Thesis Project Portfolio

Nutritional Protein: Plant Based Chicken Nuggets

(Technical Report)

NeoNatural Flavors: Social Factors Affecting the Adoption of Microbially Derived Flavorants

(STS Research Paper)

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Executive Summary

The division of labor within food production is the most important bedrock of our civilization. As time has progressed, the volumes and varieties of food produced have required intermediate processing steps. The alterations within the processing steps can concentrate the nutritional value or create entirely new products for the consumer to experience. This rationale of using food processing to concentrate nutritional and monetary value is the basis for the design of a production facility for sesame based plant chicken nuggets. The factory allows for waste sesame flour to be recast as a protein source for both economic and environmental benefit. One of the major ways of making these products more palatable is through the addition of flavorings. Flavorings are not supposed to change the nutritional value of the foods they are flavoring, but the actual body of scientific knowledge in this avenue is not very complete. An additional area of concern is that the means of producing flavors using biopharma processes has become widespread, without any significant oversight or adaptation to current legislation. By understanding the physical and chemical steps to create a processed food product, the motivations of food manufacturers in the avoidance of revealing information about their products can become better understood. On the other hand, understanding consumer-manufacturer relations in the flavorant aspect of a processed good can better illuminate the rationale behind design decisions within the sesame nugget production process.

Due to environmental concerns, plant based meats have become a growing market within the food industry. The majority of plant based products currently on the market are soy based. Soy is a major allergen, and the government incentives for soy production have resulted in environmental issues from its widespread adoption. To alleviate both of these concerns, sesame seeds are the major feedstock for the nugget product. Production of the nuggets occurs in four main phases: removal of oil within the seeds through pressing and extraction, fermentation of seed solids and removal of lactic acid from the post fermentation media, preparation of yeast extract for flavoring, and final mixing and cooking of the nuggets. Optimization of these processing conditions was conducted including production scale, unit operation choice, unit operation conditions, capital cost estimation, feedstock and waste costs, operating profit, and depreciation economics.

Following this investigation it was determined that a sesame based chicken nugget plant could be a venture that is profitable enough to offset its risk with some alterations to its overall design. This version of the factory features three main phases, and purchases yeast extract to flavor the nuggets. The other major departure from the original design is the disposal of lactic acid nutrient broth due to low selling price. Using this factory design an internal rate of return 65.7% can be achieved. If consumer demand of this product can be verified using taste and price elasticity studies, this investment becomes much more attractive. Other means of improving this investment include: increased yield of lactic acid solid separation, decreased oil turnover, and reduced cost of yeast extract production.

After partial takeover by artificial flavors from the 1950-90s natural flavors have returned to being the dominant category on the flavor market. The shift in the last 30 years is largely caused by the development of biopharma style processes to produce flavor compounds biologically in mass scales. The adoption of this technology was rapid and occurred without significant pushback from consumers. The long term effects of this technology remain unclear due to a weak food regulatory environment. Because flavor additives are consumed in greater quantities by lower income individuals and children, any form of endocrine toxicity could have significant social and economic ramifications. To fully understand the environment which this

technology was adopted within, and how its usage is now cemented within both the public consciousness and manufacturing lines, social construction of technology will be used. Social construction of technology states that the perception and use cases of a technology is due largely to social pressures exerted by different stakeholders, and after a critical period of discussion, the usage becomes ossified and mundane.

The process of technological assimilation for biopharma processes for the generation of flavorants was dominated by the interests of manufacturers. This was due to the adoption of this technology being an increased priority for manufacturers compared to both government and consumer interests. The drive for manufacturers to implement these technologies is partially financial as biopharma processes can more cheaply produce some flavorants. Another reason for the eager attitude to adoption is that flavorants are the core of a food manufacturer's brand loyalty, and the ability for flavors to be imitated requires a huge research and development division. The constant arms race in implementing new methods and products means that manufacturers are open to new methods and the penalty for waiting if a technology produces no chronic effects is significant. The other forces to counter this eager behavior were not attentive during the critical phase of implementation. The federal government regulatory arm under the FDA has many priorities and food additives ranks behind all drug focuses, and preventing food borne illness epidemics. The FDA also has a precedent for allowing manufacturers to use ingredients without toxicology information testing for novel ingredients. Consumers also did not have a significant interest in altering the usage for this technology. Flavorants produced through this process are labeled natural flavors, which co-opts powerful psychological effects, especially for risk determination. Additionally, issues without acute threats are frequently difficult to mobilize political will towards. These factors combine to a lack of oversight in the regulation of cultured flavors and an environment which will unlikely overcome the inertia of the current system.