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Quality Consideration of Processed Wheat Soya Blend (WSB) Products in Bangladesh in the Framework of Process Capability Sixpack

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***Abstract*-- The industrially processed pack Wheat Soya Blend (WSB) Products analysed data were collected from different analytical sections of Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka over the year 2007 to 2012 by Single Stage Cluster Sampling method. Popular statistical qualitative technique process capability sixpack were used to analyze the physiochemical and microbial observational data. The Figure 1 to 8 shows that most of the Wheat Soya Blend (WSB) parameters of the different period are in the process out of control. Also the results showed that we are dealing with a normally distributed and stable process that most of the parameters ware not follows a Normal distribution as well as symmetric distribution.**

Keywords: **Single Stage Cluster Sampling; physiochemical and microbial observational data; Normal distribution; Symmetric distribution; process out of control.**

I. Introduction

Fortified Blended Foods (FBFs) are blends of partially precooked and milled cereals, soya, beans, pulses fortified with micronutrients (vitamins and minerals). Special formulations may contain vegetable oil or milk powder. Corn Soya Blend (CSB) is the main blended food distributed by WFP but Wheat Soya Blend (WSB) is also sometimes used. FBFs are designed to provide protein supplements. In food assistance programs to prevent and address nutritional deficiencies. They are generally used in WFP Supplementary Feeding and Mother and Child Health programs. Also, to provide extra micronutrients to complement the general ration. Usually mixed with water and cooked as a porridge [21].

II. A. Description Of Wheat Soya Blend (WSB)

Wheat Soya Blend is a product preferred for young children aged 6 months – 2 years.

The product is to be used as a complement to breastfeeding. The product is not a breast-milk replacer. Super Cereal*plus* is prepared from heat treated wheat and de-hulled soya beans, sugar, dried skim milk, refined soya bean oil, vitamins and minerals. If Super Cereal *plus*- Wheat Soya Blend is consumed as a porridge or gruel, it should be prepared by mixing an appropriate proportion of flour and clean water (i.e. 50g of Super Cereal *plus*- Wheat Soya Blend with 250 g of water) followed by a boiling time at simmering point from five to ten minutes. Super Cereal*plus*- Wheat Soya Blend shall be manufactured from fresh wheat grain and soy beans of good quality, free from foreign materials, substances hazardous to health, excessive moisture, insect damage and fungal contamination and shall comply with all relevant national food laws and standards. Sugar, dried milk powder and soya bean oil shall be of optimal food quality and meet the Codex standards for these commodities [1].

The Six Sigma Methodology is a customer focused continuous improvement strategy that minimizes defects and variation towards an achievement of defects per million opportunities in product design, production, and administrative process [25]. [26] state that Six Sigma is a strategy of continuous improvement of the organization to find and eliminate the causes of the errors, defects and delays in business organization processes. The design of experiments is one of the most important tools inserted in DMAIC (define, measure, analyse, improve and control) methodology. This tool searches problems solutions in a coordinated way and the improvement of processes and people involved in the same activities always defined by the project manager [19, 24]. The six sigma DMAIC method was critically compared with insights from scientific theories in the field of problem solving [12, 15].

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It was used to examine multiple measures of experience and their relationship to the performance of work teams[4], the impact of adopting Six Sigma on corporate performance[20], and also in manufacturing execution systems (MESs)[8], in information security risk management (ISRM)[18] and in a knowledge management system[13].

This study has provide information about the quality of Wheat Soya Blend products. The result of the study will help to establish the fundamental principle of 'Food Safety'. Applying statistical technique to the data and learn from each other variation and fit of the technique. To evaluate and test the physiochemical characteristics of processed Wheat Soya Blend products using statistical models that examines whether the food products are acceptable or not on the basis of the norms as prescribed by the national or international food standard organization.

III. Materials And Methods

A. Selection Of The Six Sigma Tools

There are many quality and problem solving tools from which to choose. The seven basic quality tools were selected because there are the most commonly known, promoted, and used of the quality tools[5]. These seven tools[10, 11, 14, 22] are;

Cause and effect diagram: A schematic tool that resembles a fishbone that lists causes and sub-causes as they relate to a concern, also known as fishbone diagram or Ishikawa diagram.

Check sheet: A form used to collect, organize, and categorize data so it can be easily used for further analysis.

Histogram: A graphic display of the number of times a value occurs.

Pareto diagram: A bar chart that organizes the data from largest to smallest to direct attention on the important items (usually the biggest contributors).

Process flow diagram: A graphical illustration of the actual process.

Scatter diagram: A graphical tool that plots one characteristic against another to understand the relationship between the two.

SPC control chart: A graph of time-ordered data that predicts how a process should behave.

The other tools selected for the matrix are the quality and organizational tools from the Six Sigma operation[3, 6, 7, 10, 11, 16, 22]. Alphabetically, these tools are;

Box plot: A graphical display fo data in a box format that displays the median and variation of the data.

Capability analysis: A calculation used establish the proportion of the operating window taken up by the natural variation of the process.

Control plan: A written description of the systems for controlling parts and processes.

Cost benefit analysis: A summary analysis that weighs the cost of improvement to the customer against the cost of the change to the process.

DOE: A systematic set of experiments that permit the evaluation of the effect of one or more factors on the response.

Failure mode and effects analysis (FMEA): A structured approach to identify the way the product or process can fail and eliminate or reduce the risk of failure to protect the customer.

Hypothesis testing: Data driven tests that answer the question: "Is there a real difference between A and B?" using relatively small sample sizes to answer questions about the population.

Process flow diagram: A graphical illustration of the actual process.

Thought process map: A graphical representation of the logical sequence in which the Black Belt will solve the problem using Six Sigma methodology.

Trend/run chart: A graphical display of data over time to understand what the process is doing based on the pattern of the data[23].

B. Data

The Wheat Soya Blend products 36 analysed observations were collected from Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka over the year from 2007 to 2012 by Single Stage Cluster Sampling method. [9]. Data collection methods were non-participant observation of organization included in the study. Archival research included hard-copy issues of reports of analytical documents.

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IV. Results And Discussion

A. Application Of Control Charts On Wheat Soya Blend (WSB)

In order to verify whether quality of food products were under control condition or not we have adopted following control chart of Wheat Soya Blend (WSB) for such purposes we have used several Shewhart Control Charts. In this works we present results and analysis that is application of control charts. We show the results and analysis by type of products and types of control chart.

B. Process Capability Analysis (Using Normal Distribution Curve)

In this case, we want to assess the process capability for different industries producing certain Wheat Soya Blend (WSB).

The proximate analysis of the Wheat Soya Blend (WSB) is of concern. The specification limits on the Wheat Soya Blend (WSB) are in given appendix 4. There has been a consistent problem with meeting the specification limits and the some process produces a high percentage of rejects. The histogram of the data shows that proximate analysis of Wheat Soya Blend (WSB) follow a normal distribution or approximately normal distribution. The variation from Wheat Soya Blend (WSB) toWheat Soya Blend (WSB) can be estimated using the within group standard deviation. Since the process is stable and the measurements are normally or approximately normality distributed, the normal distribution option of process capability analysis can be used.

Quality characteristic: Moisture

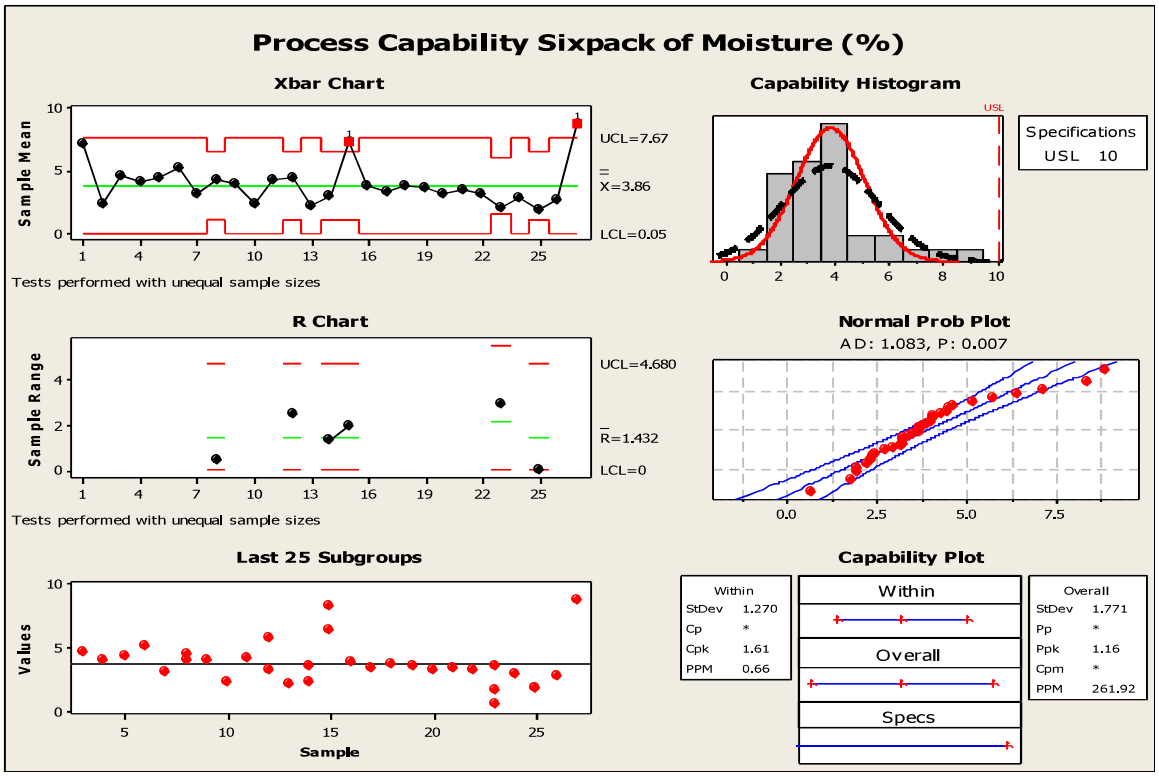

Figure 1: Quality Control Charts and Process Capability Analysis for Moisture (%) of Wheat Soya Blend (WSB).

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The quality control and process capability analysis chart given as output is the chart of Moisture (%). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is out of control in the control limit in mean chart.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of standard deviations.

Figure 1 shows the histogram of the data along with normal curves overlaid on the histogram. Moisture % of Wheat Soya Blend (WSB) products exceed the Upper specification limit (USL). An insignificant percentage of the Moisture (%) of Wheat Soya Blend (WSB) is outside of Upper Specification Limit.

From the Normal probability plot in Fig. 1, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the 0.05 significance level. This is due to the fact that the p-value is 0.007, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =1.61 is greater than 1 means that the process is centered and capable.

Quality characteristic: Protein

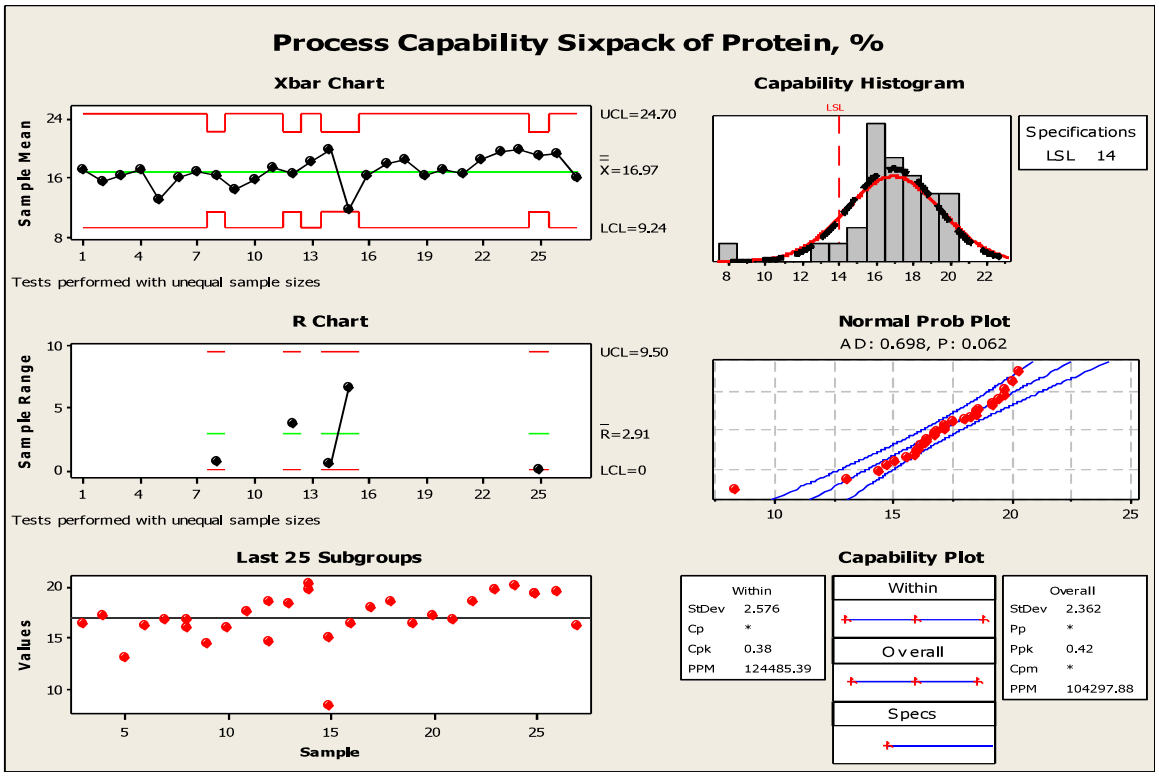

Figure 2: Quality Control Charts and Process Capability Analysis for Protein, % of Wheat Soya Blend (WSB).

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The quality control and process capability chart given as output is the chart of Protein, %. These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is under control.

The upper right box reports the process data including the lower specification limit. The calculated values are the process sample mean and the estimates of standard deviations.

Figure 2 shows the histogram of the data along with normal curves overlaid on the histogram. Protein, % of Wheat Soya Blend (WSB) products are exceeding the lower specification limit (USL). A significant percentage of the Protein, % of Wheat Soya Blend (WSB) is outside Lower Specification Limit.

From the Normal probability plot in Figure 2, the Anderson-Darling (AD) Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the α = 0.05 significance level. This is due to the fact that the p-value for the A-D test is 0.062, which is greater than 0.05 - a frequently used level of significance for such a hypothesis test, The necessary assumptions appear to have been fulfilled and investigate the capability of this process, as shown in Figure 2.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =0.38 is less than 1 means that the process is off centered and not capable.

Quality Characteristic: Fat, %

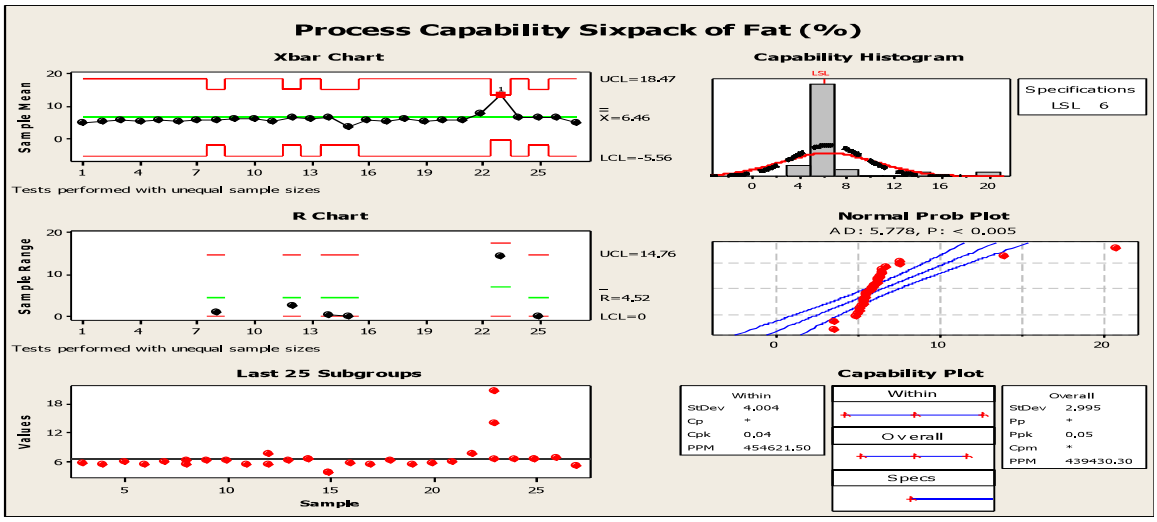

Figure 3: Quality Control Charts and Process Capability Analysis for Fat, % of Wheat Soya Blend (WSB).

The quality control and process capability chart given as output is the chart of Total Ash (on dry basis), %. These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is in of control except only a point outside upper control limit.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of standard deviations.

Figure 3 shows the histogram of the data along with normal curves overlaid on the histogram. Fat, % of Wheat Soya Blend (WSB) products are exceeding the Upper specification limit (USL). A significant percentage of the Fat, % of Wheat Soya Blend (WSB) is outside Upper Specification Limit.

From the Normal probability plot in Fig. 3, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the 0.05 significance level.

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This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =0.04 is less than 1 means that the process is off centered and not capable.

Quality Characteristic: Vitamin A (IU/100g)

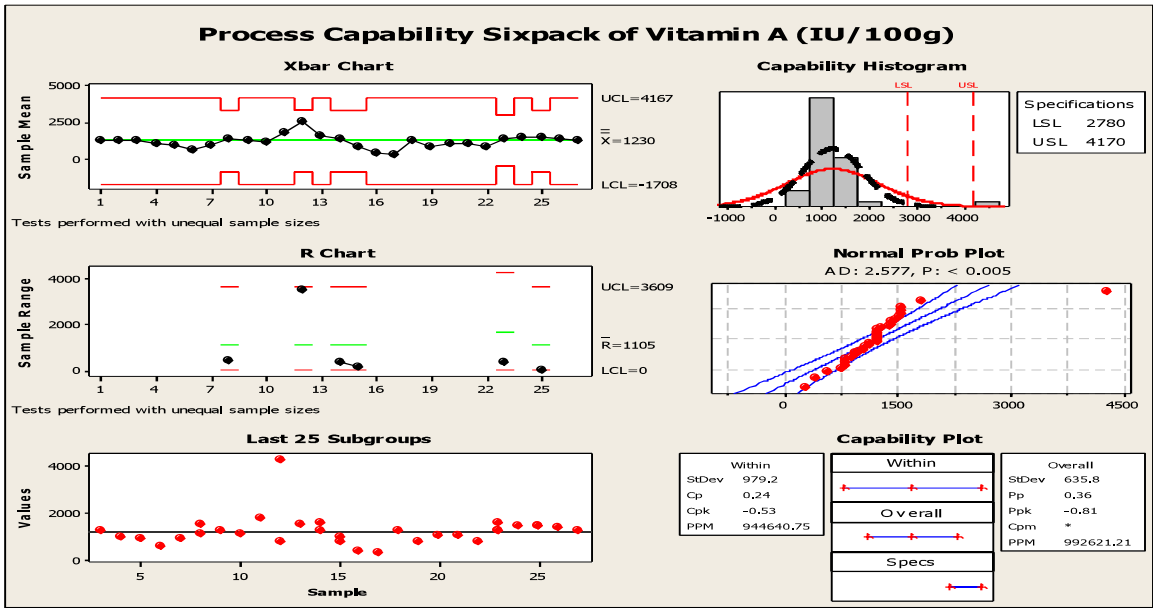

Figure 4: Quality Control Charts and Process Capability Analysis for Vitamin A (IU/100g) of Wheat Soya Blend (WSB).

The quality control chart given as output is the chart of Vitamin A (IU/100g). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is under control.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of within standard deviations.

Figure 4 shows the histogram of the data along with normal curves overlaid on the histogram. The products of Wheat Soya Blend (WSB) of Vitamin A (IU/100g) analysis report by this process exceed the lower specification limit (LSL) and Upper specification limit (USL). A significant percentage of the Vitamin A (IU/100g) of Wheat Soya Blend (WSB) is outside of lower specification limit (LSL) and Upper Specification Limit.

From the Normal probability plot in Fig. 4, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the ≤ 0.05 significance level. This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =-0.53 is less than 1 means that the process is off centered and is not capable.

Quality Characteristic: Iron (mg/100g)

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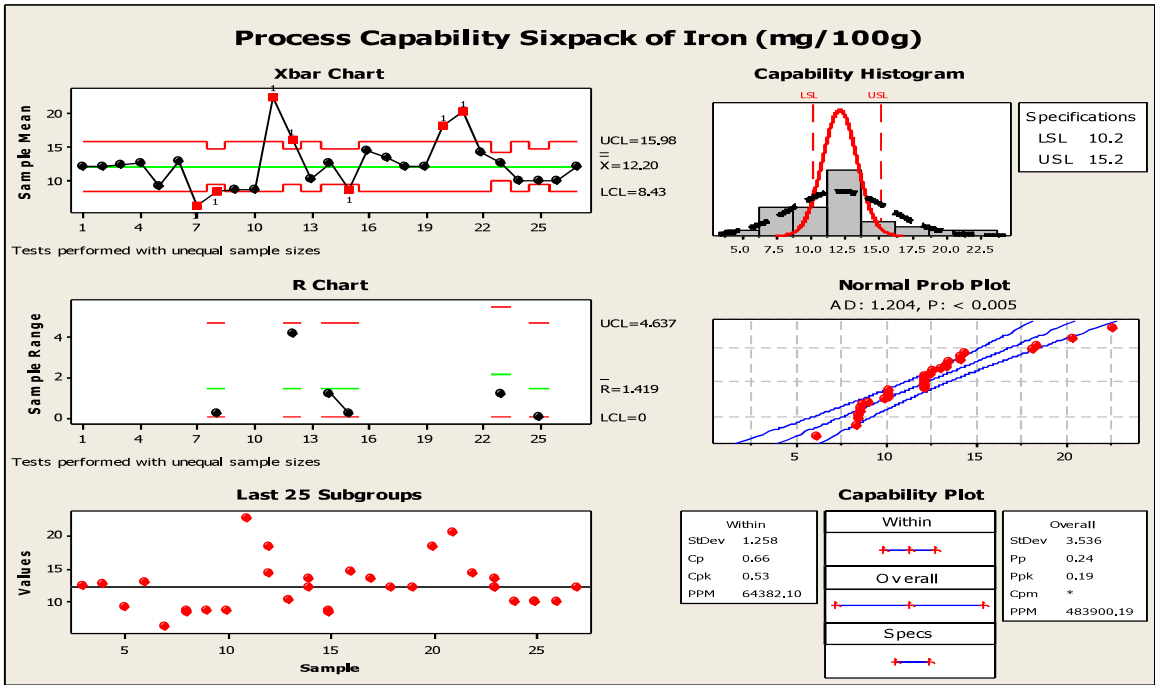

Figure 5: Quality Control Charts and Process Capability Analysis for Iron (mg/100g) of Wheat Soya Blend (WSB).

The quality control chart given as output is the chart of Iron (mg/100g). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is out of control.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of within standard deviations.

Figure 5 shows the histogram of the data along with normal curves overlaid on the histogram. Iron (mg/100g) of Wheat Soya Blend (WSB) products exceed the Lower specification limit (LSL) and upper specification limit (USL). A significant percentage of the Iron (mg/100g) (%) of Wheat Soya Blend (WSB) is outside of Lower Specification Limit and upper specification limit (USL).

From the Normal probability plot in Fig. 5, the Normality test shows that we reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the 0.05 significance level. This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =-0.53 is less than 1 means that the process is off centered and is not capable.

Quality Characteristic: Standard Plate Count (cfu/g)

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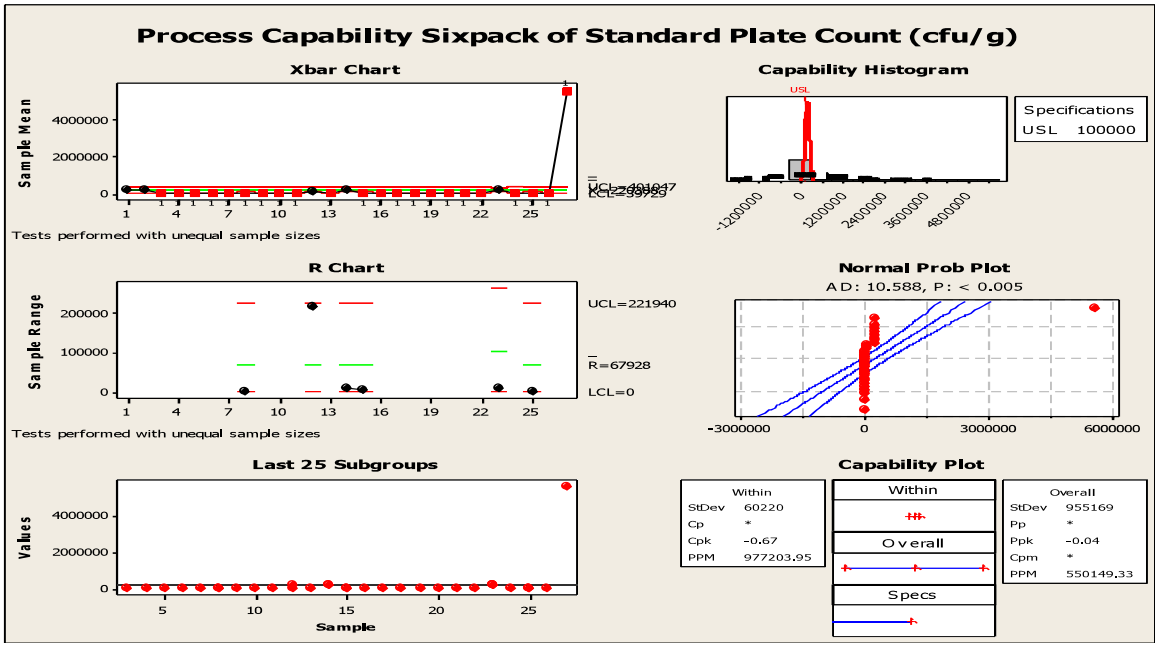

Figure 6: Quality Control Charts and Process Capability Analysis for Standard Plate Cournt (cfu/g) of Wheat Soya Blend (WSB).

The quality control chart given as output is the chart of Standard Plate Cournt (cfu/g). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is out of control.

The upper right box reports the process data including the lower specification limit. The calculated values are the process sample mean and the estimates of standard deviations.

Figure 6 shows the histogram of the data along with normal curves overlaid on the histogram. Standard Plate Count of Wheat Soya Blend (WSB) products are exceeding the Upper specification limit (USL). A significant percentage of the Standard Plate Count (cfu/g) of Wheat Soya Blend (WSB) is outside Upper Specification Limit.

From the Normal probability plot in Fig. 6, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the ≤ 0.05 significance level. This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =-0.67 is less than 1 means that the process is off centered and is not capable.

Quality Characteristic: Total Coliform (MPN/g)

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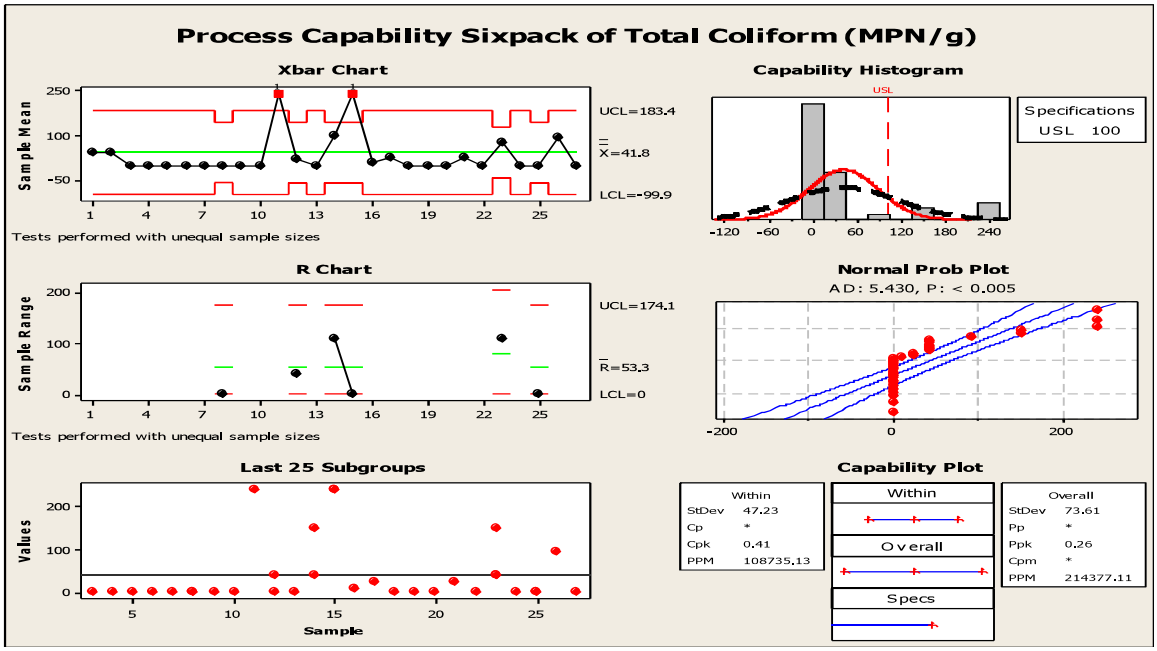

Figure 7: Quality Control Charts and Process Capability Analysis for Total Coliform (MPN/g) of Wheat Soya Blend (WSB).

The quality control chart given as output is the chart of Total Coliform (MPN/g). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is out of control.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of standard deviations.

Figure 7 shows the histogram of the data along with normal curves overlaid on the histogram. Total Coliform of Wheat Soya Blend (WSB) products exceed the Upper specification limit (USL). A significant percentage of the Total Coliform (MPN/g) of Wheat Soya Blend (WSB) is outside Upper Specification Limit.

From the Normal probability plot in Fig. 7, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the 0.05 significance level. This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =0.41 is less than 1 means that the process is off centered and is not capable.

Quality Characteristic: Escherichia Coli (MPN/g)

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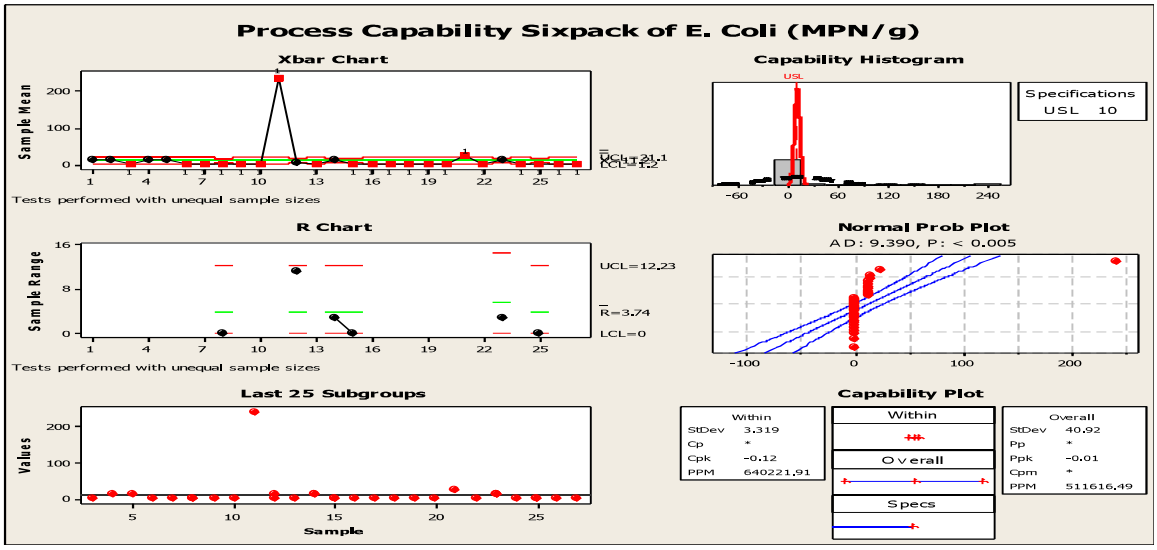

Figure 8: Quality Control Charts and Process Capability Analysis for *E. Coli* (MPN/g) of Wheat Soya Blend (WSB).

The quality control chart given as output is the chart of *E. Coli* (MPN/g). These charts, which are pretty much self-explanatory, clearly shows the date wise sample point along with the (UCL and LCL) control limits. It is clear that the process is in out of control.

The upper right box reports the process data including the upper specification limit. The calculated values are the process sample mean and the estimates of within standard deviations.

Figure 8 shows the histogram of the data along with normal curves overlaid on the histogram. E. Coli of Wheat Soya Blend (WSB) products exceed the Upper specification limit (USL). A significant percentage of the E. Coli (MPN/g) of Wheat Soya Blend (WSB) is outside Upper Specification Limit.

From the Normal probability plot in Fig. 8, the Normality test shows that reject the null hypothesis, H_0: data follow a Normal distribution vs. H_1: data do not follow a Normal distribution, at the 0.05 significance level. This is due to the fact that the p-value is 0.005, which is less than 0.05 a frequently used level of significance for such a hypothesis test, as opposed to the more traditional 0.05 significance level.

The potential or within process capability of the process is reported on the right hand side. The value of Cpk =-0.12 is less than 1 means that the process is off centered and is not capable.

The Figure 1 to 8 shows that most of the Wheat Soya Blend (WSB) parameters of the different period are inthe process out of control. Also the results showed that we are dealing with a normally distributed and stable process that most of the parameters ware not follows a Normal distribution as well as symmetric distribution.

V. Conclusions

The results of process capability sixpack study of the given Wheat Soya Blend (WSB) analysis results reveals that, graphical presentsted of parameters approaches very nearer to the magnitude of the analytical values and hence graphical approach could be treated as equivalent to analytical method. Graphical approach can be used to study the variability of foods analysis data. It is one ofthe tools to convey the results through which it is easy to make inference on the quality of data. The approach helps a stakeholder of the food to make the assessment about the analyzed parameters. Thus, it also helps to process management and identifies opportunities for improvement quality and operational performance [17]. The estimation of process capability is one of the basic tasks of the statistical process control (SPC). The values of Cp, Cpk indices are very precise information on a process potential relating to the client'sexpectations. Correct determination of Cp, Cpk indices values requires identification of a distribution size, atleast as a general settlement whether it is a normal distributionor not.

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If it is a normal distribution, for the estimation of Cp,Cpk this can use a simple classic approach that isbased on the rule of three standard deviations. If it is not a normal distribution, the application of a classic approach leadsto wrong results [2].

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