

RESEARCH ARTICLE | JUNE 15 2017

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AIP Conf. Proc. 1855, 020009 (2017)

<https://doi.org/10.1063/1.4985454>



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Process Quality Planning of Quality Function Deployment for Carrot Syrup

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Abstract. Carrot products are rarely available in the market. Based on previous research that had been done using QFD to generate product design of carrots products, the research to produce the process quality planning had been carried out. The carrot product studied was carrot syrup. The research resulted in a process planning matrix for carrot syrup. The matrix gives information about critical process plan and the priority of the critical process plan. The critical process plan on the production process of carrot syrup consists of carrots sorting, carrots peeling, carrots washing, blanching process, carrots cutting, the making of pureed carrots, filtering carrot juice, the addition of sugar in carrot juice, the addition of food additives in carrot juice, syrup boiling, syrup filtering, syrup filling into the bottle, the bottle closure and cooling. The information will help the design of the production process of carrot syrup.

INTRODUCTION

Carrots are healthy vegetables but they are rarely processed into food products that add values to the carrots. A research had been conducted to find some food products based on carrots valued by customers [1]. The research used the product planning phase of QFD. The research had found two carrots products, namely candied carrot and carrot syrup. Based on House of Quality resulted from the product planning phase, a research used product design phase of QFD had been carried out to result in product design matrix [2].

In order to get more information about how to produce the carrot products a research using the process planning phase of QFD had been done. The carrot product that was continued to develop in the third phase of QFD, namely process quality planning for this research was the carrot syrup.

Quality Function Deployment (QFD) is a method to plan and develop a product that is able to translate the needs and wants of the customer [3]. The method is able to translate the needs and wants or customer requirements to be a functional design [4]. QFD can also be applied to the development of food products [5]. Application of QFD in the food industry have been done a long time, which is generally it is used as a tool of product development to meet the requirements of the food industry but there are not many published application of QFD in the improvement of product development processes especially on an industrial level [6]. Although the literature about application of QFD in the food industry is limited, a positive feature of QFD method is that the matrices can provide a link between the quality characteristics as demanded by the consumers and the actors in the production chain [7].

Carrots are known as healthy vegetables. They are known to have a high content of nutrients such as sugar, fiber, and antioxidant substances such as vitamin C, vitamin E, carotenoids and beta-carotene [8]. They are also well known as a source of vitamin A because they have higher levels of carotene (provitamin A) and processed carrots such as carrot juice is good for health [9]. Since carrots based products are rarely available in the market, the development of carrots into food products needs to consider the preference of the consumer. Developing newer, healthier foods that are accessible, affordable and satisfying to the consumer makes individuals easier to choose healthier food products [10]. QFD that includes customers in the process method is considered appropriate to develop carrots based products.

METHODOLOGY

There were several steps in process quality planning carried out to produce the process planning matrix. The first step that needed to be done on the use of QFD method was to determine the selected critical parts obtained from the second phase of QFD matrix. In this stage, it was conducted the process of finding the relation between selected critical parts to the plan defined processes.

The next step was to determine the process plan. An analysis of the flow of critical processes in the production process of the products was conducted. The determination of the process plan was done by conducting interviews and discussions with practitioners who were experts in the production process of syrup. After the process plan had been established, the next step was determining the importance for each of the critical parts. The critical part that had a high priority will have a value of high importance as well.

In addition to determining the value of interest, it also needed to find the relative weights of selected critical parts. The relative weight was used in the calculation of the importance weight of critical process plan.

Then, the matrix correlation between critical parts and critical process plan was built. The correlation was done by giving the appropriate value in the column of critical parts corresponding to the critical process plan being assessed. Each critical part can affect more than one critical process plan and vice versa.

The next step was determining the importance weight. At this stage the importance weight was calculated by multiplying the value of the relative weights of critical parts to the value of the relationship between critical parts with critical process plan.

After doing all of the calculations and data processing related to process planning, the final step in data processing activities that need to be done was to put the calculation results along with results of data processing that has been done on the process planning matrix.

RESULTS

The first step that needed to be done in process quality planning was to determine the selected critical parts obtained from the product design phase of QFD for syrup carrots. Based on the product design matrix for carrot syrup [2], the critical parts and their importance weights were given on the Table 1.

The process plan for the production process of carrot syrup was obtained from the discussion with some experts who understand well in syrup production. In general, the process plan can be divided into two parts, namely the primary process plan and the secondary process plan. The primary process plan is a plan for a process that tends to be more common, while the secondary process plan is a plan that is more specific and is a derivative of the primary process plan. The primary process plan of carrot syrup production process consisted of the raw materials preparation, the making of syrup and filling.

Secondary process plan which was derived from raw material preparation consisted of the carrots selection process (sorting), carrots peeling, carrots washing, blanching process and carrots cutting. The secondary process plan which was derived from the process of making the syrup consisted of the making of pureed carrots, carrot juice filtering, the addition of sugar in carrot juice, the addition of food additives in carrot juice, syrup boiling and syrup filtering. Finally, the secondary process plan which was derived from the filling process consisted of the process of filling the syrup into the bottle, bottle closure and cooling. The primary and secondary process plan for the production process of carrot syrup were given on Table 2.

TABLE 1. Critical Parts for Carrot Syrup

Critical Parts	Importance Weights	Priority
The type of food additives	628.8462	1
The amount of food additives	628.8462	1
The process method	544.6679	2
The type of tool materials	201.0222	3
Processing time	170.3603	4
Processing temperature	143.4879	5

The production process of carrot syrup began with the process of selecting (sorting) raw materials, in this case the main raw material was carrots. The process of sorting carrots required high observational skills to pick the carrots that were considered appropriate for use in the production process. The quality of the carrots used will

greatly affect the quality of carrot syrup produced. After the process of carrots selection, the process of peeling the surface of the carrot was done and followed by the washing process. The next process was the process of blanching and it can be done in two ways: steaming or boiling. The purpose of the blanching process was to make the process of mashing carrots easier. In the process of blanching, the steaming method had advantages over the boiling method because vitamins in carrots can be dissolved in water when boiled. Blanching process was usually done at a temperature range of 60°C to 100°C within 5 to 10 minutes.

The next process was making pureed carrot that began with carrots are cut into smaller pieces so the process of mashing was easier. Making pureed carrot can be done by using a blender or other crushers designed according to the needs (small or large). When the carrot had become pureed carrot that was smooth enough, then do a filtering process for separating the carrot juice from the pulp. Then adding sugar to the carrot juice. The amount of sugar added to the carrot juice was approximately 70% of the total volume of the carrot juice. The process of adding sugar, then, was followed by the addition of food additives, such as stabilizers, colorants, sweeteners and preservatives. For stabilizing syrup, commonly used Na-CMC with a rate of 1.5% of the total volume of carrot juice, while the dose for coloring, sweeteners and preservatives usually customized according to the needs.

TABLE 2. Primary and Secondary Process Plan

Primary Process Plan	Secondary Process Plan
Raw materials preparation	Carrots selection process
	Carrots peeling
	Carrots washing
	Blanching process
	Carrots cutting
The making of syrup	The making of pureed carrot
	Carrot juice filtering
	The addition of sugar in carrot juice
	The addition of food additives in carrot juice
	Syrup boiling
Filling	Syrup filtering
	Filling the syrup into the bottle
	Bottle closure
	Cooling

The next process was the boiling process of carrot juice that had been mixed with sugar and food additives. The boiling process was done at 100°C in less than 30 minutes. The purpose of boiling process was to kill microbes contained in the syrup being made. Thus, the storability of carrot syrup can be increased (more durable). After carrot syrup had been boiled, then the second filtering process on the carrot syrup was done. The filtering process served to ensure no deposits/dirt from food additives and sugar remaining in the syrup. The filtering process was followed by the process of filling the syrup in bottles that have been sterilized at 100°C for 30 minutes. After the filling process of the syrup into the bottle, then the process of closing the bottle and bottle cooling at room temperature. Due to carrot syrup product to be manufactured was a new product, then the all plans of the existing secondary process were used as a critical process plan.

After establishing the process plan, the next step was to determine the importance of critical parts. The function of the value of the importance was to describe the interests of each selected critical parts to produce the products according to the expected critical process plan.

In addition to determining the importance, it also required to determine the relative weights of selected critical parts that will be used in the calculation at a later stage. The value of the relative weights of selected critical parts can be obtained from the comparison of each importance weight to the total weight of the importance of the selected critical parts. The calculation of the importance and the relative weights of selected critical parts made on all critical parts selected.

Then, the process of determining the value of the correlation or relationship between the critical parts with critical process plan that had been determined was conducted. The correlation was determined by giving the appropriate values in the column of critical parts that correspond with the critical process plan wanted. Each critical parts can affect more than one critical process plan and vice versa. The value used in the determination of this correlation was 0 (no relation), 1 (weak), 3 (moderate), and 9 (strong).

temperature or too long in the blanching process can damage the nutritional contents in carrots. Temperatures that are too low or too quick in the blanching process will make carrot difficult to be processed at a later stage. The process of boiling syrup also no less importance to the process of blanching. The temperature and the length of time of the boiling process will determine the quality of the syrup.

Critical process plan which ranked third was the filtering process of the syrup with a value of importance weight of 189.24. The filtering process of the syrup was also worth noting because this process was to separate the filtrate syrup with impurities that may still be contained in the syrup. The next critical process plan was the process of adding sugar in carrot juice which ranked fourth. To get good quality syrup, the sugar used must be of good quality. It would be much better if the syrup using real sugar compared with artificial sweeteners although the real sugar prices were relatively more expensive. Critical process plan placing fifth priority order was the process of making pureed carrots and the filtering of pureed carrot. Both of these processes were closely related because the filtering of pureed carrot process was done after the process of making pureed carrots. Both of these processes must be done properly to obtain carrot extract filtrate with good quality while retaining the vitamins in it.

CONCLUSION

The critical process plan on the production process of carrot syrup consisted of carrots sorting, carrots peeling, carrots washing, blanching process, carrots cutting, the making of pureed carrots, filtering carrot juice, the addition of sugar in carrot juice, the addition of food additives in carrot juice, syrup boiling, syrup filtering, syrup filling into the bottle, the bottle closure and cooling. The priority of critical process plans in the production process were the addition of food additives in carrot juice, the process of blanching, syrup boiling, syrup filtering, the addition of sugars in carrot juice, the making of pureed carrot and filtering of carrot juice. The information will help the design of the production process of carrot syrup.

REFERENCES

1. V. Halim, and Y. Ekawati, "Perencanaan Produk Olahan Wortel Menggunakan Metode Quality Function Deployment", *Symbol*, vol. 1, no. 1, pp 57-67, 2014.
2. Y. Ekawati and M. Bazarado, "Designing Food Products Based on Carrots Using the Product Design Phase of Quality Function Deployment," *ARNP Journal of Engineering and Applied Sciences*, vol. 11, no. 5, pp. 3109-3116, March 2016
3. L. Cohen, *Quality Function Deployment: How to Make QFD Work for You*, Massachussetts: Prentice Hall, 1995.
4. S. T. Foster, *Managing Quality. Integrating the Supply Chain*, New Jersey: Prentice-Hall, 2007.
5. A. R. Linnemann, and M.A.J.S. Boekel, *Food Product Design. An Integrated Approach*, Wageningen Academic. 2007.
6. A. I. A. Costa, M. Dekker, and W. M. F. Jongen, "Quality Function Deployment in the Food Industry: A Review," *Trends in Food Science and Technology*, vol. 11, pp. 306-314, 2001.
7. M. Simione, and G. Marotta, "Towards an Integration of Sensory Research and Marketing in New Product Development: A Theoretical and Methodological Review," *African Journal of Business Management*, vol. 4, no. 19, pp.4207-4216, December 2010.
8. C. Alasalvar, J. M. Grigor, D. Zhang, P. C. Quantic, and F. Shahidi, "Comparison of Volatiles, Phenolics, Sugar, Antioxidant Vitamins, and Sensory Quality of Different Colored Carrot Varieties," *J Agric Food Chem*. Vo. 49, pp. 1410-1416, 2001.
9. A. S. Potter, S. Foroudi, A. Stamatikos, B.S. Patil, and F. Deyhim, "Drinking Carrot Juice Increases Total Antioxidant Status and Decreases Lipid Peroxidation in Adults," *Nutrition Journal*, vol. 10, no. 96, 2011, retrieved from <http://www.nutritionj.com/content/10/1/96> on 16 October 2014.
10. P. Bordi, K. Lee, and M. Conklin, "Sensory Evaluation of Vegetables-Infused Fruit-Flavored Applesauce, and the Comparison between Adults and Children," *Food and Nutrition Sciences*, vol. 4, pp. 559-565, 2013.