Vibubs

A diet lemon flavored carbonated pea protein beverage

IFTSA & MARS

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Product description

Vibubs is a lemon flavored diet soda with colorful bubbles of pea protein. This soda not only provides very low calories but also provides 100% of the recommended daily amount of dietary fiber and additional protein content that average soda could not provide. Vibubs not only can help reduce fat absorption but also prevent constipation problems. In an attractive appearance with colorful bubbles encapsulation included **(Fig.1)**, Vibubs provide a sustainable source of pea protein in a light carbonated lemonade while being a vegan drink. This product focuses on millennials that are concerned about weight loss and constipation problems as this age group usually consumes fast food that lacks dietary fiber, where Vibubs can balance out the need.

Background Story

Intake of soda drinks has been associated with an increased risk lot of diseases, including type 2 diabetes, heart disease, and other chronic conditions. This is because of the high amount of added sugar that is added in soda. Therefore, soda drinks have started using sweeteners in drink, creating the diet soda line. Although the calorie intake of soda drinks has been lowered by adding less sugar, soda is still seen as non-nutritious drinks because of the lack of nutraceuticals. Moreover, most soda drinks are most commonly consumed with fast foods, which are high in fat and low in dietary fiber. It is hard to limit the consumption of soda in the US, with its popularity that is provided in fast food chains and low cost. To balance out such diet, Vibubs is a diet soda that provides an extra amount of dietary fiber while providing a good amount of plant protein. The dietary fiber in the soda drink can reduce the absorption of the fat in your meal while increasing the bioavailability of protein in the drink. The high amount of dietary fiber in the drink equals to 100% of recommended daily value, which on average Americans only consumes half of this value. The pea protein in the drink is a more sustainable source of protein that provides most essential amino acids. This protein will be encapsulated in sodium alginate beads to prevent sandy mouthfeel while drinking the soda drink. This product can be produced with low cost, thus can be marketed at fast food chains.

Ingredient statement, Formulation and Nutritional Claims

The formulation and nutritional profile for the beverage are in **Table 1** and **Fig. 2**. To create a light and novel mouthfeel, carbonated water is added to provide air bubbles to interact with pea protein beads in the mouth. Lemon juice is used not only to provide flavor but also to play a role to inhibit the growth of pathogen since its low pH can increase acidity of the product. To adjust the pH lower than 4.6, where the acidity could inhibit the growth of microbes, citric acid is also added. As the special property of our product, dietary fiber in the form of

maltodextrin is added. Dietary fibers promotes the movement of material through your digestive system and increases fecal bulk, so it can be of benefit to those who struggle with constipation. What should be noticed of Vibubs is that it provides 100% DV of dietary fiber for our consumers. Pea protein is added to Vibubs to deliver a boost of energy. Protein content in every bottle of Vibubs reaches 16% DRV (Daily Reference Value) which could help to compensate the lack of protein consumption especially for vegetarians. Although protein is added into Vibubs, it does not have a thick and unpleasant texture thanks to the technology of encapsulation. Encapsulation is utilized by the combination of sodium alginate and calcium chloride to form pea protein beads. When the mixture of sodium alginate and protein is injected into calcium chloride solution, an egg box-structure will be formed to produce the spherical beads. Sucralose, stevia, aspartame as sweeteners here replace the function of sugar and reduce total calories in Vibubs for people who have concern of additional sugar intake. This helps us target consumers that are on a diet and people that have high risk in obesity. Vibubs is also going to be attractive to them for more dietary fiber consumption but low calories from carbohydrate.

Ingredient:

Carbonated water, lemon juice, water, dietary fiber (maltodextrin), pea protein, citric acid, sodium alginate, sucralose, aspartame, stevia, annatto extract.

Table 2. Ingredient functionality and formulation percentage of Vibubs

Ingredient	Per Serving size (g)	Percentage (%)	Functionality
Carbonated water	360	72	Basic ingredient
Lemon juice	58.5	11.7	Flavor
Water	40	8	Basic ingredient
Dietary fiber	27	5.4	Basic ingredient, texture, density adjuster
Pea protein	10	2	Basic ingredient
Citric acid	3.9	0.78	pH adjuster, flavor
Sodium alginate	0.5	0.1	Texture
aspartame	0.1	0.02	Sweetener
Stevia	0.6	0.12	Sweetener
Sucralose	0.1	0.02	Sweetener
Annatto extract	0.05	0.01	Colorant
Total	500.75	100	

Processing Description

Raw materials and packaging will be inspected and stored under appropriate conditions after being received. All the dry ingredients in the form of powder will be stored at 25°C (77°F).

Carbonated water and lemon juice will be refrigerated at 4°C (40°F). Sodium alginate and pea protein, distilled water and natural colorant will be weighed out and blended. The annatto extract should be added last for better dissolving of the pea protein and sodium alginate. The blended and homogeneous mixture will be filled in a bottle with a 3 mm hole on the tip of the cap. Separately and at the same time, calcium chloride and distilled water will be weighed for the 1% calcium chloride solution. The pea protein mixture will be squeezed out through the bottle and dropped into the calcium, solution to form spherical beads. The protein beads will be soaked in the solution for an hour to make sure the structure of gel is strong enough to encapsulate the protein. While waiting for the beads to be ready, carbonated water, lemon juice, dietary fibers and sweeteners will be weighed and added to sterile plastic bottle. Dietary fibers and sweetener will be well-dissolved in lemon juice first before adding ingredients into carbonated water to prevent over-stirring of the product, which may increase the loss of gas from the product. After an hour, pea protein beads will be rinsed for 30 seconds by distilled water to remove the bitter taste of calcium chloride and then be pasteurized in distilled water at 100°C (212°F) for 30 seconds. Next, the beads will be cooled and removed from the water. Each bottle of weighed carbonated water will receive same portion of beads and lemon juice mixture. Individual bottles will be packed into boxes and be stored under 25°C (77°F) during shipment. The process diagram can be seen in **Fig. 3**. Retail and consumer storage could be on shelf or refrigerated for better taste.

Product Quality, safety and Shelf life

A HACCP plan for Vibubs has been developed including 4 critical control points (CCPs) **(Table. 3)**. The first CCP – Inspection of raw materials, is not only for safety control but also for quality management. We will need to verify that our suppliers have a good manufacturing procedure to provide safe ingredients and also recheck the material upon receiving. All dry ingredients will be stored at 25°C (77°F). Carbonated water and lemon juice will be refrigerated at 4°C (40°F). The second CCP is to inactivate any pathogens during processing of the beads. The beads will be fully pasteurized at 100°C (212°F) for 30 seconds. To control the strength of the beads, the soaking time of the beads in calcium chloride solution should be monitored and recorded surely to guarantee that the structure of the beads is strong enough to prevent the leakage of protein from the beads and the growth of molds. Concentration of calcium chloride solution will also need to be tested every time before dripping protein mixture in this CCP plan. The third CCP is set to control the acidity of the carbonated lemonade. This critical control point aims at inhibition of pathogen growth but meanwhile maintain the quality of the drink. In the technical solving of our product design, we found that high acidity of the liquid could facilitate the stability of the protein and alginate. Therefore, it is significant to make sure our carbonated lemonade (around pH 2-3) has pH lower than 4.6 to inhibit biological hazard and successfully control the quality for our product. The last CCP of Vibubs is controlled during packaging and

distribution steps. Finished Vibubs product will be inspected by visual appearance and stored and deliver at 25°C (77°F) to maintain the quality.

Vibubs has an estimated shelf life of 2 months when stored at 25°C (77°F). This shelf life is based on quality of the product rather than microbiological concern. The shelf life will be confirmed by conducting standard real-time shelf life testing, analyzing product via microbial counts, and sensory evaluation over a projected 6-month period. A "Best By" date, lot code, and plant code will be found on each product packaging to ensure proper tracking and identification. Good Manufacturing Procedures (GMP) and Good Hygiene Practice (GHP) will be followed, including employee training. Standard Operating Procedures such as pest control and sanitation will be followed and performed to promote the output of a high quality and safe product.

Technical Problem Solving

- **Shape of beads:**

  In the beginning of beads making, the shape of beads were not uniform at all. There were all kinds of shapes but not the ideal spheres. We ended up finding that the hole on the tip we used was too small and the viscosity needed to be adjusted. When the hole is too tiny, shear force will be generated by squeezing the bottle, which will in turn change the shape of beads. Moreover, viscosity plays a significant role to form the beads. Under high viscosity, solution will be more likely to attach to the exposed surface of the bottle. This will elongate the appearance of the beads and make it more like "noodles." After the utilization of a more appropriate bottle and calibration of the viscosity, perfect spherical beads could be made.

- **Stability of beads:**

In the few previous experiment, we stored the beads in water and would like to observe their stability over time. However, pea protein leaked out the beads and turned the drink into a turbid look. More severely, there were even molds growing in the drink after the the leakage. To solve the problem, we found that the key factor to keep protein inside the beads and maintain the stability of the structure was through the acidity of the liquid outside the beads. First of all, we noticed the isoelectric point (IEP) of pea protein is around pH 4.5. The stabilizing effect of particles in solution (emulsion) is predominantly determined by electrostatic interaction of the droplets. To produce a stable emulsion, it is important to ensure that the pH is far from the IEP of the proteins so that the charges are not significantly screened and the zeta potential (ζ) remains high (Ravindran *et al.*, 2018). Similarly, sodium alginate has a higher zeta potential under low pH. Placing the beads into a more acidic solution can make sure protein would not penetrate through the pores on the beads surface and the alginate gel will be more stable. Therefore, we determine our product to be lemonade where much less chance of mildew will occur.

Appendix

Figure. 1: Photograph of Vibubs

Figure. 2: Nutrition Label

Nutrition Facts	
1 servings per container	
Serving size	**1 (500g)**
Amount Per Serving	
Calories	**150**
	% Daily Value*
Total Fat 0.5g	**1%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 55mg	**2%**
Total Carbohydrate 29g	**11%**
Dietary Fiber 29g	**104%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 8g	**16%**
Vitamin D 0mcg	0%
Calcium 0mg	0%
Iron 0mg	0%
Potassium 20mg	0%

*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. 3: Process Diagram

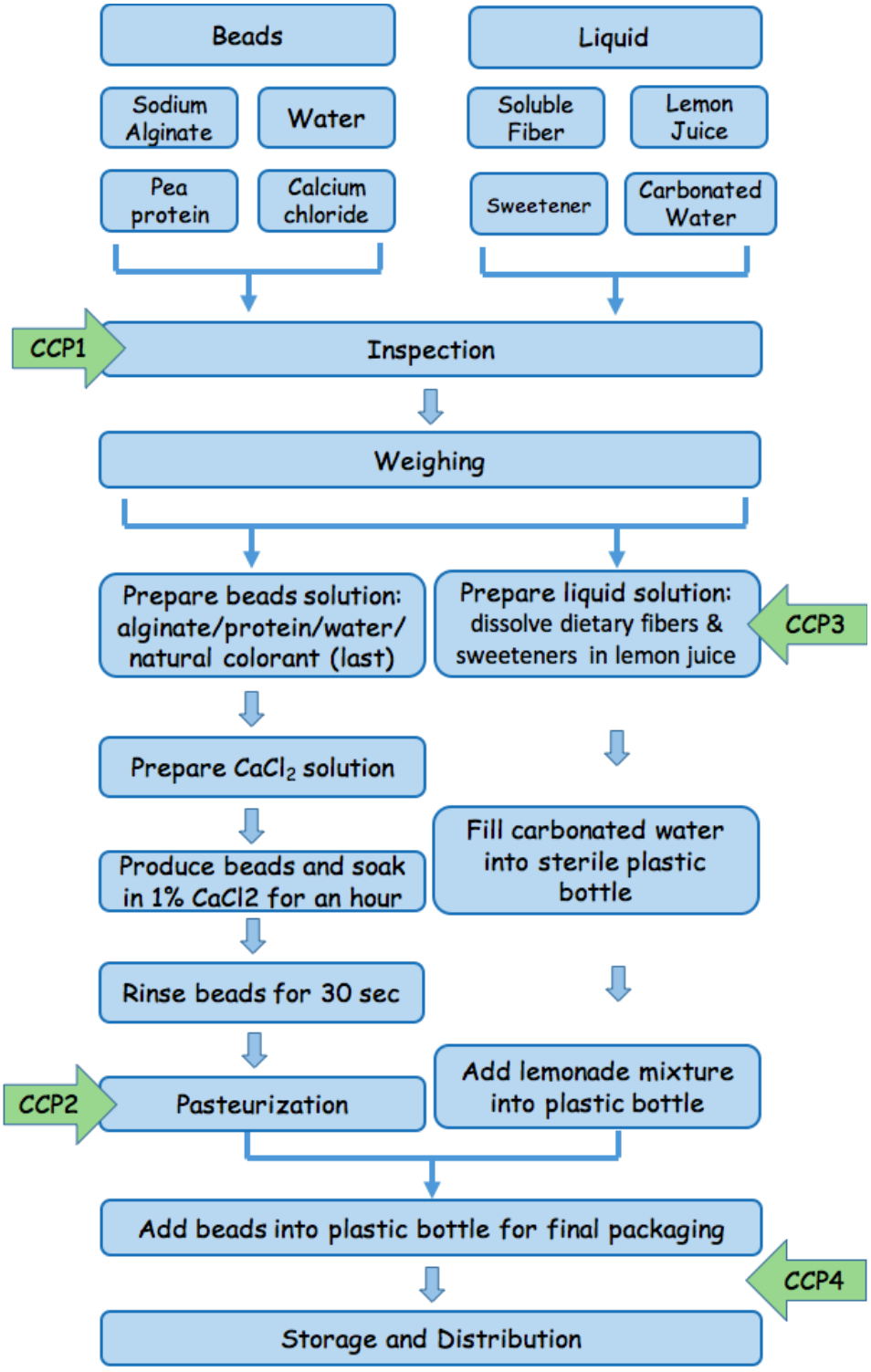

Table 3. CCPs and Corrective Action for Vibubs

CCP	Description	Hazards controlled	Monitoring process	Critical limit	Corrective action	Records
1	Ingredient Inspection	Biological (Pathogens) Chemical (Allergen) Physical (Foreign Material)	- Visual inspection or ingredients' packaging (dates, physical damage) - Check temperature of refrigerated food with calibrated thermometer	- No signs of damaged packaging - Internal temperature of food is less than 4°C (40°F)	- If damaged packing, discard - If above 4°C, check materials or discard	Corrective Action Log, Temperature Log, Thermometer Calibration Log
2	Pasteurization	Biological (Pathogens)	Monitor temperature of boiling water	- Temperature of boiling water at 100°C (212°F) for 30 sec	- If not boiling, halt production and adjust heating	Corrective Action Log, Food Temperature Log
3	pH control	Biological (Pathogens)	Monitor pH of lemon juice carbonated liquid	- pH of liquid lower than pH 4.6, even better if lower than pH 3	- If higher than pH 4.6, discard and adjust acidity	Corrective Action Log, pH Monitoring Log
4	Packaging and Storage	Biological (Pathogens) Physical (Foreign Material)	- Visual inspection - Monitor temperature of storage	- No sign of damage to packaging - Temperature of storage less than 25°C (77°F)	- If package shows sign of damage, discard - If above 25°C, check product or discard	Corrective Action Log, Temperature Log, Thermometer Calibration Log

Table 4. Cost analysis

Ingredients	weight(g)	cost	$/per gram	$/per serving
Carbonated water	360	$0.25 / L	0.000025	0.009
Lemon juice	58.5	$4.39 / Gal	0.001159	0.0678015
Water	40	$3.38 / kGal	0.000008929	0.00035716
Fiber	27	$3.15 / kg	0.00315	0.08505
Pea protein	10	$8.44 / kg	0.00844	0.0844
Citric acid	3.9	$14.88 / 3.6 kg	0.0041	0.01599
Stevia	0.6	$13.99 / 2.5lbs	0.1233	0.07398
Sodium alginate	0.5	$20 / 400 g	0.5	0.25
Aspartame	0.1	$24.96 / 500 g	0.04992	0.004992
Annatto extract	0.05	$1.59 / 2.5 oz	0.02243	0.0011215
Sucralose	0.01	$25.99 / 2500 g	0.01036	0.0001036
Total (w/o packaging)	500	–	–	0.59279576
Plastic bottle	–	0.1 / each	–	0.1
Total (w/ packaging)	–	–	–	0.69279576
Cover price	–	–	–	**2.5 / bottle**

References

Borgogna, M., Skjåk-Bræk, G., Paoletti, S., & Donati, I. J. T. j. o. p. c. B. (2013). On the initial binding of alginate by calcium ions. The tilted egg-box hypothesis. 117(24), 7277-7282.

Bunch S. *et al*., N. (2017). Water and Wastewater Annual Price Escalation Rates for Selected Cities across the United States. Energy Efficiency & Renewable Energy

The Food and Drug Administration. Nutrition facts label: Dietary Fiber. Retrieved from https://www.accessdata.fda.gov/scripts/interactivenutritionfactslabel/factsheets/dietary_fiber.pdf

Fung, T. T., Malik, V., Rexrode, K. M., Manson, J. E., Willett, W. C., & Hu, F. B. (2009). Sweetened beverage consumption and risk of coronary heart disease in women. The American Journal Of Clinical Nutrition, 89(4), 1037–1042.

Meg C. (2018, December 20). What is the recommended daily serving of fiber?. Retrieved from https://www.ucsfhealth.org/education/increasing_fiber_intake/

Ravindran, S., Williams, M. A. K., Ward, R. L., & Gillies, G. (2018). Understanding how the properties of whey protein stabilized emulsions depend on pH, ionic strength and calcium concentration, by mapping environmental conditions to zeta potential. Food Hydrocolloids, 79, 572-578.

Schulze, M. B., Manson, J. E., Ludwig, D. S., Colditz, G. A., Stampfer, M. J., Willett, W. C., & Hu, F. B. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. JAMA, 292(8), 927–934.