

# Consumer Acceptance of Plant Protein Supplemented Coconut and Almond Yogurt

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and Life Sciences Field of Food Science and Technologies

by

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## ABSTRACT

The protein content of food has become increasingly important in recent years. Many consumers are interested in purchasing products that are high in protein due to perceptions of added health benefits. In addition, veganism is becoming more popular. However, vegan yogurts have less protein than more traditional styles of yogurt. Thus, there exists an untapped market for plant-based yogurts with additional protein supplementation, ideally from plant-based sources. Two types of plant-based yogurts (almond and coconut based) were tested with a consumer sensory panel (n=108) to determine acceptance with and without added protein. The plant-based proteins added in each case were pea and wheat derived, with 5g of each added, for a total of six samples tested in the study, including unadulterated controls. The purpose of this project was to determine combinations of plant-based yogurt and protein with the highest degree of liking. This information will be beneficial in the development of vegan yogurts with protein additives. The panelists preferred the control plant-based yogurts over the yogurts with the added protein. There was a higher amount of liking of the almond yogurt as compared to the coconut yogurt. In addition to, a higher amount of liking of the wheat gluten as opposed to the pea protein.

## BIOGRAPHICAL SKETCH

Jennifer Jacobowitz obtained her Bachelor of Science (BS) degree from the University of Massachusetts Amherst in May 2018. Upon completing her bachelor's degree, she continued her education through the MPS program at Cornell. Jennifer wanted to further her knowledge of food science and specifically focus on the sensory science field. Through her time at Cornell, she combined her passion of product development with sensory evaluation to research different types of protein additions in almond and coconut yogurt. After graduation, Jennifer plans on working within the food industry in R&D doing product development.

## ACKNOWLEDGEMENTS

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# INTRODUCTION

## Chapter 1

### **1.1 Consumer Demand**

Consumers tend to associate foods that are vegan with being healthier (Brückner-Gühmann et al, 2019). Foods with plant proteins are selected for weight control (Tuso et al, 2013), people with allergies or intolerances and environmental sustainability (Henchion et al, 2017). This trend has received a lot of media attention recently (Rabschnuk, 2018).

Plant-based proteins were rated as one of the healthiest nutrients as stated in the 2018 Food & Health Survey. Tied into this perception of health benefits are increases in sales (2018 Food and Health Survey, 2018). There continues to be an increase in the number of vegans within the United States (Top Trends, 2017). In addition to vegans, lactose intolerant consumers may experience digestive issues consuming cow's milk or yogurt. Others who purchase dairy-free yogurts are doing so because they do not want to consume as much dairy for perceived health benefits (He et al, 2007). Another reason for people eating plant-based proteins are consumed is a result that plants have a lower environmental impact than animal proteins. This is a result of lower greenhouse gas emissions from plant proteins as compared to animal proteins (Henchion et al, 2017). As a result, between 2016 and 2017 the plant-based milk section of the market grew 5% and is expected to continue to grow (Executive, 2017).

### **1.2 Almond and Coconut Based Yogurt Demands**

Products simulating milk and milk products can be produced from a number of plant-based sources. As shown in Figure 1, almond has the largest market share as compared to the

other plant based non-dairy milk products in North America. Soy milk and coconut milk are tied for the second most commonly purchased plant-based milk products (Executive, 2017).

FIGURE 1: NON-DAIRY MILK PURCHASE, JULY 2017

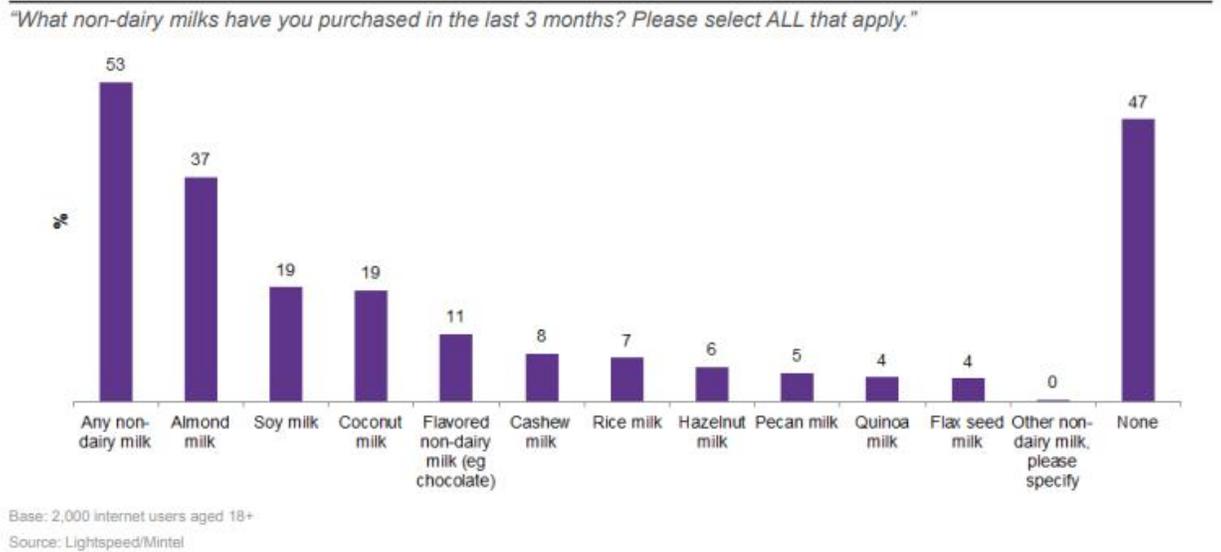


Figure 1 (Executive, 2017)

### 1.3 Plant Based Yogurt Processing

Almond yogurt is produced by extracting almond milk, heating the almond milk to thirty-seven degrees Celsius, and then adding the starter culture of lactic acid bacteria. The yogurt is then packaged and incubated for ten hours (Matsunobu et al, 1984). The pH of almond yogurt is between 4.41 and 6.00 depending on the sample (Ozturkoglu-Budak et al, 2016). The processing of coconut yogurt must also occur at thirty-seven degrees Celsius. It takes about 8 hours to fully ferment the coconut yogurt sample. The starter culture is three percent of the total composition of the coconut yogurt sample. The pH values of coconut yogurt range from 4.01 to 5.79 depending on the sample that is used (Yaakob et al, 2012).

## **1.4 Satiety Response**

Higher protein yogurts are desired by consumers because they have more of a positive sensory response (Morell et al, 2015). Consumers expect to have a smooth texture and mouthfeel for a yogurt product (Brückner-Gühmann et al, 2019). People that consume higher protein foods tend to experience an increase in fullness from these foods (Vandewater and Vickers, 1994). Therefore, higher protein yogurts can trigger an increase in satiety in addition to decreasing the amount of hunger that the person experiences later (Douglas et al, 2013). Since dairy products have a higher protein content than most plant-based products, increasing the protein content within coconut and almond yogurts may allow for an increase in satiety response. The given yogurts obtain a flavor profile that mimics the flavor profile of the given milk that is being used to process the yogurts. For an example, almond yogurt has similar taste profiles to almond milk (Matsunobu et al, 1984).

## **5.1 Nutrition Claims**

The regulation for a claim of “high in protein” is 20% or more of the daily value of protein based on a 2,000 calorie a day diet, thus a protein enhanced almond yogurt product may satisfy this claim “high in protein.”. The daily value for protein is 50 grams per day based on a 2,000 calorie a day diet (Wartella et al, 2010). Therefore, the minimum protein content needed for the claim “high in protein” is 10 grams. Each of the samples were based on a 150 g sample. The supplemented almond yogurt tested had 11 total grams of protein within the yogurt, with 6 grams of protein in the *Silk Almond Yogurt* and 5 grams of added protein into the final product.

The coconut yogurt had a lower amount of protein initially which led to a lowered protein amount as compared to the almond yogurt. The nutrition claim that can be made for the protein

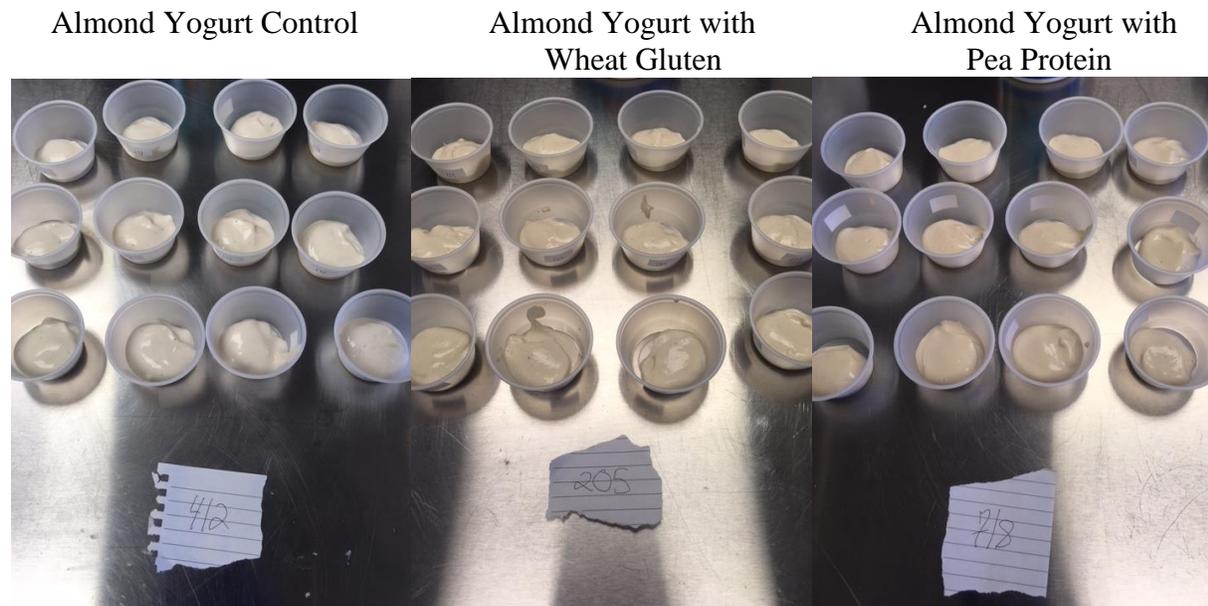
enhanced coconut yogurt product is “good source of protein.” The regulation for “good source of protein” is 10-19% of the daily value of protein based on a 2,000 calorie a day diet (Wartella et al, 2010). Therefore, the minimum protein content needed for the claim “high in protein” is 5 grams. The coconut yogurt that was tested had a total of 6 grams of protein within the yogurt (for a 150 g sample), 1 gram of protein in the *So Delicious* coconut yogurt, and 5 grams of protein added into the final product.

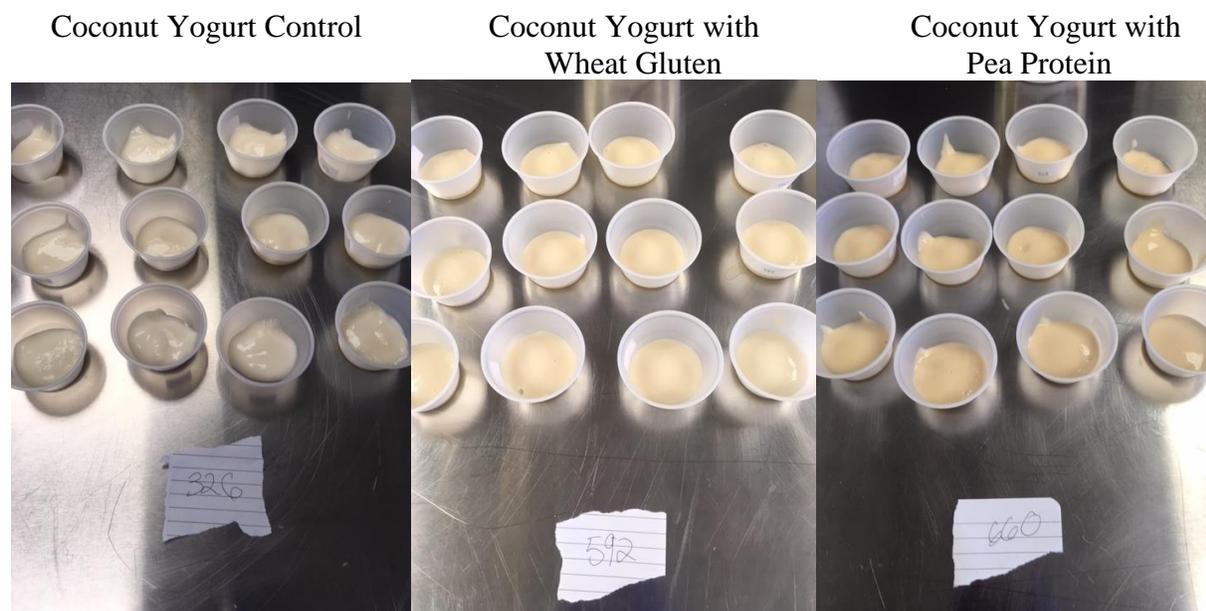
# MATERIALS AND METHODS

## Chapter 2

### 2.1 Preparation of Plant-Based Yogurt Sample

The pea protein that was used was Pea Protein Powder from the company Terrasoul Superfoods (Fort Worth, TX). The wheat gluten that was used was Anthony's Premium Vital Wheat Gluten from the company Anthony's Goods (Glendale, CA). There were 5 g of added protein to each 150-gram sample. The coconut and almond yogurt samples were mixed in an automatic mixer and the added protein was added into the yogurt slowly. The samples were then stored in the plastic yogurt containers in a refrigerator that was kept at 4 degrees C. The samples were then placed into 2 oz sample cups and served to panelists.





## 2.2 Sensory Test

All the procedures used in the study were reviewed and approved by the Cornell University Review Board for Human Participants. The panelists were recruited through the Cornell Sensory Evaluation Center email list and through flyers posted around Stocking Hall. The sensory evaluation study occurred on Wednesday March 20th from 10 am- 4 pm and we had a total panelist count of 108. The panelists were screened to make sure they were not allergic to coconut, almond, pea protein, wheat gluten and soy. The panelists tested a total of 6 samples during the sensory study, which took roughly 20 minutes to complete. The panelists completed questions on computer screens within individual booths in the Sensory Evaluation Center. The questions consisted of 9-point hedonic liking, JAR scales, Likert Scale and demographic questions.

## 2.3 Panelist Demographics

The panelists involved in the study were 22% male and 78% female. 77.8% of the panelists stated that protein is important when purchasing plant-based yogurt. All the panelists prior to participating were willing to taste plant-based yogurts and are not allergic to coconut, almond, soy, wheat, or pea protein.

<b>Age of Panelists</b>	<b>Number of Panelists</b>
<18	0
18-24	39
25-29	17
30-34	12
35-39	10
40-44	7
45-49	6
>50	17

Figure 2

## Frequency of Consuming Plant-Based Proteins

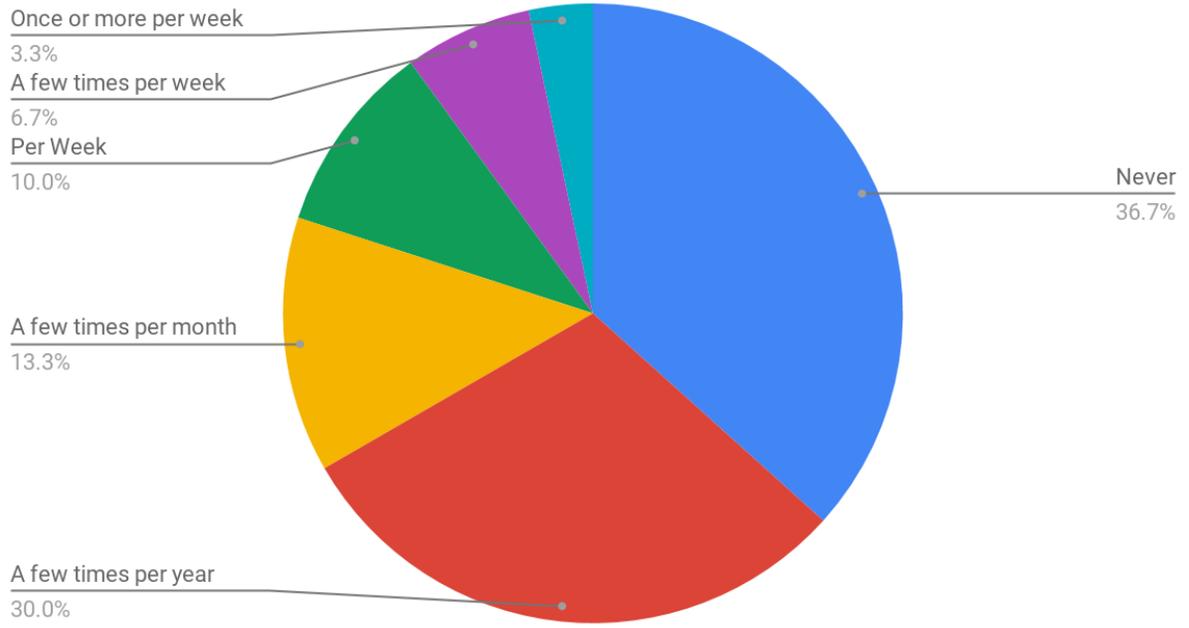


Figure 3

## RESULTS

### Chapter 3

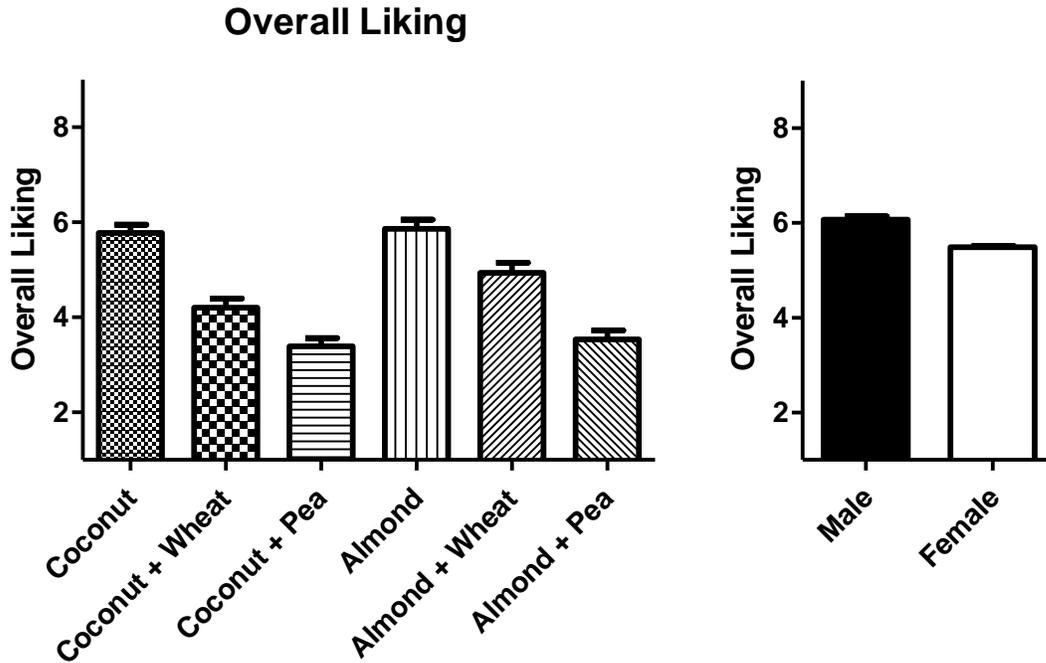
#### 3.1 Overall Liking

A linear mixed model examined the influence of yogurt type, protein type, sex, age, frequency of consumption of yogurt and protein importance, as well as the interaction between protein and yogurt types, on overall liking of the samples (p-values shown in Table 1, red signifies  $p < 0.05$ ).

Source	Liking	AppLiking	TexLiking	PI
Sex	0.002	0.06	0.004	0
EatingFreq	0.07	0.308	0.181	0.149
ProteinImp	0.426	0.886	0.331	0.271
Yogurt	0.013	0	0	0.003
Protein	0	0	0	0
Age	0.105	0.806	0.178	0.059
Yogurt * Protein	0.076	0	0	0.15

A significant relationship existed between overall liking and sex ( $p = 0.002$ ), the type of yogurt that was being used ( $p = 0.013$ ) and the protein used in the formulation ( $p < 0.001$ ), as well as an interaction between protein and yogurt that approached significance ( $p = 0.076$ ). This interaction would suggest the importance of selecting a particular protein for the yogurt in question. Males exhibited a higher degree of overall liking of the yogurts than females. While the almond and coconut yogurts alone were not liked significantly more than one another, within the

whole model, almond was preferred to coconut, suggesting it was more amenable to protein supplementation than coconut. This was particularly evident for almond plus wheat protein, which was significantly more liked than almond yogurt with pea protein.

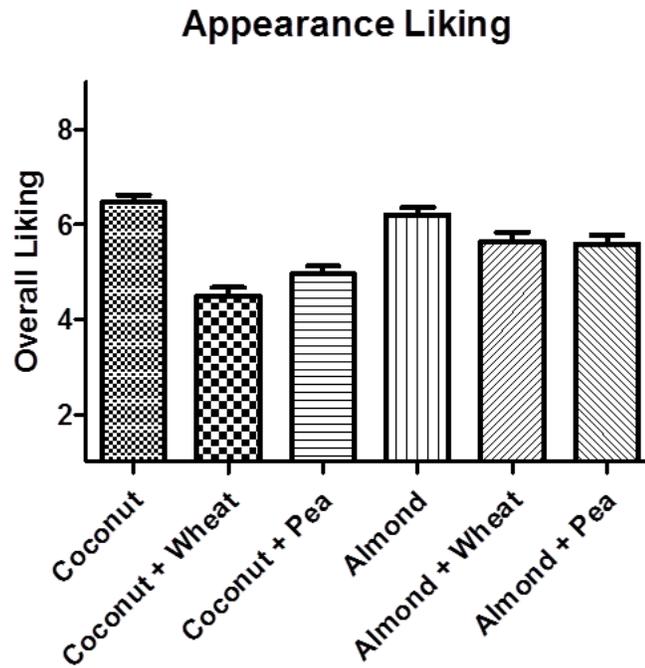


**Figure 4:** Overall liking of coconut and almond based yogurt samples supplemented with wheat and pea protein by sample (left) and by sex (right). Liking was assessed with the 9-point hedonic scale, bars signify mean plus SEM.

### 3.2 Appearance Liking

A significant relationship existed between appearance liking and sex ( $p = 0.06$ ), the type of yogurt being used ( $p = 0$ ), the type of protein used in the formulation ( $p = 0$ ) and the interaction between protein and yogurt ( $p = 0$ ). This suggests that choosing a protein is important for the appearance of the yogurt samples. Males had a higher amount of appearance liking of the

yogurts than females. Although the almond and coconut yogurts aroma was not liked significantly more than one another, the almond yogurt was overall preferred over the coconut yogurt. The one exception to this, was the coconut yogurt control appearance was preferred over any of the over samples.

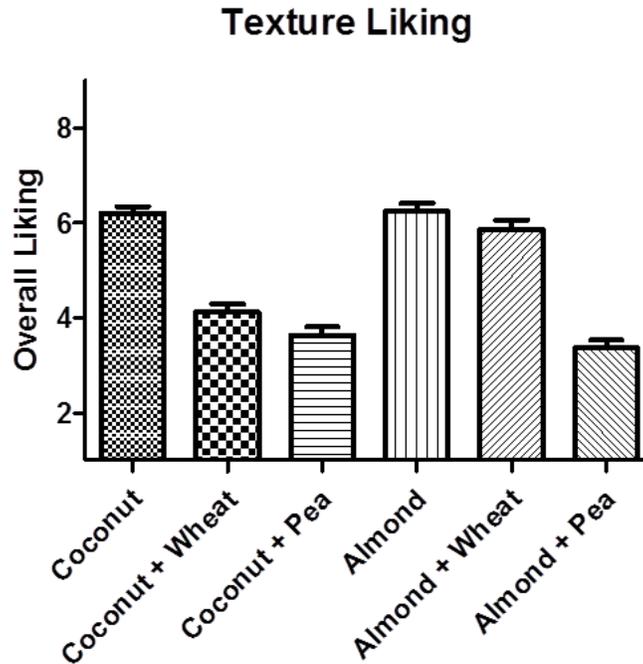


**Figure 5:** Appearance liking of coconut and almond based yogurt samples supplemented with wheat and pea protein by sample. Liking was assessed with the JAR scale, bars signify mean plus SEM.

### 3.3 Texture Liking

A significant relationship existed between texture liking and sex ( $p = 0.004$ ), the type of yogurt being used ( $p = 0$ ), the type of protein used in the formulation ( $p = 0$ ) and the interaction between protein and yogurt ( $p = 0$ ). This suggests that choosing a protein is important for the texture of the yogurt samples. Males had a higher amount of texture liking of the yogurts than

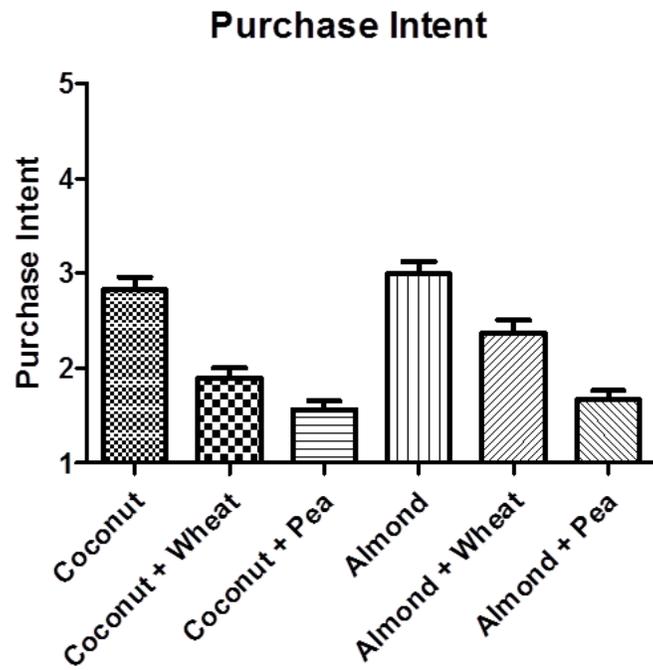
females. Although the almond and coconut yogurts texture was not liked significantly more than one another, the almond yogurt was overall preferred over the coconut yogurt. The one exception to this, was the almond yogurt sample with pea protein supplementation.



**Figure 6:** Texture liking of coconut and almond based yogurt samples supplemented with wheat and pea protein by sample. Liking was assessed with the JAR scale, bars signify mean plus SEM.

### 3.4 Purchase Intent

A significant relationship existed between purchase intent and sex ( $p = 0$ ), the type of yogurt being used ( $p = 0.003$ ), the type of protein used in the formulation ( $p = 0$ ) and the age of the panelists approached significance ( $p = 0.059$ ). This suggests that choosing a protein is important for the texture of the yogurt samples. Males had a higher amount of aroma liking of the yogurt samples than females. Although the almond and coconut yogurts aroma was not liked significantly more than one another, the almond yogurt was preferred over the coconut yogurt.



**Figure 7:** Purchase intent of coconut and almond based yogurt samples supplemented with wheat and pea protein by sample. Liking was assessed with the Likert scale, bars signify mean plus SEM.

## DISCUSSION

### Chapter 4

Although there are some samples where the “liking” ratings are higher, when the data are compared with the others, it can be seen that in general none of the “liking” ratings are very high. In one study, it was stated that yogurt that contains anything within the sample which is not considered usual within the samples are usually not enjoyed. Therefore, having the proteins supplemented in the plant-based yogurts will be considered foreign to the panelist consuming the plant-based yogurt (Luckow, 2005).

Overall, the study showed that men liked the yogurt samples more than women did. One potential reason is that women eat more dairy products than men do. As a result, women may prefer dairy products to plant-based products (Kiefer et al, 2005). Another potential reason is that men preferred the yogurt samples since they are more willing to try new foods (Alley and Burroughs, 1991). Since protein supplemented plant-based yogurts are currently not a product that is currently available for consumers.

The type of protein and type of plant-based yogurt affected the consumer liking. In a study that looked at different types of proteins in extruded snacks, the acceptability differed greatly based on the type of protein that was used. This may translate to the acceptance of the plant-based yogurts and the supplemented proteins. (Kreger, 2011).

In this study, peoples view on protein content importance did not have an influence on their liking of the yogurt. A study that looked at purchase intent of fortified yogurts with soy protein and the control. Although the consumers were told the protein content was higher in the soy fortified yogurts, the consumers stated that they were more willing to purchase the control

sample. This was a result of the consumers preferring the flavor of the control sample over the soy fortified sample (Drake and Gerald, 2003). Another study looked at consumer acceptability with soy fortified ice cream. This study also found that consumers found the ice cream that had a higher protein content to be less acceptable overall than the soy fortified ice cream (Friedeck et al, 2003).

With an increase in the amount of people who are vegans, there will continue to have an increase in the number of plant-based yogurts that are consumed (Veganism, 2006). Therefore, continued innovation of different types of added proteins would continue to be important to the plant-based yogurt market (Top Trends, 2017). Some of the limitations with the study are that most people that participated with 63% of the participants are between the ages of 18-34. Therefore, there is a concentration in the age bracket that participated in the study. Another limitation is that the participants may not necessarily be consumers of plant-based yogurts on a regular basis. Many of the panelists that participated in the study are living around the Ithaca area or are attending school in the Ithaca area. Therefore, this lacks data from other regions of the country and world. Overall, there was a higher amount of liking of the control samples as opposed to the samples with the wheat gluten and pea proteins added. There was a higher amount of overall liking of the almond yogurt samples as compared to the coconut yogurt samples. There was a higher amount of overall liking of the wheat gluten samples as compared to the coconut yogurt samples (Figure 4). The results of the study also found that the consumers thought that protein was important when purchasing plant-based yogurts.

## CONCLUSION

### Chapter 5

The purpose of the study was to determine the consumer acceptance of plant-based yogurt samples supplemented with plant-based proteins. The panelists overall liked the control samples more than the samples with the supplemented protein, suggesting that proteins were not particularly palatable without further development. The panelists liked the almond plant-based yogurt samples over the coconut yogurt samples, when supplemented with protein. The panelists also liked the wheat gluten more than the pea protein samples, with men liking the samples overall more than the women did.

This study used almond and coconut plant-based yogurts and pea and wheat gluten protein, which were liked more than other options in preliminary bench-testing. Therefore, further study could test other types of plant-based yogurts as well as other types of proteins. The limitations of the study include that the mixing of the ingredients occurred in a stand mixer which is not used in a larger scale operation to mix ingredients, and that a single level of supplementation (5g of additional protein per sample) was tested. Finally, the population of the panelists were primarily from the age ranges of 18-29 which represented 52% of the panelists, so conclusions on participants outside of this range should not be drawn. Taken together, our results suggest that wheat protein is more promising in plant-based yogurts, but more extensive product development is needed to effectively supplement protein levels in such samples.

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