



## STATISTICAL QUALITY CONTROL OF THE PRODUCTION MATERIALS IN LIFE LAGER BEER



C. E. Okorie\*, O. Adubisi and O. J. Ben

Department of Mathematics & Statistics, Federal University Wukari, P.M.B. 1020, Taraba State, Nigeria

\*Corresponding author: [chyokanmelu@yahoo.com](mailto:chyokanmelu@yahoo.com)

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**Abstract:** Consumers make complaint about the state of home-made goods. Some of the consumers claim that foreign goods are of high quality compared to home-made goods. We discovered that many indigenous industries are no more in existence and so this brought the desire to carry out this research work so as to find out whether Life Lager beer, the product of an indigenous company is void of the consumers' complaint. For clarity and easy handling of this topic, data were collected on the two major components that are used in the production of Life Lager Beer; Hop extract and Calcium hydroxide. The data collected covered a period of four months, from January to April and the readings were twice a day. This was collected from the company's register. Control charts, Standard Deviation charts and Cumulative Sum Technique charts (CUSUM) were used in the analysis. The results were presented with the use of charts. The results indicated that Life Lager beer production materials are in perfect control.

**Keywords:** Calcium, cumulative, extract, Hop, hydroxide, technique

### Introduction

It has been in the mind of people from the onset of creation of industries that goods to be produced by these industries be of good quality. This is the reason why the Federal Government of Nigeria came up with legislations to protect the buyers from buying inferior goods. The urge to have high quality goods is the desire of every nation. For instance, in 1963, the government of India set up legislation for a comprehensive programme of quality control and pre-shipment inspection was enacted under the export (quality control and inspection) Act, 1963. The Act which came up into force with effect from 1<sup>st</sup> January, 1964 empowered the government to notify specific commodities which would be subject to quality control and inspection or recognize one or more standard specifications of commodities and prohibit export of such commodities unless they satisfy the conditions of quality control and inspection.

However, it is of great importance to say that quality control is as old as industry itself. During middle Ages, the maintenance of quality was to a large extent controlled by the long periods of training required by the guilds. This training instilled in workers pride in making their products come out to be the best. In Modern times, factory inspection and research, Food and drug acts, activities of professional societies, all have sought for years to ensure the quality of output. Quality control has thus had a long history. Quality control of any product can be defined as the regular sampling of the output of an industrial process in order to detect any variation in quality. The purpose of this study is; (1) To check whether the components used in the production are combined in the proper proportions set out by the Brewery in order that the product will not be harmful to health. (2) To find out if there is variation in the quality of the products. The complaints of consumers over home-made goods have been alarming and needed urgent attention so as to prevent indigenous industries from experiencing loss as a result of low demand or lack of demand of their products by the consumers, This is the reason for this research work on quality control so as to find out whether Life Lager beer is of high standard and if not suggestion on remedies should be made. In order do that, we looked at various work that have been done on Quality Control such as; Okorie CE *et al.*, 2016, used Statistical Quality Control in assessing the quality standard of Indigenous brewery Companies in Nigeria. They stated that the companies need to have their products in constant check in order to avoid loss. Karim Houchi *et al*

2015. In their study on 'Statistical Quality Control of High-Resolution Winds of Different Radiosonde Types for Chmatology Analysis', observed that quality control is among the most important steps in any data processing. Mahosh BP and Prabhswany MS 2010, used Statistical Quality Control in carrying out a research on 'Process Variability Reduction Through Statistical Process Control for Quality Improvement'. They observed that improving quality is a key factor leading to business success, growth and an enhanced competitive position.

Rohitha Goonatilake *et al.*(2011), used Statistical Quality Control in carrying out research on the topic titled 'Statistical Quality Control Approaches to Network Intrusion Detection', observed that it is very helpful in detecting the network intrusion so as to safeguard public and private interest and to capture the law-breakers. Borde Vukelic *et al.*(2008) used Statistical Quality Control to carry out a research on the topic titled 'Development of a System for Statistical Quality Control of production Process', observed that Statistical methods for quality evaluation provide analyses of production processes which can serve as the basis for undertaking adequate preventive and corrective measures in order to increase the total production quality. Maria Emilia et al 2008 used classical method Shewart, Cumulative Sum method (CUSUM) and Exponentially Weighted Moving Average (EWMA) to determine the Statistical Quality Control of a production line and they observed that the cumulative sum method is more effective in detecting small changes in the mean. James C Benneyan (1998) used Statistical Quality Control Charts in studying methods in Infection Control and Hospital Epidemiology. Chambers Encyclopedic English Dictionary page 1033, defined quality as standard of goodness or excellence and quality control as the regular sampling of the output of an industrial process in order to detect any variations in quality. Dele H Besterfield in his book Quality control second edition, defined quality control as the use of techniques and activities to achieve, sustain and improve the quality of a product or service. Baker Michael, in his book called Macmillan Dictionary of Marketing and advertising page 210, defined quality control as the monitoring of outputs (usually goods but the term also applies to service delivery) to ensure that they meet the standards necessary to deliver the satisfaction expected by the purchaser.

Traditional quality control has been achieved by regular samples of individual units of output to determine that they meet the agreed standards for content and performance. More

recently, it has been recognized that quality is something you build into a product or service and not something which you seek to control after it has been produced. To encourage the development of attitudes and practices which maintain and improve quality, many firms now encourage the formation of quality circles which are informal groups of people concerned with the production process who are made responsible for both maintain and improving quality. Quality control ensures uniformity, wholesomeness, product reliability and quality assurance. Statistical quality control has been recognized and accepted as a vital tool of quality control. Its scope is to deal with collection, analysis, interpretation of numerical data obtained by inspection and test of a product.

Statistical quality control makes the quality of a given product possible enough to have some kind of qualitative measure of quality assurance. This method however, permits and provides a statistical inference. This method permits and provides a statistical inference technique. Besterfield (1986) concluded that quality control is involved with the activities of specification, design, production or installation, inspection and review of usage. He also noted that statistical quality control is a branch of quality control which involves collection of data, analysis and interpretation of data for use in quality control activities. Mittag *et al* 1993 defined quality control as all the inspection procedures administered during the process of manufacturing which are suitable to give information about the state of the process and thus make it possible to intervene in the process with the intention to maintain the quality characteristic of the product within the specified tolerance limit Starr 1989 concluded that quality control is an ongoing inspection procedure. It is a sequential sampling method that is more powerful than 300 percent inspection; the reason is that it does much more than spot detectives and remove them. It diagnoses the problems of a process in delivering the specified qualities and allows them to be corrected. Mayer (1975) observed that quality control is not to be confused with inspection. He noted that in inspection activity that the emphasis is placed on the quality of the past output, but the emphasis is on the quality of the future output in quality control.

King-Scott (1971) noted that quality control process seeks to bring about a situation where deviations from the required standards are detected as they develop rather than after they have occurred. By that corrective actions can be taken by production staff before the article starts being produced outside the limits of acceptability. Chaser/Aquilano 1989 concluded that traditionally manufacturing quality control was operated as a gate keeping activity; the objective was to control product quality at the output stage through inspection. They went on to say that quality control administration provides the statistical tools and services used by other parts of quality control organization. Dervitsiotis (1981) noted that given a set of specifications, that is a desired quality level as a target, control of quality involves keeping track of the variability from these specifications, observed in actual units of the product or service. Modum 1995 observed that quality control has long been recognized as a major mechanism for the detection and prevention of fraud and other related sharp practices.

**Materials and Methods**

**Control chart**

Just as the construction of a house requires sequencing and timing of the work of many individuals artisans in proper relationship one to the other, so it is with the quality control job. Thus control charts may be defined as; A chronological (hour by hour, day by day) graphical comparison of actual product quality characteristics with limits reflecting the ability

to produce as shown by past experience on the product characteristics (Feigenbarm, 1961, p. 250)

However, a control chart can simply be said to be a graphical tool for conducting periodic significance tests as an aid to maintain acceptable standards of quality. The control chart can therefore be said to be a tool used primarily for analysing data either discrete or continuous, which are generated over a time period.

In any production process, some variation in quality is unavoidable and the theory behind the control chart originated by W. A. Shewart is that this variation can be divided into two categories: random variation and variation due to assignable causes.

Certain variations in quality are due to causes over which we have some degree of control, such as different quality of raw materials or new or unskilled workers; we call these assignable causes of variation.

The random variation is the result of each cause being slight; by and large nothing can be done about this cause of variation except to modify the process,

The Shewart control is a simple device which enables us to define this state of statistical control more precisely, and which also enables us to judge when it has been attained.

A sample of a given size is taken at frequent intervals and a chart is kept of, say, the points on the chart enable us to judge whether the process is or is not in control.

The control charts have limits shown as horizontal lines. There are the upper warning limits or the upper control limits and the lower control limits or the lower warning limits. There are also the action lines for both the upper and lower boundaries.

There are upper and lower action limits for  $\bar{x} - chart$ . If a point falls outside the action limits, there is very strong evidence that assignable causes of variations are present and action to trace and eliminate these causes should be limited.

In order to improve the sensitivity of the control charts, warning limits are drawn. These limits are usually set at

$$\bar{x} \pm 1.96 \frac{\sigma}{\sqrt{n}} \quad \sigma = \frac{\bar{R}}{d_2} \quad (1)$$

So that when the process is in control one point should be above the upper warning limit. Two successive points outside the warning limits are usually taken to be good evidence that assignable causes of variation are present.

For the purpose of this work,  $\bar{x} - chart$  is used. This is the most common type of control chart using continuous values.

The  $\bar{x} - chart$  shows any changes in the mean value of process.

For the purpose of this work, the researcher uses the formula below to find out the central line, lower and upper boundaries.

The central line for the  $\bar{x} - chart$  is

$$\bar{\bar{x}} = \frac{\sum_{i=1}^k \bar{x}_i}{g} \quad (2)$$

Where,

$i$  is the number of samples

$\bar{\bar{x}}$  is the average of the subgroups average

$\bar{x}_i$  is the average of  $i$ th subgroups

$g$  is the number of subgroups.

Upper control limit for

$$\bar{x} - chart = UCL_{\bar{x}} = \bar{\bar{x}} + A_2 \bar{R} \quad (3)$$

Lower control limit for

$$\bar{x} - chart = LCL\bar{x} = \bar{\bar{X}} - A_2 \bar{R} \quad (4)$$

$A_2$  values is found from table of control chart constants

$$\bar{R} \text{ is the mean of the range of the samples} = \sum \frac{R_i}{g}$$

In plotting the  $\bar{x} - chart$ , the  $\bar{X}_i$  are plotted on  $Y$  axis corresponding to numbers attached along the  $X - axis$ .

**Cumulative Sum Technique**

The cumulative sum technique is the commonly used name for CUSUM which is primarily used to detect the changes in the mean by keeping cumulative total of the deviation from a reference value. In other words, it is used to detect when charts are out of control.

A constant usually a standard value commonly called reference value or mean is subtracted from the observation and the results are cumulated. The main advantage of this technique over the  $\bar{x} - chart$  is that it detects small change in process.

Let the successive sample mean be denoted by  $\bar{x}_1, \bar{x}_2, \dots$

and  $S_1, S_2, S_3, \dots$  be the corresponding cumulative sum of their deviation from some reference value say  $k$ .

Then the value of  $S_r = S_{r-1} + (\bar{x}_{r-k} - k)$  plotted against  $r$  produce the CUSUM plot or chart.

**Results and Discussion**

**3.1 Hypothesis:**

- $H_0$ : Components are combined in the proper proportions
- $H_1$ : Components are not combined in the proper proportions.
- $H_0$ : There is no variation in the quality of the products.
- $H_1$ : There is variation in the quality of the products.

Accept the null hypothesis, if there is no point above the upper and lower control limits.

Using Minitab for drawing the graphs, the following results were obtained.

From Fig. 1, we discover that there is no point above the upper control limit and lower control limit in both  $\bar{x} - chart$  and the Range chart. This then shows that the components are combined in the proper proportions. From Fig. 2, we observe that the null hypothesis should be accepted which shows that components are combined in the proper proportions. This is because, the points were within the upper and lower control limits, though the company needs to be on the watch out because three points fall on the lower control limit which can easily fall off if not properly controlled.

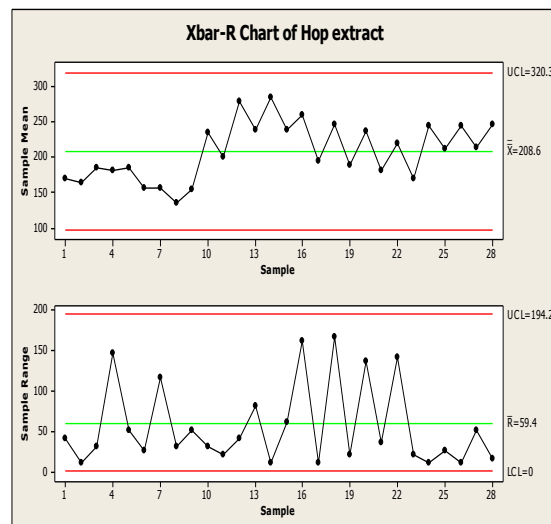


Fig. 1: Control charts of Hop extract

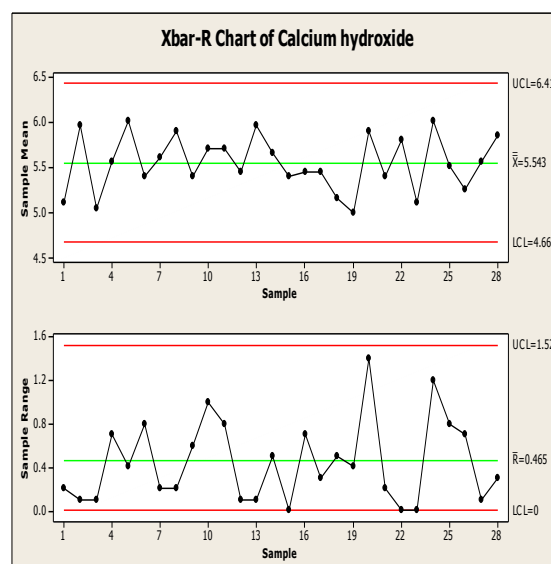


Fig. 2: Control charts of Calcium hydroxide

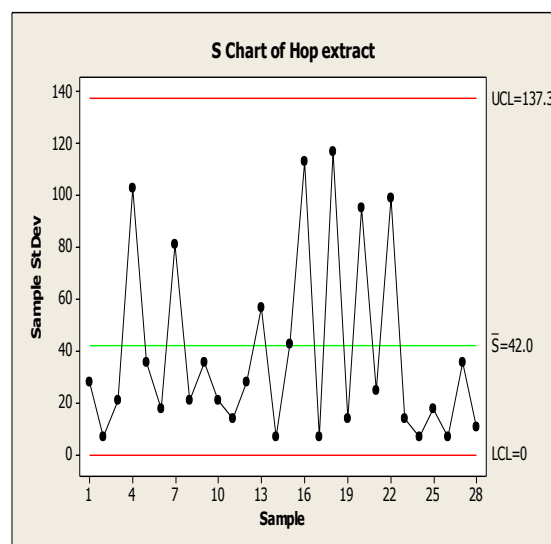


Fig. 3 S-Chart of Hop extract

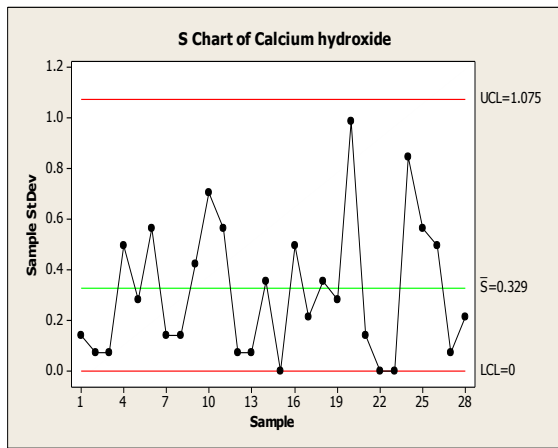


Fig 4 S-Chart of calcium hydroxide

The S-Chart of Hop extract in Fig. 3 shows that the null hypothesis should be accepted because there is no point that falls after the upper and lower control limits. The S-Chart of Calcium hydroxide in Fig. 4 shows that the null hypothesis should be accepted because there is no point that falls after the upper and lower control limits.

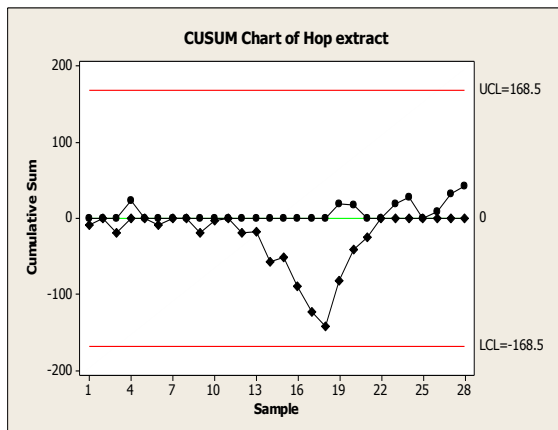


Fig. 5: CUSUM Chart of Hop extract

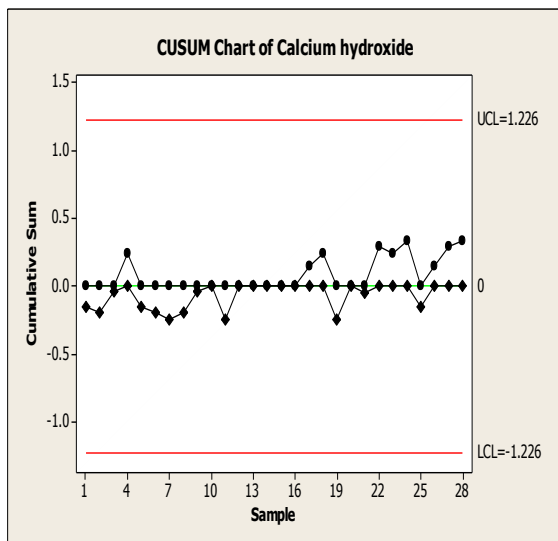


Fig. 6: CUSUM Chart of Calcium hydroxide

From the graph on CUSUM of Hop extract (Fig. 5), it is observed that there is no point that falls outside the V-masks. This then means that there is no variation in the means of the

process. The CUSUM of Hop extract is drawn with 200 as the target/reference value. From the graph on CUSUM of calcium hydroxide (Fig. 6), it is observed that there is no point that falls outside the chart. This then means that there is no variation in the means of the process. The CUSUM of Calcium hydroxide is drawn with 5.5 as the target/reference value.

**Conclusion**

The results obtained from the various methods used show that the components for the production of Life Lager beer are in the right proportion and there are no variations in the mean of the process during production.

However, the S-Chart and Xbar-R Chart of Calcium hydroxide indicated that three points (3) from each of the Charts fell on the Lower control limit line. Also, the CUSUM Charts for both for both Hop Extract and Calcium hydroxide clustered on the control line. This shows that the Quality Control Unit of the Company should not relent in carrying out quality test on the product.

Due to the fact that there are many competing Brewery industries, there is need for Life breweries Limited to always be of high quality so as to survive competition with other products from other companies.

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