



# Study Of Quality Assurance And Quality Control In Making Baked Products

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**Abstract:** The Bakery industries are suffering from quality related problems. These problems include produce items of international standards, low quality raw material, low product confidence due to lack of quality assurance systems and increased pressure from high quality and competitive products in the local as well as global market. [1] The proposed solution is to implement certain Quality Assurance (QA) systems such as GMP (Good Manufacturing Practice), HACCP (Hazard Analysis Critical Control Points), ISO: 9000 and Quality Control (QC) activities in all their manufacturing processes.

The main aim of this research work is to identify the major biscuit defects and their possible root causes to improve the quality of biscuits in order to be competitive in the local as well as global market. In this study, GMP (Goods Manufacturing Process) has been studied and two analyses have been done namely Pareto analysis and Ishikawa Cause and Effect diagram. Major biscuit quality defects have been identified by using Pareto Analysis and their possible root causes have been identified by using Ishikawa Cause and Effect Diagram. Based on the analysis of the collected data in the biscuit manufacturing Industry, 3 (three) major biscuit defects (burnt, pale and dark edge joint biscuits) and their possible root causes have been identified out of 8 (eight) defects. The identification of most significant and less significant causes among all the causes will be the research work for further study. This sort of work has left untouched due to lack of experimental setup, lack of resource and lack of some essential data.

**Keywords:** Quality Assurance (QA), Quality Control (QC), GMP (Goods Manufacturing Process), HACCP (Hazard Analysis and Critical Control Points), ISO: 9000, Pareto Analysis, Ishikawa Cause and Effect Diagram.

**1. Introduction:** Bakery products, particularly biscuits are ready to eat, convenient and inexpensive food products in rural and urban areas among all the age groups of Assam as well as India. These products have about 6-7% proteins. Because of their long shelf life, wider consumption, low cost among other processed foods, varied taste, easy availability and good eating quality, biscuits are considered useful for nutritional enrichment in feeding programs (Agrawal., 1990). [2,3] Breads and biscuits are major products accounting for 80% of the total bakery products in India (Agarwal, 1990; Shukla et al., 2000) [3]. In recent years, consumption of biscuits has increased in most of countries as they served as important source of nutrients (Ranhotra. 1980)[2].

The Biscuit Manufacturing industries have played a major role to dominate the economy mainly due to the very high demand for their products in the local as well as global market. This has created competitions among themselves to produce good quality products in order to be competitive in the market. The manufacturers of baked products have to meet certain mandatory and voluntary requirements such as World Trade Organization's agreements (Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT)), WHO/FAO guidelines (Guidelines for Hygienic Practices) and safety management systems

such as HACCP and ISO standards to participate in any global trading. Each manufacturer has to implement proper Quality Assurance system and Quality control technique in all their manufacturing processes to keep slice of the market.

In this research approach, GMP (Goods Manufacturing Process) have been studied and major Biscuit quality defects have been identified by using Pareto Analysis and their possible root causes have been identified by using Ishikawa Cause and Effect Diagram.

**2. Objectives:** The Primary objective is:

- To identify Major Biscuit defects and their possible root causes to improve the quality of baked products by using Pareto Analysis and Ishikawa Cause & Effect Diagram in a Biscuit Manufacturing Industry.

The Secondary objective of the study is:

- To study the Quality assurance and Quality control activities in making baked products adopted by the industry.

**3. Significance of the study:** The primary merits of the study go to the university academics. Since there are few and shallow studies in this area, it will give a comprehensive starting point for more specific quality researches for Rural Biscuit Manufacturing Industries. Organization, which is taken up as a case study, will get at least some idea about major quality related problems and their probable causes for the Company. Hopefully, this will motivate them to improve their quality related problems by taking necessary corrective action. Finally, anybody who is interested in quality especially in processed food products can get good ideas from this project.

**4. Profile of the Industry:** The profile of the industry that has been used in this research work is shown in Table-1:

Name of the company	Proprietor	Address of the factory	Type of organization	Started on	Manpower	Major biscuit brands	Manufacturing Capacity	Market of biscuits
M/S Gattani Biscuit Industries	M/S Kaziranga Udyog Pvt Ltd	Jorhat, Jorhat, Assam	Small Scale Industry	10-12-2000	100	Marie Bisq. Butter Gold. Snacks. Crackers. Coconut. Nice. Rock N Roll and Cream Biscuits.	300 M.T. on two shift basis per month	30 Distributors all over the entire N.E. region (e.g. one in Imphal, Dimapur and Shilling) and many parts of West Bengal and Bihar.

**5. Research methodology:** The methodology of the present study is as follows:

**5.1. Area of the Study:** Gattani Biscuits Industries is a Company, located at Jorhat Mariani Road under Cinnamara Police Station in the Jorhat District of Assam.

**5.2. Source of data:** The Primary data has been collected for the study is mostly from Director, concerned persons related to QA/QC, and labourers working at M/S Gattani Biscuit Industries and from direct observations. Secondary data sources such as Company's Records, Quality Manual, various research publications, and websites have been used to gather information for the study. Apart from these, a number of field visits have been made in conducting a face-to-face discussion with shop floor employees helped for the preparation of this paper.

**5.3. Limitations of the Study:** The following are the limitations of this study:

- The study is restricted to identify major biscuit defects and their possible root causes of baked products (i.e. Biscuits only).
- The study only touches those parts that are pertinent for the Quality Assurance and Quality Control in the Biscuit Manufacturing Industry.
- Lack of information specific to the Biscuit Manufacturing Industry.
- There is poor documentation and record of activities in the industry.
- Quality related information specific to the Biscuit Manufacturing are not available adequately.
- The study is only confined to one Biscuit Manufacturing Industry only.
- Unwillingness of labourers' to disclose information.

**5.4. Analysis and interpretation of data:** The observed data were tabulated for making better analysis and interpretation.

**6. Quality Assurance (QA):** Quality assurance involves prevention of quality problems through planning and systematic action. It takes a wider view than quality control. Quality should not be about fixing a problem but preventing it. Quality assurance, therefore, includes the whole production and distribution system starting from the supply of raw materials through the internal management to the customer. Quality assurance system must be documented to clearly show who is responsible for doing what and when. Employees must be motivated and well trained to carry out the quality assurance activities. A two-way communication must also be there to facilitate the quality effort in the organization. Quality assurance system need not be complex and should be continuously improved and refined.

Different international standards have been developed to give the basic requirements for a quality system and a framework against which companies gauge their quality achievements. The basic QA systems in the Agri-food sector are GMP (Good Manufacturing Practice), HACCP (Hazard Analysis and Critical Control Point), and ISO.

**6.1 Good Manufacturing Practice (GMP):** The term 'Good Manufacturing Practice' describes the key requirements for all aspects of commercial food production, storage, and distribution necessary to ensure a consistent product that conforms to all food safety, quality, and consumer attribute requirements. It involves application of defined principles and practices in company organization and management, including staff training, provision of process and storage facilities (buildings and equipment), quality assurance, new product development, food legislation, and product distribution. Demonstration of good practice is a prerequisite for evidence of due diligence in food manufacture.[4]

**6.2. Hazards Analysis Critical Control Point (HACCP):** Hazard Analysis Critical Control Points (HACCP) is a systematized approach that aims to provide the foundation for observing the total food network, right from harvesting to utilization or consumption, and to diminish the risk of foodborne diseases. Basically, the system is outlined to identify and control all the potential risks or problems before they take place.[5] (World Trade Organization) has made HACCP mandatory for trade between its member states. The USA and European countries have even adopted it into their food laws, which sometimes used as a nontariff trade barrier for exporters into their country.

**6.3 International Organization for Standardization (ISO):** ISO aims to achieve uniformity in products and / or services, and to prevent technical barriers to trade throughout the world. It requires the establishment of all activities and handling in procedures, which must be followed by ensuring clear assignment of responsibilities and authority (8). The International Organization of Standardization publishes ISO 22000 standard that helps the organizations involved in the food supply chain to establish and implement the Food Safety Management System within their organization. ISO 22000 combines the quality management factor of ISO 9001 and the safety management factor of HACCP to ensure the quality and safety of food at all levels. This standard also helps your food chain business in identifying the food-related risks and planning corrective measures to prevent or mitigate them.

**7.0. Quality Control & Assurance Process:** All the raw materials used in the biscuit manufacturing including the packing material is supplied by the approved vendors. Information of this received through copy of purchased orders sent by the customers. Procedures have been developed for inspecting the customer supplied products and they are accepted only after inspection as per established procedures. Though the supplies are stored for limited period, however the company has the policy to report the loss, damage and unsuitable quality of material for its use. The following figures illustrates the process.

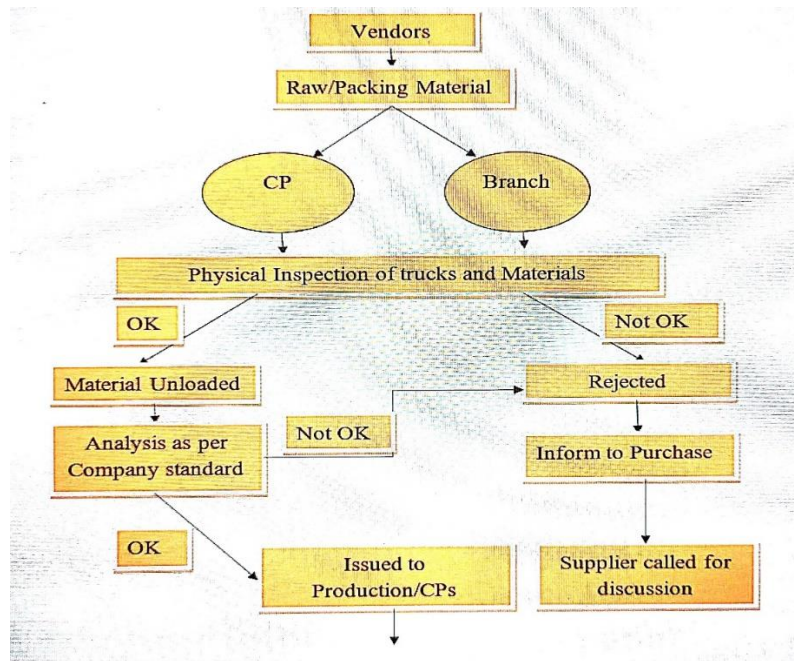


Fig.-1: Process Flow Chart

**7.1. Measurement Assurance:** The weighing scales and other instruments are calibrated within the stipulated periods to ensure full measurement assurance. A list of all measuring equipments requiring calibration is available with the laboratory in-charge. In case of equipment's where calibration is not possible, special procedures are employed to validate their performance/operation based on the final Quality of the product and customer feedback (if applicable), and the same are used with the approval of the Quality Control Representative of M/S Gattani Biscuits Industries. This methodology is also adopted in case of testing of final product. Computerized test method/Software is not employed in M/S Gattani Biscuit Industries and only manual testing is done. The in-charge of the laboratory is responsible for ensuring that equipment's are calibrated in time. The supervisors as a normal routine also perform random checking for ensuring procedure control in their respective areas.

The accuracies of various measurements like weight at various stages etc. has been ensured through the proper use of correct equipment at the right place.

**7.2. Plan for In-Process Control:** M/S Gattani Biscuits Industries views inspection and testing an important tool for objectively ensuring that the product quality is being consistently maintained and only conforming products are allowed to pass to the customer. Established procedures for inspection and testing the Quality of the product at all stages of the manufacturing processes for incoming raw material inspection and testing to that of the packing quality of the final product are available. These inspecting and testing requirements are decided in consultation with the customer. For achieving these objectives, M/S Gattani Biscuit Industries has established a special test laboratory under the control of in-charge quality control. This ensures prompt testing of the raw materials and the final product and other material and also ensures fast decisions which helps in achieving tight delivery schedule. The chemicals used in the laboratory are clearly marked and kept in their designated places.

Established and documented test procedures have been developed for performing the various tests listed above and records shall be maintained in the laboratory. Only biscuits of acceptable quality are allowed to send for packing/ further processing in case of cream biscuits by the own operator. The respective shift in-charge and or oven operators are authorized to release the product for packing after ensuring that the product has successfully completed the baking and other previous stages of manufacturing and relevant inspection and manufacturing records are maintained. It is ensured by the production manager/ production supervisor/Lab in-charge that the product has successfully completed the previous stages of manufacturing. Only such finished product which has satisfied all the requirements of quality is allowed to be kept in outgoing store. The finished goods are dispatched only after necessary authorization by director/Manager. The final quality of the baked products is always ensured by ensuring adherence to established procedures at all stages of

manufacturing and inspection. The in-process inspection of the baked products at all stages of manufacturing is explained with the help of the following flow diagram.

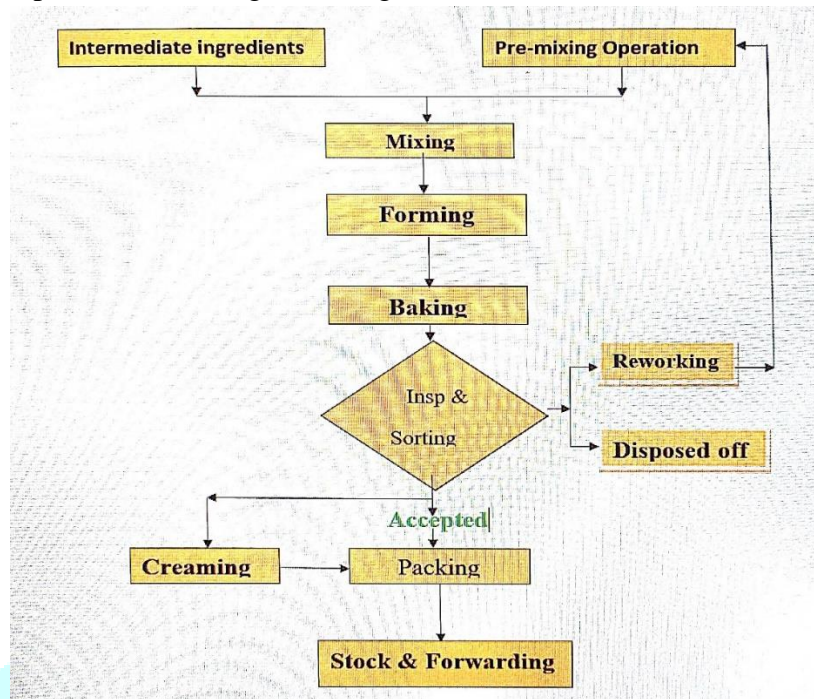


Fig.-2: Process Flow Chart

**8.0. Quality Control activities:** All in-coming materials must pass through a series of steps before they are accepted into the processing [7]. A technician will take a sample, inspect and label as soon as the materials are received. Sampling should be done according to the sampling plan prepared beforehand. The container must be tagged with all the necessary information after sampling. Each lot and batch must be recorded into a master ledger. Dispositions are made based on the result of the analyses of the samples taken. The material is retagged in accordance with the decision of the disposition. In the processing stage, quality characteristics are checked against the design of the process. Defective materials at any stage of the process are removed. Sampling and analysis tests are made on the finished product before it is packed, labeled and transferred to the warehouse. Different Quality Control Tools such as Cause-and-Effect diagrams (Fish-bone diagram or Ishikawa diagram), Pareto Chart, Check Sheet, Histogram, Scatter Diagram, Flow Chart, and Control Charts have been developed and can be implemented in the food processing industries [8].

**8.1. Quality Policy:** The policy of M/S Gattani Biscuit Industries is to maintain the confidence of customer through-

- Consistency in quality
- Transparency of operation
- Continual Improvement through
- Human resources development
- Customer satisfaction

It is ensured that the quality policy is understood implemented and maintained at all the levels of the organization through suitable training and regular monitoring. To identify the customer satisfaction the following data to be analyzed.

- Monthly production schedule
- Monthly delivery schedule
- Follow up of purchase orders issued by customer
- Company's production Executive Report

**8.2. Quality Manual:** Quality management manual is a document consisting of the general quality policies, procedures and practices of an organization. It may be difficult and inconvenient to prepare a comprehensive manual, which presents all activities for large organizations. In such cases, only the location and contents of other manuals detailing the procedures and practices for specific areas can be given in the quality management manual.[9] M/S Gattani Biscuits Industry have not yet gone for any certification like ISO 9000:2000, but they are planning to have ISI or HACCP (Hazard Analysis and Critical Control Point) certification. Their system of operation covers the GMP (Good Manufacturing Practices). This manual defines the overall structure of the quality control/Assurance systems to be followed in biscuit Industries right from the receipt of raw materials at factory to till Depot. This manual shall serve as a policy document to ensure delivery of safe products to satisfy their existing and potential customers on a continuing basis. [10]

**9.0. Inspection Plan for Finished Products:** The sampling of finished products (i.e. Biscuits) shall be discussed as given below:

**9.1. General requirement of sampling:**

- Sample shall be taken in a protected place, which is free of odour and not exposed to damp air, dust or soot.
- Precaution shall be taken to protect the samples, the lots being sampled, the sampling instrument and the containers for samples from adventitious contamination.
- The samples shall be stored at room temperature.
- Samples shall be tested within as short a time as possible after their drawl, preferably within 24 hours of sampling.

**9.2. Scale of sampling:** All the Corrugated Box Boards (CBBs) in a single shift belonging to the same batch/code shall constitute a lot. The number of Corrugated Box Boards (CBBs) to be sampled from a lot shall depend upon the size of the lot and shall be in accordance with the following table:

Table-2: Scale of sampling for CBBs

Lot Size	Sample size
Up to 50	3
51 to 150	4
151 to 300	5
301 to 500	6
501 to 1000	8
1001 above	10

The CBBs shall be selected from the lot at random. After selection of CBBs as per lot size, the sample packs to be taken randomly from each by selecting the sample size, taking the lot size as number of packs per CBB, as per above table.

**9.3. Preparation of samples for checking of analytical characteristics:** From each lot, about 300 g biscuit shall be taken from different packets. This quantity of 300 g shall be, after proper mixing, divided into two equal parts of 150 g biscuits each. These biscuits shall be kept in air tight dry containers. The second part of 150 g shall be suitably powdered and the moisture content shall be tested from two portions of this sample. The other portion of 150 g shall be thoroughly mixed so as to constitute the composite sample. Test for the determination of acid insoluble ash and acidity of extracted fat shall be conducted on the composite sample.

**9.4. Classification of defect of Products and Pack Quality:** The product and pack quality defects are classified depending on the criticality. The classes are as follows:

Table-3: Classification of defect of Products and Pack Quality

Class	Criticality
A	Unacceptable to the consumer or Unacceptable due to statutory requirements
B	Repeated occurrence will be unacceptable to the customer
C	Consumer will be delighted if the pack product found free of such defect
D	For maintaining better quality control from manufacturer's point of view

**9.5. Type of Quality defects:** Table-4 shows class, pack quality and biscuit quality defects:

Table-4: Type of quality defects

Class	Pack Quality defect	Class	Biscuit Quality defects
A	Average weight less than the declared weight and packets having less than 7% net weight w.r.t. declared weight	A	Biscuits containing insect/fungus infestation, harmful, harmful/injurious foreign matter
	Packets with burst seal		Biscuits with off smell/taste
	Packets having crushed biscuits		Burnt biscuits
	Packets with defective coding		Soft biscuits
B	Packets with sealing defect	B	Odd shaped biscuit
	Loose packets		Biscuits having hard bite
C	Packets having improper code aesthetics	C	Biscuits with dark edge/joint biscuits
	Packets with defective registration		Slight dark/Pale biscuits
	Slanted packs		Biscuits with impression defect
	Packets with broken biscuits		Biscuits with improper surface/ spray finish
D	Packets having net weight more than $\pm 4\%$ of the declared weight	D	Biscuit size greater or lesser than standard limit

**9.6. Quality control of baked Biscuits:** The final quality of the baked products is always ensured by ensuring adherence to established procedures at all stages of manufacturing and inspection. The in-process inspection of the biscuits is carried out as shown in Table-5. The requirements desired from the final biscuits is shown in Table-6.

Table-5: In-process inspection of the final biscuits.

Sl No	Biscuit Brand	Parameters	Requirements
1	Butter Gold-250gm (Round Biscuit)	(a)Gauge/Stack- Height (b)Cut off length (c)Coil length	97 mm 208 mm 324 mm
2	Marie Bisq-120gm (Round Biscuit)	(a)Gauge (b)Cut off length (c)Coil length	135 mm 232 mm 198 mm
3	Butter Top-120 gm	(a)Gauge (b)Cut off length (c)Coil length	76 mm 196 mm 274 mm
4	Weight of 16 biscuits (Baked biscuit)	(a)butter Gold-250 gm (b)Marie Bisq-120 gm	89 gm 77 gm

	(c)Butter Top-120 gm	74 gm
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Table-6: The requirements desired from the final biscuits

Sl No	Parameters	Requirements
1	Moisture	2% (max) for soft biscuits 1.2%(max) for Hard biscuits
2	Total Ash	1.5%(max)
3	Acid Insoluble ash	0.05%(max)
4	Acidity of extracted fat	1.2%(max)

**9.7. Analysis of Biscuit Defects:** Total Quality management (TQM) and Total Quality Control (TQC) literature make frequent mention of seven basic tools. Kauro Ishikawa contends that 95% of a company's problems can be solved these seven tools. In this study, Pareto charts and Ishikawa cause & effect diagram have been used in the analysis of biscuit defects.

**9.7.1. Pareto Principle (chart):** This technique was developed by Italian Economists ALFRED PARETO. The Pareto principle suggests that most effects come from relatively few causes. In quantitative terms: 80% of the problems come from 20% of the causes (machines, raw materials, operators etc.); 80% of the wealth is owned by 20% of the people etc. Therefore, effort aimed at the right 20% can solve 80% of the problems. Pareto charts are extremely useful because they can be used to identify those factors that have the greatest cumulative effect on the system, and thus screen out the less significant factors in an analysis. Ideally, this allows the user to focus attention on a few important factors in a process.

**9.7.2. Identification of Major Biscuit defects by using Pareto Principle:** The following Table-7 & 8 shows the data regarding Biscuit Quality defects from the batches of 2000 kgs of baked biscuits:

Table-7: Biscuit Quality defects

Type of Defect	No of Complaints
Dark (Burnt) Biscuits	40
Pale Biscuits	10
Dark edge Joint Biscuits	5
Odd shape Biscuits	4
Hard Bite	3
Soft Biscuits	3
Size greater or lesser than Std limit	3
Color	1
Total	69

Table-8: Cumulative %

Defects	No. of complaints	% contribution to total complaints	Cumulative %
Dark (Burnt) Biscuits	40	57.97	57.97
Pale Biscuits	10	14.49	72.46
Dark edge Joint Biscuits	5	7.25	79.71
Odd shape Biscuits	4	5.80	85.51
Hard Bite	3	4.35	89.86
Soft Biscuits	3	4.35	94.21
Size greater or lesser than Std limit	3	4.35	98.56
Colour	1	1.45	100.01
Total	69		



**9.7.3. Pareto Chart for Biscuit Quality Defects:** The following figure shows the Pareto chart for biscuit quality defects of the above problem.

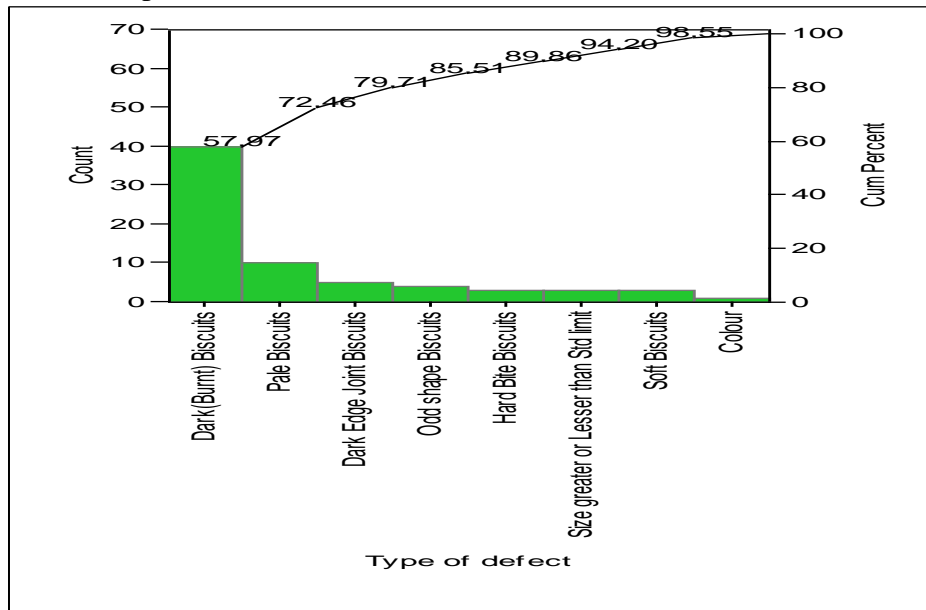


Fig.-3: Pareto Chart for Biscuit Quality Defects

From the above Pareto it is concluded that Burnt biscuits, Pale biscuits & Dark Edge Joint biscuits are contributing to 80% complaints, so need to focus on them.

**9.8. Cause and Effect (CE) Diagram:** The Cause and Effect (CE) Diagram was introduced by Kaoru Ishikawa in early 1940s. An Ishikawa Cause and Effect (CE) Diagram (also called fishbone or simply cause and effect diagram) is a simple but effective tool that helps to identify, sort, and display possible causes of a problem or quality characteristic. A CE diagram consists of a main “bone” to which main causes of the problem are connected. Each main cause may have several sub-causes that lead to the main cause. Similarly, each sub cause may have third level causes leading to them and so on. That structure is presented in a CE diagram to provide system analysts and manager’s valuable information about the roots of the problem and where to start at for fixing it. Therefore, the way an organization is going to spend its resources may very well depend on a CE diagram. The possible root causes of burnt, Pale and Dark Edge Joint Biscuits are identified by using cause and effect diagram.

**9.8.1. Cause and Effect diagram for Dark (Burnt) Biscuits:** The possible root causes of Burnt Biscuits are shown in Fig.-4 by using Ishikawa’s Cause and Effect diagrams.

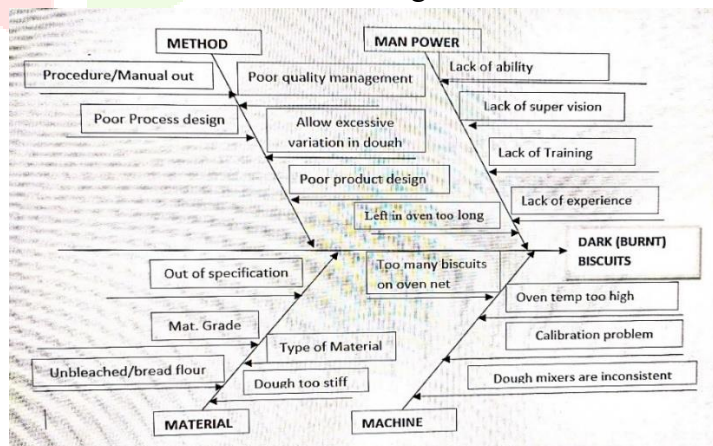


Fig.-4: Cause and effect diagram for dark (burnt) biscuits

**9.8.2 Cause and Effect diagram for Pale Biscuits:** The possible root causes of Pale Biscuits are shown in Fig.-5 by using Ishikawa's Cause and Effect diagrams.

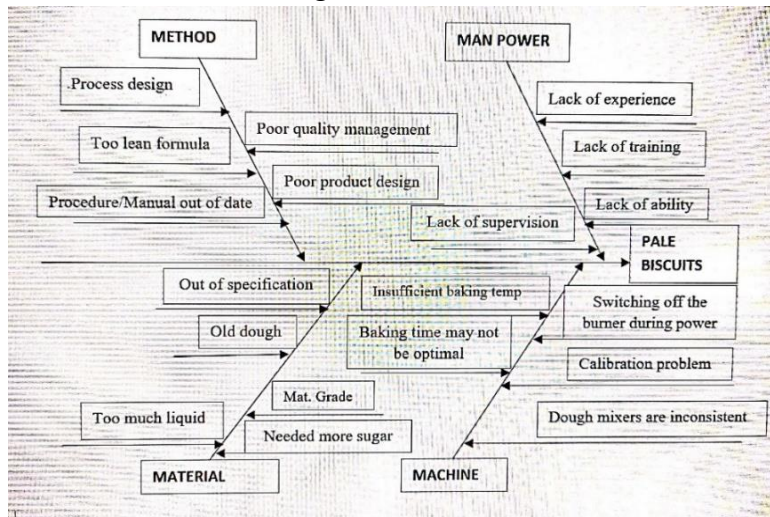


Fig.-5: Cause and effect diagram for pale biscuits

**9.8.3 Cause and Effect diagram for Dark Edge Joint Biscuits:** Fig.-6 shows the possible root causes of Dark Edge Joint Biscuits by using Ishikawa's cause and effect diagrams:

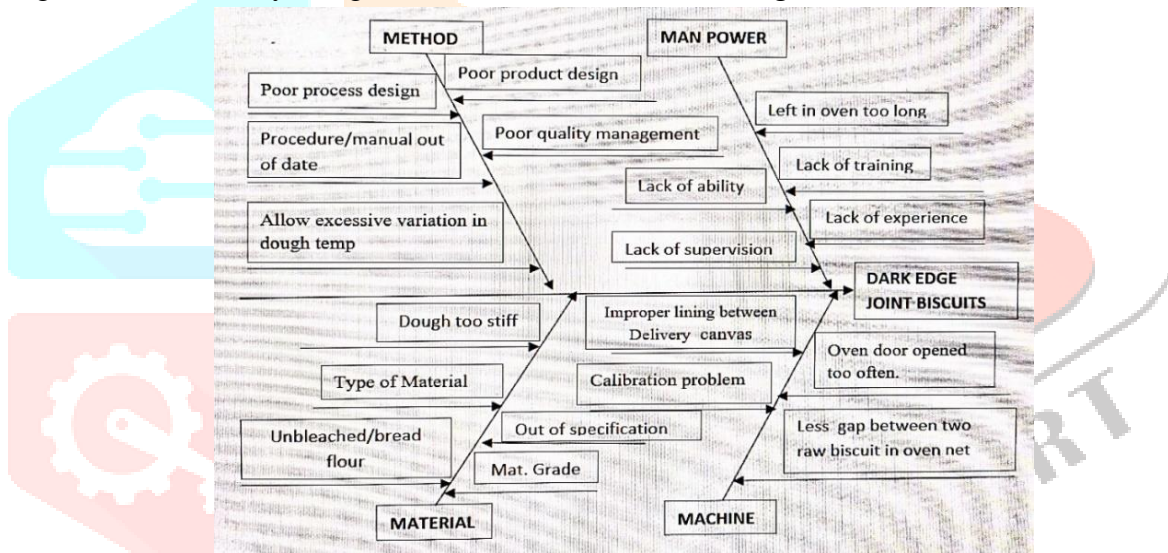


Fig.-6: Cause and effect diagram for Dark edge joint biscuits

**10. Future Scope:** Identification of the most significant and less significant causes among all the causes could be another research work for future study.

**11.0. Conclusion:** In this study, only two analyses have been done - Pareto Principle & Cause and Effect Diagram. The Major biscuit defects have been identified by Pareto Principle - Burnt, Pale & Dark Edge Joint Biscuits. The possible root causes of the defects have been identified by Cause & Effect Diagram.

**12. Recommendations** Few recommendations have been compiled based on engineering concepts as follows:

- ✓ **Quality Assurance-** The system of operation of the company covers GMP. It is good starting point to improve the manufacturing process of a plant. The company should go for ISO (International Organization for Standardization) or HACCP (Hazard Analysis and Critical Control Point) certification etc. This will help the company to be efficient, competitive and ensure an international recognition and products of consistent quality.
- ✓ **Quality Control-** Statistical Quality Control techniques such as control charts can be effectively implemented in determining the quality level of raw materials and finished products and to control manufacturing processes in the company. A computerized laboratory facilities should be set up to perform all types of tests required for the control of process & product in the plant.

- ✓ **Quality Improvement-** The gaps for improvement of products as well as the manufacturing processes can be identified using other competitors (benchmarking) or through surveying customers. Improvement process must be implemented in all aspects of the industry.
- ✓ **Quality Review and Auditing-** Conduct of Internal Audit must be institutionalized and are conducted regularly to ensure the effectiveness of the installed quality system. The findings of the audit shall be placed before the management for review during the review committee meetings to take necessary corrective action.
- ✓ **Raw materials-** The main ingredient used in the biscuit making is wheat flour. The cleaner, lighter color of all-purpose flour should be used instead of unbleached/bread flour.
- ✓ **Dough temp-** In general, wheat-based doughs should be between 75°F and 78°F at the end of mix time. If dough is coming off the machine at 70°F one day and 80°F the next, uniformity in the results cannot be expected.
- ✓ **Baking Time and Temperature-** Recommended baking time and temperature should be used to avoid biscuit defect.
- ✓ **Machine calibration** should be done in regular intervals to keep the machine in good working condition.
- ✓ Biscuit lining should be proper in delivery canvas and proper gap between two biscuits to avoid Joint biscuits.
- ✓ The company can use nitrogen in packaging biscuits by lowering percentage of oxygen, which can improve shelf life of biscuits.

Lastly, it can be concluded that the matter embodied in this study will give a comprehensive starting point for more specific quality researches for Rural Biscuit manufacturing Industries.

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