CORNELL EWE YOGURT PRODUCT DEVELOPMENT AND BUSINESS PLAN

A Project Paper

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ABSTRACT

Making and marketing ewe milk yogurt is a business at the starting phase in the United States. Ewe milk yogurt has unique health benefits from assisting digestion to reducing illness in lactose intolerance people. The experiment reported here that was sponsored by the Cornell Sheep Program demonstrated a correlation of fermentation time via overall acceptability and pH levels and provides fundamental ideas for future explorations. The Cornell Sheep Program has unique advantages for outreach to consumers within the college community and advertising the product through a variety of methods. In all, the ewe milk yogurt product, which is planning to be established by Cornell Sheep Program, will be a healthy, tasty, and attractive product with great development potential.

BIOGRAPHICAL SKETCH

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LIST OF ABBREVIATIONS

LAB	lactic acid-producing bacteria
T2D	type 2 diabetes
CAGR	compound annual growth rate

1. Introduction and Background

Yogurt, a type of fermented dairy product, is tremendously popular and enjoyed around the world. The origin of yogurt is thought to be around 5000 BC in Mesopotamia. Nowadays, this slightly acidic flavor product is served in a variety of forms such as beverages, snacks, desserts, meal replacements and high protein sports drinks.

Unlike some beverages and drinks, yogurt is available and healthy for people to consume at all ages. A study showed that one of the main components of yogurt – lactic acid-producing bacteria (LAB) supports gastrointestinal health by gut microflora intervention, bowel transit, and adaptive immune responses¹. Another report demonstrated that yogurt is highly associated with protecting against type 2 diabetes (T2D), which is not feasible in other dairy products². Moreover, yogurt can be a good protein source for a meal.

While cow milk is the most common ingredient to make yogurt, the milk from ewes, goats, camels, water buffalo, and yaks are also good sources for yogurt products³. Plant-based milk such as soymilk, rice milk, and nut milk were developed in the 2000s and are suitable for vegans. According to the FDA, *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which are LAB, are the two microbial cultures required to be added for fermentation⁴. Other ingredients including vitamins, nutritive carbohydrate sweeteners, flavoring ingredients, color additives and stabilizers are also accepted in making the product tastier and more attractive.

Ewe milk, as well as ewe milk yogurt, are superior dairy products on sale in the market. Ewe milk contains double the concentration of solids and minerals found

in cow milk, which makes it extremely nutritious. Due to the high concentration of fat, protein and lactose, ewe milk produces a higher yield of yogurt than cow or goat milk. The high nutritional value of ewe milk is also associated with the proline content, which stimulates the production of hemoglobin⁵. Also, people who suffer from lactose intolerance have less trouble when consuming ewe milk product⁶.

Globally, China, Australia, and India are the top 3 countries of the world in sheep inventory, while America is far behind. When compared with the rest of the livestock businesses, the sheep industry contributes less than 1% of total U.S. animal revenues so that a huge opportunity is available for the sheep dairy industry to develop⁷. Most sheep dairies are in the upper Midwest and New England. New York state has a few dairy sheep farms and one of them belongs to the Cornell Sheep Program. The ewes are machine milked twice a day by Cornell Animal Science students during lactation. The grade A dairy provides an opportunity for sale of raw milk to private creameries with the possibility of working with food scientists to develop and sell retail products derived from pasteurized milk.

This paper aims to be an applicable business plan for the Cornell Sheep Program to develop a creamery and ewe milk yogurt, and to design a mature marketing model. The following sections analyze the ewe yogurt market; introduce the development of ewe yogurt products; and use the Cornell Sheep Program as an example to present the steps of developing an ewe yogurt creamery. Additionally, this document will be accessible to operators of small dairy farms for reference and to modify to fit their businesses.

2. Market Analysis

2.1 Market Landscape

With increasing numbers of product launches and preferences for yogurt among people, professionals believe that the yogurt market is projected to register a compound annual growth rate (CAGR) of nearly 5% by 2023. In 2019, the global yogurt market reached approximately 85.54 billion U.S. dollars and will maintain at 4 billion U.S. dollar growth per year⁸.

The yogurt market has existed and developed for centuries. Currently, yogurt products can be found in most supermarkets, hypermarkets, and convenience stores. The existence and penetration of those independent and specialist retailers is critical due to the non-evenly distributed American population. However, ewe yogurt is a small portion of overall dairy yogurt consumption due to the cost and lack of awareness of its benefits.

The intention of this market analysis is to display a local ewe yogurt market framework for the segments of customer, competitors, and company, and to assist the Cornell Sheep Program for preparing future developments.

2.2 Customers

Greek yogurt was the consumer's top choice and had taken more than half of the total market. Conversely, in recent years as people developed a great interest in Icelandic and non-dairy yogurt, the demand for Greek yogurt went down (Figure 1).

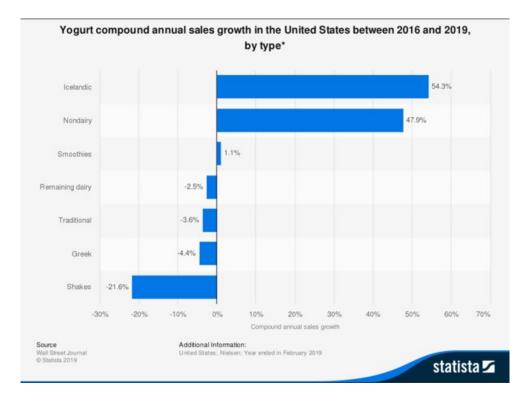


Figure 1. Yogurt compound annual sales growth in the United States between 2016 to 2019, by type⁹.

The majority of people have low tolerance for sour flavor so that they prefer flavored and sweetened yogurt. According to the retail volume sales by different flavors in 2018, the strawberry blend is the most pleasant flavor that takes 19.9% of total sales¹⁰. Vanilla and plain are the second and third most popular flavor, with 13.1% and 12.3% of sales, respectively. Nevertheless, these tasty yogurts are full of high sugar and preservative content, which is contrary to people's original intention in staying healthy. The high calorie content may lead some consumers to find alternative shakes and drinks, resulting in reduced numbers of buyers.

Health benefits are the main drive for people consuming yogurt. Statistics indicate that low-fat yogurt is the most accepted type assorted by fat content (Figure 2). Since a group of people who suffer from lactose intolerance are not able to

consume regular dairy cow yogurt, ewe yogurt becomes a great alternative, which provides those people a higher density of nutrients with no sickness symptoms.

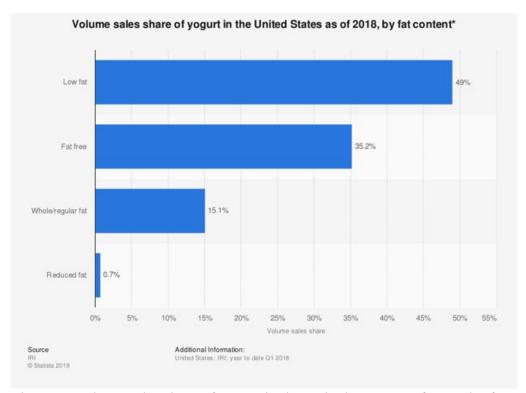


Figure 2. Volume sales share of yogurt in the United States as of 2018, by fat content¹¹.

However, only a small portion of Americans are loyal consumers of ewe yogurt products. The main reason is that people are used to dairy cow products and are not willing to try a new product. Thus, making people realize the existence of ewe yogurt and developing the interest to taste it becomes critical for exploring the ewe yogurt market.

2.3 Competitors

Seventy-five percent of overall U.S. yogurt market is controlled by Danone, Chobani, and General Mills¹², but none of those big players produce ewe milk yogurt. Because of this, local farms, barns, and creameries dominate ewe yogurt products. According to the USDA NASS Sheep and Goat Report, published in Jan 2020, New York state is not in the top 10 states of overall sheep and lamb inventory, but New York is home to one of the largest sheep dairies in the United States.

Old Chatham Creamery and Valley Shepherd Creamery are the main representatives of New York State ewe yogurt producers. Old Chatham Creamery has an over 25 year history producing sheep dairy products. This creamery partnered with Meadowood Farm to develop and update a sheep milk creamery as well¹³. The yogurt product can be found in local retail stores and supermarkets. It has 16 oz cup original and vanilla ewe yogurt, and 6 oz cup ewe yogurt with original, vanilla, maple, blueberry, and ginger flavors. The 16 oz cup original ewe yogurt is the most common one displayed on shelves. Valley Shepherd Creamery is in New Jersey, but the product can be purchased from farmers markets, local restaurants, and an online store. It has vanilla, blueberry, strawberry, raspberry, American cherry, and peach mango flavors in 6 oz cups, and plain vogurt in both 6 oz and 16 oz cups. The creamery claims that their yogurt is from pure grazed ewe milk with no hormone additives¹⁴. Any sheep milk producer could make the same claim about no hormone additives because none are allowed. However, fancy claims and descriptions attract people's attention and stimulate consumption. Many yogurt products are labeled with claims such as Humane raised and handled, Grade A and Gluten Free. With regard to dairy products, "gluten free" is an oxymoron because there is no grain in the products.

2.4 Company

The Cornell University Department of Animal Science houses the Cornell Sheep Program and the departmental sheep flock, which is dedicated to varieties of activities, including education, research, production, breeding, and management of sheep. Widely adopted publications and techniques connect the Cornell Sheep Program with professional organizations such as the Dairy Sheep Association of North America (DSANA).

Lamb meat and ewe milk are the primary income sources to help with expenses of the sheep flock. Except for the products used for teaching and research, all products are offered for sale to Cornell University's faculty, staff, and students. Ewes are milked twice a day during the lactation season, and the milk yield rises each year as more ewes with dairy breeding are added. This student-operated sheep dairy reached 53 East Friesian and Lacaune crossbred ewes by the end of May 2020. In 2019 the Cornell sheep dairy partnered with a creamery to supply ewe milk for cheese making. The yogurt product will be launched as an alternative market for the sheep dairy, serving the Cornell community and contribute to the total revenue.

3. Product Development

3.1 Product Overview

Yogurt products were made with Cornell ewe milk using six types of commercial yogurt starter cultures. Each yogurt culture was fermented for 4 time durations. Four Cornell Animal Science faculty and students evaluated the products and scored taste, aroma, texture, and acceptability with a 5-point hedonic scale (5 excellent, 1 unacceptable). The main aim of this study was to trial a production to test and validate the production line before commercial manufacture.

3.2 Research and Development Process

3.2.1 Experimental Design

Six starter cultures (Table 1) were each used to create 1-gallon batches of yogurt from pasteurized Cornell ewe milk. One quart of yogurt was removed and refrigerated at 4 times after the start of fermentation. The 4 times were different for each yogurt starter culture.

Starter Culture	Ferm	Fermentation time (hours)				
Bulgarian	7	8	9	10		
Greek	7	8	9	10		
Lactic acid culture, 1/4 tsp	6	7	8	9		
Lactic acid culture, 1/8 tsp	8	9	10	11		
Traditional	7	8	9	10		
Old Chatham yogurt	6	7	8	9		

Table 1. Starter cultures and fermentation times.

Each of the resulting 24 yogurts was sampled for sensory attributes by 4 evaluators, with each evaluator sampling the 4 times within each yogurt sequentially. A cracker was consumed before the evaluators sampled the next yogurt batch. A commercially produced yogurt was also sampled for sensory attributes by the evaluators. The pH of each of the 24 yogurts was measured using a gel-filled electrode, that was rinsed with distilled water before measuring each yogurt.

3.2.2 Statistical analysis

The sensory attribute data for the yogurts were analyzed by the following

repeated measures analysis of covariance model:

 $A_{ijk} = \mu + Y_i + Ej(Y_i) + b_1H_k + b_2Y_iH_k + b_3H_k^2 + b_4Y_iH_k^2 + e_{ijk}$

where:

 A_{ijk} is the attribute response to the ith yogurt culture from the jth evaluator within the ith yogurt, from the kth hour of fermentation

 μ is the overall mean,

Y_i is the ith yogurt culture,

 $Ej(Y_i)$ is the j^{th} evaluator within the i^{th} yogurt culture,

b1 is the estimated linear covariate for hour of fermentation,

H is hour of fermentation,

 b_2 is the estimated effect of the ith yogurt on the linear covariate for hour of fermentation,

Y_iH_k is the cross product of the ith yogurt culture with hour of fermentation,

b3 is the estimated quadratic covariate for hour of fermentation,

 H_k^2 is the quadratic hour of fermentation,

 b_4 is the estimated effect of the i^{th} yogurt on the quadratic covariate for hour of fermentation,

 $Y_i H_k^2$ is the cross product of the i^{th} yogurt culture with quadratic hour of fermentation

 e_{ijk} is the random error for the ith yogurt culture from the jth evaluator within the ith yogurt at the kth hour of fermentation.

If the p-value for the $b_4 Y_i H_k^2$ term was not less than 0.05, it was removed from the model. Then, if the p-value for the $b_3H_k^2$ term was not less than 0.05, it was removed from the model. Then, if the p-value for the b₂Y_iH_k term was not less than 0.05, it was removed from the model. The mean squares for $E_i(Y_i)$ were used to test the effect of yogurt.

The pH data were analyzed with a similar statistical model except that Ej(Yi) was not included.

A Commercial yogurt was tasted by all the evaluators for sensory attributes,

which provided the SEM.

3.2.3 Results and Discussion

Effect	Taste	Aroma	Texture	Acceptability	pН		
Yogurt starter	At mean of 8.3 hours						
Bulgarian	2.2	2.6	2.6	2.2	5.00		
Greek	3.4	3.6	2.9	3.2	4.61		
Lactic Acid 1/4tsp	3.7	4.0	3.7	3.5	4.36		
Lactic Acid 1/8tsp	3.3	2.4	2.7	2.8	4.62		
Traditional	3.0	3.1	2.2	2.5	4.44		
Yogurt	3.7	3.7	3.5	3.9	4.14		
SEM (largest value)	0.03	0.46	0.30	0.36	0.054		
P-value	0.046	0.143	0.017	0.012	0.007		
Fermentation time							
Change per hour	0.165	0.144	0.031	0.126	-0.078		
SE	0.0596	0.0575	0.0508	0.0512	0.0137		
P-value	0.007	0.015	0.540	0.016	< 0.001		
Yogurt x Fermentation time							
P-value	ns	ns	ns	0.029	0.024		
Commercial yogurt ¹							
Mean	4.5	5.0	4.4	4.9			
SEM	0.29	0.00	0.24	0.13			

Table 2. Effect of yogurt culture starter and fermentation time on sensory attributes.

¹Purchased ewe milk yogurt.

Sensory tests, including taste, aroma, texture, and acceptability were the main criteria to evaluate the overall outcome of all yogurt products in this experiment. Measured pH levels for all products averaged from 4.14 to 5.00 (Table 2).

Taste, texture, and acceptability scores and the pH values were significantly affected by yogurt starters (Table 2). Aroma was not affected. Only the linear effect of fermentation time was significant. Most responses changed positively (p < 0.05) with increasing fermentation time. However, texture was unrelated to fermentation time.

Yogurt starter affected the relationship of Acceptability (p = 0.029) and pH (p = 0.024) to fermentation time (Table 2, Figures 3 and 4, respectively). As the hours of fermentation increased, acceptability of 4 of the 6 yogurts increased (Figure 3). The overall acceptability of yogurt made from two starters, Greek and Lactic acid (1/8 tsp), had slopes slightly less than 0.

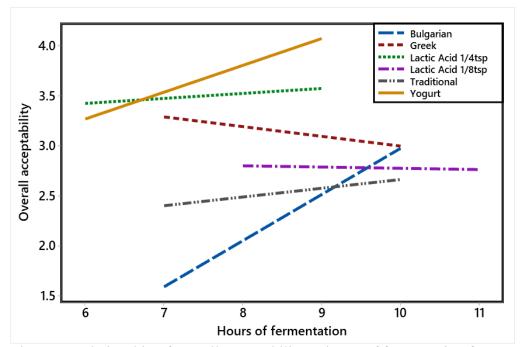


Figure 3. Relationship of overall acceptability to hours of fermentation for yogurts from 6 starter cultures.

As expected, pH declined (p < 0.001) with increased fermentation time (Figure 4), but the pH of yogurt made with the Bulgarian starter was dramatically higher than the pH values of yogurts made from the other starters at all fermentation times. The average pH change per hour was -0.078 units. The decline in pH was most rapid for yogurts started with the Traditional and 1/8 tsp of Lactic acid starters (Figure 4), but the yogurts started with commercial Yogurt and 1/4 tsp of Lactic acid starters were lowest at the first fermentation sampling time.

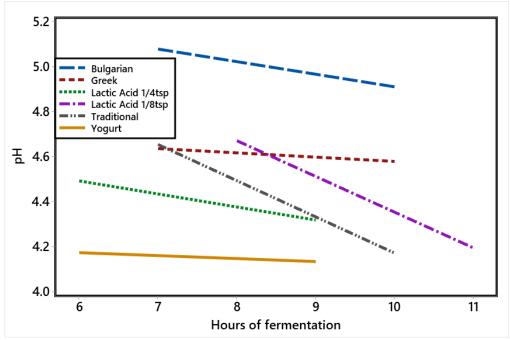


Figure 4. Relationship of pH hours to hours of fermentation for yogurts from 6 starter cultures.

More positive sensory responses were closely correlated with lower pH values by the evaluation panel (Table 2). Whether this would be the same for consumers less enamored with acidic yogurts needs to be considered.

4. Business Case

4.1 Product Line

The sheep dairy product line is composed of ewe milk and yogurt. The first two processing steps of these products are the same - milking and pasteurizing. The only difference is that yogurt has to be fermented with cultures before packaging, while milk does not. All those steps can be accomplished in the creamery without inputting additional cost. Supervision of Cornell Animal Science and Food Science expertise will assure the food safety and flavor of these products.

Ewe yogurt brings multiple advantages to people. The high nutrient-density makes it a unique alternative energy drink with a creamy taste. The live cultures assist digestion after each meal. The refrigerated condition offers people an option to cool down during hot weather. The Cornell Sheep Program will focus on 6 oz Greek yogurt as the star product at the beginning. Vanilla and strawberry will be launched as additional flavor choices with the same serving size as the original one.

4.2 Manufacture

The production will take place at Cornell Sheep Creamery. The installation and manufacture will strictly comply with the State Construction Law and under the guidance of the Regional Milk Processing Supervisor. The construction sketch where the production line will take place is shown in Figure 5. Ewes live on the barn with easy access to the milking parlor. Milkers will wash up and change boots in the fitting room before transferring fresh milk to the bulk tank if bucket milking. If a pipeline system is installed, the milk will go directly into the bulk tank. The bulk tank is

equipment will be cleaned and sanitized. Milk will be transferred to the pasteurizer from the bulk tank before fermenting into yogurt or packaged and stored in the refrigerator as whole milk. All yogurt products will be packed in glass containers. The packaged products will be refrigerated until pickup by distributors.

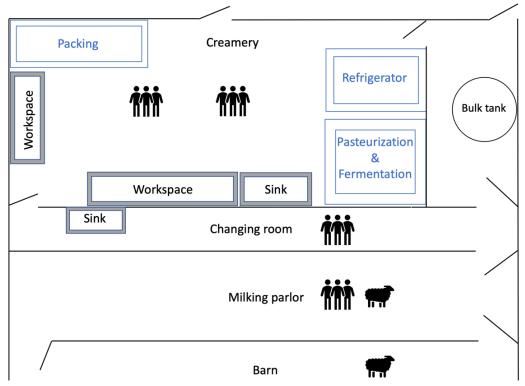


Figure 5. Sketch of possible layout of milking parlor, changing room, bulk tank room, and creamery.

4.3 Pricing

As a premium ewe yogurt product, the Cornell Ewe Yogurt price is determined by the retail price of benchmarking products. The average premium ewe yogurt is around \$0.50 per ounce. Therefore a 6 oz Greek ewe yogurt will have a retail price of \$3 per bottle. Customers will receive a volume discount pricing at 10% off when purchasing more than six bottles at a time. In order to pursue a sustainable environment, Cornell Sheep Program encourages customers to bring back the reusable glass container for cleaning and sanitizing. \$0.3 can be saved on the next purchase from each returned glass bottle.

4.4 Marketing Strategy

Cornell University encourages the development of Big Red brands. Physical and virtual advertisements will be planned. Posters will be located in libraries, gyms, and student residence halls, introducing the product, and designating where to purchase, and discounts if applicable. A detailed introduction and sales information will be sent via school mail, making sure all people who are interested in this product are made aware of the availability.

Cornell Dairy Sheep interns will display the product at all agriculture-related college events, including Ag Day, the Apple Harvest Festival, and the Farmers Market. Additionally, the Cornell Sheep Program will organize activities such as farm visits, where personal selling will take place. In addition to the 10% discount on volume pricing, other discounts will be given during festivals and memorable school events.

4.5 Distribution

In order to encourage local creameries and to support their products, the Cornell Ewe Yogurt will be for sale only within the Cornell community and at P&C Fresh located on Cornell property at East Hill Plaza. Faculty and students will be able access the yogurt through dining halls, cafes in libraries, the Cornell store and other the events partnered with Cornell Dining Services.

4.6 Risks and Mitigation

The average lactation period of dairy ewe is around 180 days, meaning that no fresh milk usually is produced for six months each year. However, the Cornell Sheep Program is developing dairy sheep that can be bred out of season and produce three shorter (120-day) lactations every two years. With two flocks and alternative successive breeding periods, this means that there will be ewes lactating year-round.

Because the target customer is limited to the Cornell community, the yogurt will not be as well-known and profitable as other commercial ewe yogurt brands.

5. Conclusions

The ewe milk yogurt business is an emerging market at the starting phase. It has unique health benefits from assisting digestion to no illness syndrome in lactose intolerance people. The experiment sponsored by the Cornell Sheep Program exhibits a correlation of fermentation time via overall acceptability and pH levels, which provides fundamental information for future explorations. Cornell Sheep Program has unique advantages of potentially loyal consumers within the college community and advertisement of the product through a variety of methods. In all, the ewe yogurt product being developed by the Cornell Sheep Program will be a healthy, tasty, and attractive product with great development potential.

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