AN OPTIMIZATION OF MIXING PROCESS PARAMETERS FOR SOY SAUCE PRODUCTION

NOORILYANA BINTI ABU BAKAR

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Buat Keluarga Tersayang

Mak abah

Jummelah binti Tahir

Abu Bakar bin Daud

Zaharah binti Othman

Keni bin Miskon

Abang-abang

Adik-adik

dan teristimewa buat suami

Khairul Luthfi bin Keni

serta anak-anak tercinta

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ABSTRACT

This research was done to reduce the variation of brixs in mixing process to produce sweet soy sauce. The objective of this research is to find the optimum setting in mixing process. Design of Experiment was used to analyze various combination of process parameters. The process parameters investigated were sugar, caramel, monosodium glutamate (MSG) for Experiment 1 and sugar, salt, water, acid acetic for Experiment 2 respectively. It was not economically practical to run experiments in the real life factory environment. As such, lab experiment was used in this study. Full factorial of design matrix has been used. The significant factors for Experiment 1 are sugar, MSG and caramel. This is including two way interactions between sugar and MSG, Sugar and caramel, MSG and caramel and the last one is three way interaction of all factors. Normally, 3 way interaction and above are assumed as insignificant factors. The significant factors for Experiment 2 are sugar, salt, water and caramel. This is including two way interactions between sugar and salt, Sugar and acetic acid, salt and acetic acid, water and acetic acid and three way interaction between sugar, salt and water and last three way interaction are sugar, water and acetic acid. The study reveals that the optimum setting is the low level (-1) of sugar (450~500 kilogram), caramel (200~225 kilogram) and MSG (64~68 kilogram) for Experiment 1. The optimum setting for Experiment 2 is the low level (-1) of sugar (1350~1450 kilogram), salt (45~55 kilogram), and acetic acid (0.35~0.45 litres) but higher level (+1) for water (800~900 litres) in order to ensure the brix reading fulfil the specification. Mathematical models have been proposed to predict the performance of mixing process with brix reading as the response within the investigated ranges. There are a few suggestions and suitable action plan were proposed to increase the quality of production.

ABSTRAK

Kajian ini dijalankan untuk mengurangkan variasi ke atas bacaan brix di dalam proses campuran menghasilkan kicap soya manis. Objektif utama kajian ini adalah untuk mencari pemboleh ubah yang optima dalam proses ini. Rekabentuk Eksperimen telah digunakan untuk menganalisa pelbagai gabungan pemboleh ubah dalam proses ini. Pemboleh ubah yang dikaji adalah gula, caramel dan perasa monosodium glutamate (MSG) untuk Eksperimen 1 dan gula, garam, air serta asid asetik untuk Eksperimen 2. Tidak praktikal dari segi ekonomi untuk menjalankan eksperimen sebenar seperti di kilang melainkan eksperimen makmal digunakan. Faktorial penuh digunakan dalam eksperimen ini. Faktor-faktor yang ketara untuk Eksperiman 1 adalah gula, MSG dan caramel, interaksi dua hala adalah antara gula dan MSG, gula dan karamel, MSG dan karamel dan yang terakhir interaksi tiga hala adalah melibatkan ketiga-tiga faktor iaitu, gula, MSG dan karamel. Kebiasaannya, interaksi 3 hala atau lebih adalah dianggap sebagai faktor yang tidak penting. Untuk Eksperimen 2, faktor-faktor yang ketara adalah gula, garam, air dan asid asetik, interaksi dua hala pula menunjukkan perkaitan antara gula dan garam, gula dan asid asetik, garam dan asid asetik, air dan asid asetik manakala untuk interaksi 3 hala pula melibatkan interaksi antara gula, garam dan air serta gula, air dan asid asetik. Kebiasaannya, interaksi tiga hala adalah dianggap sebagai faktor yang tidak penting. Hasil daripada kajian ini, pemboleh ubah yang optima adalah nilai rendah (-1) pada gula (450~500kilogram), karamel (200~225kilogram) dan MSG (64~68kilogram) untuk Eksperimen 1. Penetapan nilai optimum untuk Eksperimen 2 pula adalah nilai rendah (-1) untuk gula (1350~1450kilogram), garam (45~55kilogram) dan asid asetik(0.35~0.45litres) tetapi nilai tinggi (+1) adalah untuk air (800~900liter) untuk memastikan bacaan brix adalah memenuhi spesifikasi yang ditetapkan. Matematik model telah dicadangkan untuk menganggar keupayaan proses campuran dengan mengunakan brix sebagai respon dan beberapa eksperimen telah dijalankan. Beberapa cadangan telah dikemukakan untuk meningkatkan kualiti pengeluaran

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CHAPTER 1

INTRODUCTION

1.1 Background of the Project

In general, companies compete on three main issues: quality, price and delivery. This is true for all types of organizations, whether they are in manufacturing, services or public sector (Ho and Fung, 1994). Moreover, the business trend nowadays has also shifted to the global market. Competition is becoming more intense especially when there will be no more trade barrier and national boundary.

Statistical Process Control (SPC) plays a major part in the efforts of many organizations and industries to improve the competitiveness of their products, services, prices and deliveries. SPC is an effective approach to problem solving and process improvement or even stop producing chaos (Oakland, 2010). In continuous production activity, usually seven basic SPC tools such as flow chart, check sheet, scatter plot, control chart, histogram, Pareto analysis and Ishikawa fish bone chart are applied concurrently. Control charts are classified to the variable and attribute control charts. Control chart for variables consists of several types such as *Shewhart X-bar,R* and *X-bar,S,* Cumulative sum (*Cusum*), exponentially weighted moving average (*EWMA*), individual moving range and others. Control charts function as the statistical method to monitor and control the process variable or attribute within the computed or historical control limits. Control limits are usually computed based on drawing specification, machine capability or historical process mean and standard

deviation. Most production practices will use the tightened control limits which are 1.33 times smaller than the specification limits. For stable process, a centerline between these two control limits need to be maintained continuously. Basically, control charts acts to monitor a process by signals any plotted data that is out from the control limits.

Soy sauce is a dominant savory in Asian dietary. In order to ensure the taste and the aroma is maintained delicious and exotic, the ingredient and the procedures to manufacture the soy sauce must be standards and comply with the food safety control system. Soy sauce (also called soya sauce) is a condiment made from a fermented paste of boiled soybeans, roasted grain, brine, and Aspergillus oryzae or Aspergillus sojae molds. After fermentation, the paste is pressed, producing a liquid, which is the soy sauce, and a solid byproduct, which is often used as animal feed. Soy sauce is a traditional ingredient in East and Southeast Asian cuisines, where it is used in cooking and as a condiment. It originated in China and spread throughout Asia. Soy sauce has a distinct yet basic taste of umami, due to naturally occurring free glutamates (Khaterine,2003).

Varieties of soy sauce are salty, earthy, brownish liquids intended to season food while cooking. Many kinds of soy sauce are made in Japan, Taiwan, China, Korea, Indonesia, Vietnam, Malaysia and other countries. Variation is usually achieved as the result of different methods and durations of fermentation, different ratios of water, salt, and fermented soy, or through the addition of other ingredients.

This study focused on soy sauce company, Zara Foodstuff Industries Sdn Bhd current practice shows that the company did not measure the ingredients because they believe that the total weight stated at every pack of raw material is accurate. This situation could affect the variability of brix value of sweet soy sauce. In order to improve the quality of brix, design of experiment adopted as analyzed tools.

1.2 Problem Statement

Mixing is the main process to combine several ingredients. In order to produce a good soy sauce, the company need to control the brix value range from 63-65 Brix^{o}. The process of mixing the ingredients has resulted in high variability in the brix value. Sometimes, there is too much quantity of sugar that produced high reading in brix and sometimes, the quantity of salts is too high. Currently this problems has been addressd by try and error. Sugar is added if too salty and soy water is added if it too sweet until they get the standard specification. This method is not systematic and lack of consistency. The variability of brix suggests that the company needs to improve its problem solving technique as ample time is wasted through try and error method.

The variability of brix reading is the focus problem in this project. The aim of this project is to reduce the process variability by investigating its optimum parameter setting

1.3 Objectives of the project

The objectives of the project are:

(i) To identify the problem in a Sweet Soy Sauce process.

(ii) To study key process parameters and their influences on the Brix reading.

(iii) To obtain an optimal setting of process parameter for Brix to fulfill the product specification.

1.4 Scope of the Project

This project was carried out to monitor the manufacturing process for Zara Foodstuff Industries focusing on the following areas:

(i) This study focus on Mixing process

(ii) Only brix reading will be studied as the quality response

(iii) Focus on sweet soy sauce

(iv) Will not include cost monitoring

(v) The Classical Design of Experiment is employed

This project provides suggestions for the way forward to the case company in monitoring the soy sauce mixing process.

1.5 Methodology of the Project

The project methodology is based on several steps that allow the project to be done systematically. The methodology started with the characterization of existing process and followed by planning the experimental design. After that, the experiment was conducted by using statistical method and will be discussed in Chapter 3.

1.6 Expected Result

The Design of Experiment approach adopted in this study is expected to reduce process variability problems faced by manufacturer and to gather details information about the interaction between process parameters. Thus, the values of process parameters can be arranged according to the desired characteristics. The statistical design approach gives an opportunity to fully understand the effects of process parameters on desired brix reading by performing significantly fewer experiments than if one factor at a time had been evaluated. A good understanding of how interactions among the various factors influence the brix reading of soy sauce specimens will be obtained. Again, this information would not have been indicated if one factor at a time had been investigated. Accurate relationships, describing the effects of the various factors on brix reading will be obtained by using design of experiment approach. The aim of this project is to improve the quality of product by

reducing the variation of brix reading. When the performance is constantly closer to the target, fewer products are produced out of target. Meaning that the products are produced within specification limits or in this case study products are within Guaranty Limits.

1.7 Summary

This chapter introduces the problem in the case study company, Zara Foodstuff Industries Sdn. Bhd. The variability of brix reading is the focus problem. The aim of this project is to reduce the process variability by investigating its optimum parameter setting.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are several aspects that will be covered in this chapter which are the Quality, Statistical Process Control (SPC), process, control and Design of Experiment (DOE) to be more related to food processing regarding the case study company are manufacture of food product.

For the quality, the definition of quality from several gurus will be explained. A detailed explanation on quality procurement will be given. The next issue is regarding SPC definition, function and the important role in manufacturing. The main topic relating to process monitoring will also be discussed.

Consecutively, the basis on what should consist in process monitoring will be explained using the SPC method focused on requirements that relatives to the process.

2.2 Quality

Nowadays, the word quality appears on almost in every product such as food, automobiles and software. No matter where people go, they will see or hear about quality. In fact, people demand a certain level of quality in everything that they want

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