_3 levels of cattles. (5) Figure 14 below represents the emission of GHG gasses comparing insect emissions and cattle emissions. Apparently, all levels of gasses released from our insect Acheta Domesticus are lower than those emitted by pigs or cattles. Nitrous Oxide emission level of A. domesticus was negligible as the chart indicated. Besides, only cockroaches, termites, and scarab beetles produce CH_4 and A. Domesticus did not produce CH_4. (5)

Species	CH_4 (g/kg BM/day)	N_2O (mg/kg BM/day)	CO_2 eq. (g/kg BM/day)	NH_3 (mg/kg BM/day)
Pachnoda marginata (n = 4)	0.16±0.085 [a]	0.0±0.03 [a]	4.00±2.13 [a]	0.1±0.16 [a]
Tenebrio molitor (n = 4)	0.00±0.002 [b]	1.5±0.13 [b]	0.45±0.04 [b]	0.0±0.09 [a]
Blaptica dubia (n = 3)	0.08±0.021 [c]	0.3±0.24 [a]	2.12±0.57 [c]	3.0±1.63 [b]
Acheta domesticus (n = 4)	0.00±0.002 [c]	0.1±0.13 [a]	0.05±0.04 [b]	5.4±3.40 [c]
Locusta migratoria (n = 6)	0.00±0.017 [c]	8.0±13.50 [b]	2.37±4.02 [c]	5.4±1.65 [c]
Pigs	0.049–0.098	2.7–85.6	2.03–27.96	4.8–75
Beef cattle	0.239–0.283	N/A	5.98–7.08	14–170

BM = Body Mass;
N/A = Not Available;
Reported values for pigs and beef cattle were obtained from: [5] Aarnink et al., 1995; [49] Groot Koerkamp et al., 1998; [52] Demmers et al., 2001; [50] Nicks et al., 2003; [59] Beauchemin & McGinn, 2005; [48] Cabaraux et al., 2009 and [53] Harper et al., 2009. Mean values bearing different superscripts in a column differ significantly ($P<0.05$).
doi:10.1371/journal.pone.0014445.t003

Figure 14. Emission of GHG gasses from insects and cattles.

Moreover, insects rearing need less land and water compared to raising cattles and insects produce offspring faster. (1) Insect's life cycle is short and one female house cricket produces 50-100 eggs every 2.5 days as mentioned earlier in this article. Besides, the manure of insects can be cycled and utilized in the plantation of potatoes as a fertilizer since the manure contains a certain amount of nitrogen in it, which is a sustainable method for both the rearing of insects and plantation of potatoes.

Processing:

In brief, for the processing of Potecto in the food industry sector, we individually produce the mashed potato flakes and the cricket powder, combine them with flavoring, and finally package the mixture.

To produce potato flakes, we need a machine to wash potatoes, a machine to peel potato skin, a machine to cut potatoes into pieces, a machine to blanch the potato pieces, a machine to cook and mash the potatoes, a machine to dry the mashed potatoes, and a machine to separate the potato flakes into equal quantities. And for the manufacture of cricket powder, we require a machine to disinfect the surroundings, a machine to sterilize the cricket food, a few trays and an oven to roast the crickets, a machine to ground the crickets into powder, and a machine to sort the powder into equal amounts. For the mixing and packaging phase, we require a UV sterilizer for product sterilization and a packaging machine.

For the manufacturing of potato flakes, After harvesting the potatoes grown with cricket manure, we remove any sprouting or rotten potatoes by hand to prevent the formation of glycoalkaloids. After ensuring that the potatoes are fresh and unspoiled, we use the VOW (29), an industrial potato washer, to completely wash them. Use the steam peeler to remove the potato skin by exposing the potatoes to high pressure steam, thereby heating the water beneath the potato skin and forcing it to peel off. Afterwards, the potatoes are chopped to the desired size with a hydro cutter and blanched in a blancher. After allowing the potatoes to cool, we re-cook them until they become mashed. During this process, a monoglyceride emulsifier is added and thoroughly mixed. This will give the potatoes a desired texture.

Following the mashing of the potatoes, we use drum-dryers to completely dry the mashed potatoes and an air flow to transport the dried potato flakes to the mill shifter. The mill shifter can divide potato flakes into an equal amount, so when we mix the potato flakes with cricket powder later, we can make sure that each pack of our product has a certain amount of potato flakes and cricket powder, so that we can make sure that the nutrient concentration is under our control. We have completed the preparation of our potato flakes at this point.

For the insect preparation phase, we first purchase crickets from a cricket breeder, and then send cricket samples to a lab to determine if they are nontoxic and meet FDA requirements, as wild insects typically contain heavy metals or other contaminants. Even though our insects are farm-raised, we must still send samples to the lab to ensure they are safe for consumption.

We use condos to raise crickets and sanitize their food and environment in order to prevent diseases such as Cricket paralysis virus (CrPV), which is not dangerous to humans but can kill crickets. Around six weeks pass from the time a cricket is hatched until the time it dies. During the sixth week, the crickets lay eggs, which we use to develop the next generation of crickets. After laying eggs, we transport the crickets to a factory where they are processed into cricket powder.

After transporting crickets to the facility, we rinse them thoroughly and spread them on a tray before placing the tray in an oven. In the oven, they are roasted above 165 degrees Fahrenheit to kill E. coli and Salmonella, which are dangerous to humans and can cause diarrhea and fever. In addition, we must ensure that the crickets are sufficiently dried throughout the roasting process so that they do not clog the grinder when they are being milled. After that, we use a grinder to grind them to powder, which looks like coffee powder. The cricket powder is then separated into uniform sizes while we wait for the mixing stage.

When both powders are available, they are mixed with dehydrated vegetables and different seasonings to give them their own flavor. There are currently Onion & Chicken, Garlic & Steak, and Curry flavors. In addition, we sanitize them, place them in our packaging, and add a desiccant bag to keep our products from spoiling. Then, we return a sample to the laboratory to check that this batch of items was not tainted during these procedures. Because of the disinfection and desiccant, Potecto powder has a 12-month shelf life.

The containers we use are glass jars that are made from recycled glass, which is environmentally friendly. As such glass is a permanent and infinitely recyclable substance. In addition, recycled glass requires 40% less energy than new glass to manufacture. Likewise, when glass decomposes, it does not release toxins like plastic does. Customers may also store other foods in the jar once the powder has been consumed. Moreover, to prevent transportation-related damage, we use 100% recyclable corrugated bubble wrap and retail boxes made from post-consumer waste material.

In addition, we offer food-grade silicone cups and scoops to our customers. One scoop of Potecto powder contains approximately 45 grams, which is equal to one serving. So that consumers are aware of their approximate energy consumption. In addition, there is a line on the

cup indicating how much water should be added to 1 scoop of Potecto powder in order to make mashed potatoes. Silicone was chosen for the cup and scoop because, first, it is a renewable and abundant resource; second, it is resistant to high temperatures and would not release toxins or be destroyed when consumers use them to prepare food; and third, its production is more environmentally friendly than that of other materials.

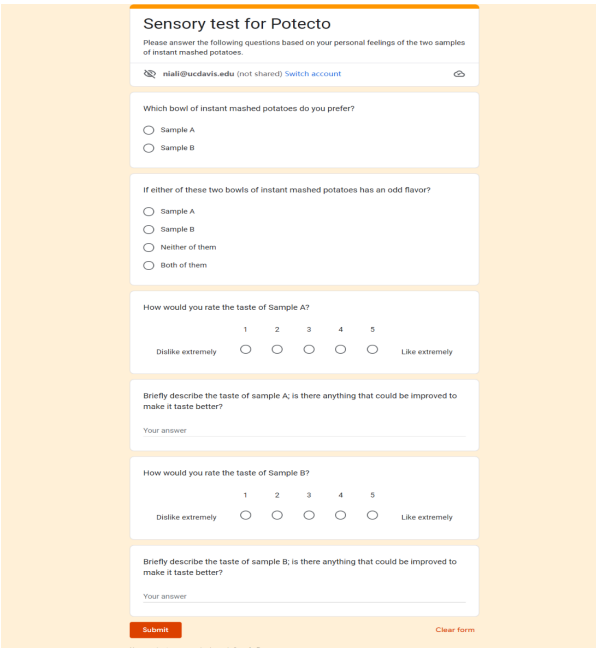

Figure 15. Sensory test of Potecto

Before Potecto goes to the market, we would first undertake a sensory test. We would recruit 100 volunteers by putting recruiting flies at gyms. Before the test we would ask the volunteers to write down their allergic history to decrease the risk of making them allergic. Next, we supply the volunteers with two protein enriched instant mashed potatoes, one is our garlic & steak flavored Potecto, the other is garlic instant mashed potatoes from Healthsmart, and ask them to conduct blind test. Then we would ask them to fill in questionnaires including questions regarding “which mashed potato tastes better” as figure 15 shows, and “if there is any odd flavor in either one of these two products' '. After collecting and coding these questionnaires, we can identify whether there is any adjustment we should make on our ingredients.

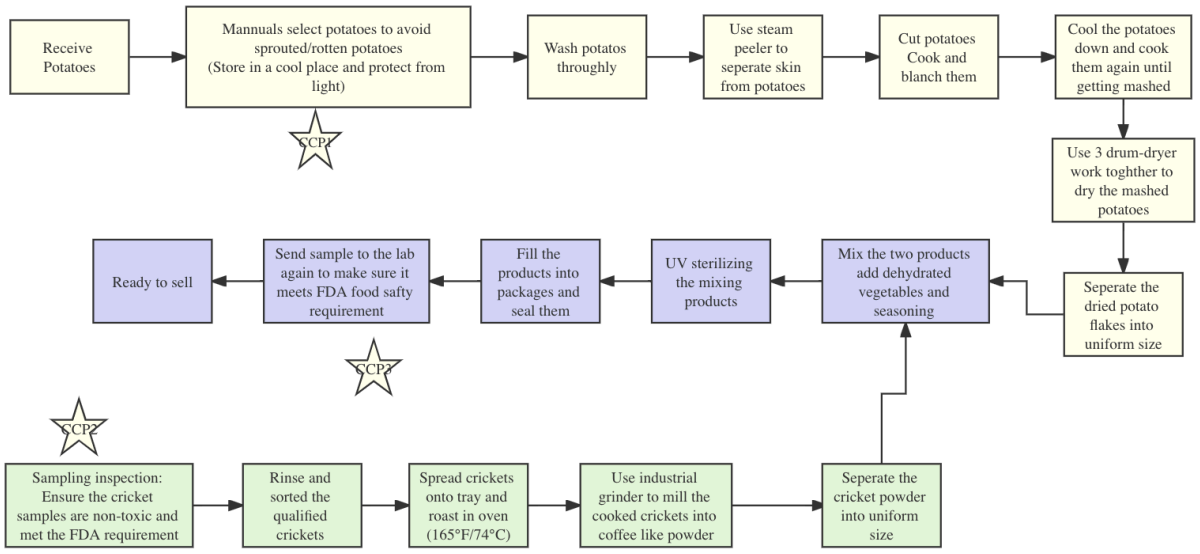

Figure 16. Steps of processing Potecto. (29, 30, 31)

HACCP

Our product, food safety is the top priority, we take it seriously to ensure that our products are safe and free from harmful contamination. To achieve this goal, we use a Hazard Analysis and Critical Control Points (HACCP) management system, which is a rigorous process that involves identifying potential hazards at each stage of the food production process and taking steps to prevent them. The potential hazards that we address during the production of our products are the presence of biological, chemical, and physical hazards.

When selecting potatoes for use in our products, we try to avoid the sprouted potato which contains glycoalkaloids as a chemical hazard that can be harmful to human health. To limit this hazard, we manually select only the highest quality potatoes and store them in a cool, dry place to prevent the growth of sprouts.

Cricket is one of the main ingredients for our product. In order to ensure the crickets are safe, we conduct regular inspections of the cricket that we use as our raw material to ensure that they do not contain any harmful bacteria such as biological hazards like *Escherichia coli,* or *Salmonella*. To limit this hazard, we closely monitor the environment in which the cricket is raised, and make sure the food and water provided to the crickets are clean. In the production process, the heating step at 165F is also a CCP to control biological hazards.

At the final stage of the process, we conduct an inspection of our final product to ensure that it meets high quality and safety standards. We also need to ensure that the final product has no metal, bateria which involves physical hazard and biological hazard. To limit the physical hazard, we need to ensure that the processing machine condition is good, and also implement regular inspections and maintenance to identify and address any issues on the machine that may lead to metal contamination. We also can use technology like X-ray and screening to detect the metal particles. We also closely monitor the temperature of our processing environment to ensure that it is high enough to kill any potential bacteria.

Overall, our approach to food safety helps to ensure that our cricket-based products are safe, high-quality, and free from any harmful contaminants. We are still committed to continuously improving our processes to ensure that we meet or exceed industry standards.

In the overall food system, our production of Potecto lies at the end of the process of the food industry. After packaging, Potecto is finalized and ready to be sold. However, we participated in all the steps from plantation to the final advertising. First of all,we pick seed potatoes and Acheta Domesticus from Agribusiness, plant the seed potatoes in our farm and rear the crickets in a separate place. During this step, our idea is to recycle the insect manure and utilize it into the fertilization of potato plantations. The potato leaves are a good feed for Acheta Domesticus helping them grow better. (28) Next, we use the raw materials from our farms to process our final product. Lastly, we advertise them with retailer companies. The whole process is regulated by the FDA for food safety and depicted in the flow diagram #17. Star signs indicate the things our factory does and Potecto, the final product, is produced at the end of the food industry and ready to be advertised and promoted.

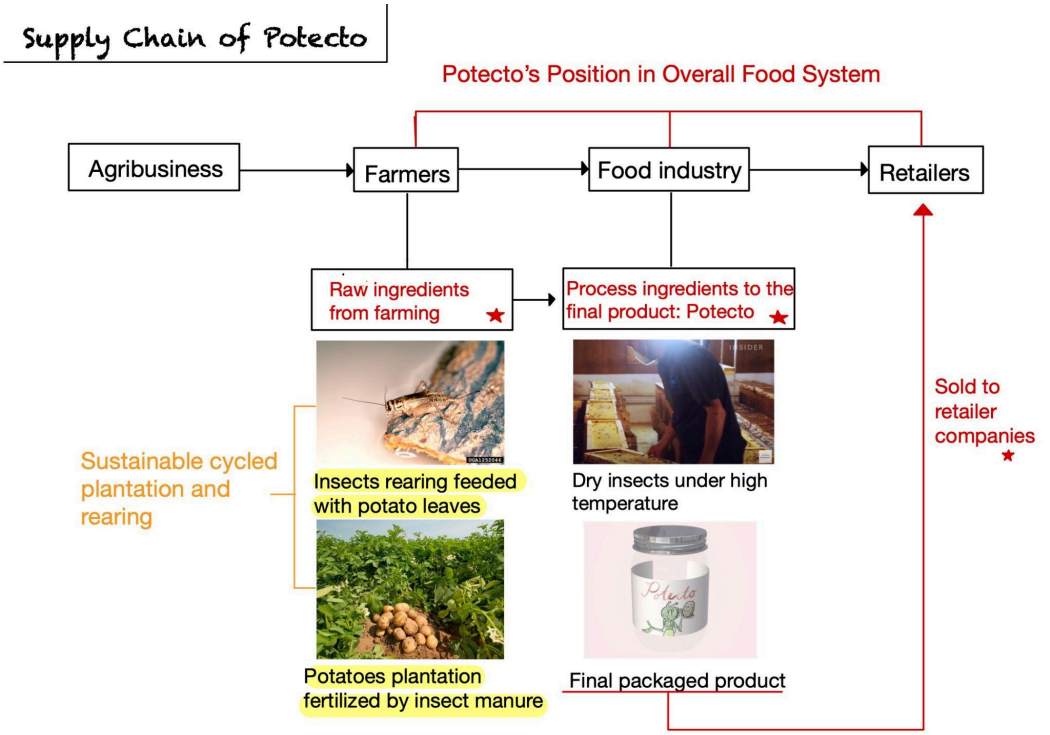

Figure 17. Flow diagram of Potecto's supply chain.

Conclusion

After listing all the advantages of consuming crickets and how we process this product, it is evitable to mention one big challenge on selling —— insect aversion. Unavoidably, many people would hesitate to try and purchase our products due to an antipathy to crickets. Since insects are not a common food and not consumed regularly in the United States, it is a concern if our product can be well accepted by the population and we need to advertise it to increase its acceptability in the market. First of all, our idea is to grind the insects into powder and incorporate them into mashed potatoes since mashed potatoes are a common dish in the USA and consumers do not directly eat the insects as a whole. In this way, people are more likely to try this newly invented mashed potato product since they will not consume the whole insect, but instead the welcomed mashed potatoes with addition of insect powders. More education is needed in regions where they don't see insects as an edible and high quality protein source regarding insects' nutritious density and sustainability. Plus, there are several regions consuming insects as their daily food. It is prospective to promote our product in these regions like African countries, Thailand, China, and Latin America etc since they see insects as a common dish and the acceptability of Potecto will be high in these markets. (25, 26)

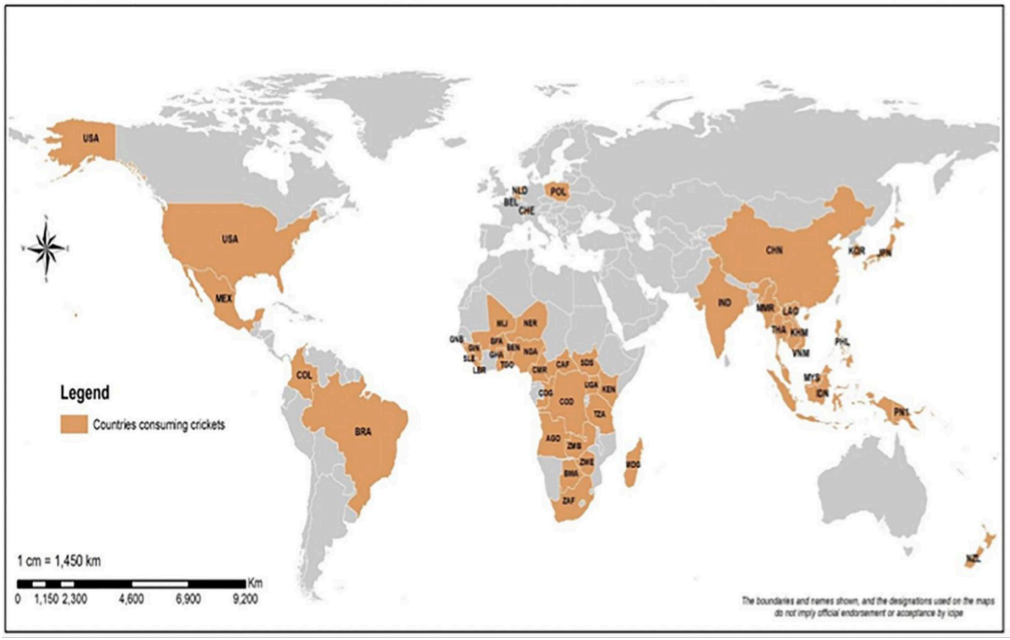

Figure 18. Countries that eat crickets regularly.

Asking a celebrity to help promote Potecto can also be a wise choice. Pamela is an influencer on YouTube who is fully capable of raising Potecto's acceptability and popularity. She posts workout videos on YouTube, has 9.44M subscribers, and has her own app posting the recipes of food she eats for people who want to incorporate workout with meals to reach their bodybuilding goals. Pamela is a perfect and persuasive promoter for our product.

Overall, Potecto is a sustainable and healthy quick carbohydrate and protein intake for gym people. Nevertheless, it can be promoted and treated as a common side dish due to its benefits to health and the environment and also due to its low price sold in the market.

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