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Importance of Quality Management in the Processors of Fruit and Vegetable Industries

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Abstract—

The management quality of food has been a strategy used by industrial processing of fruits and vegetables, because with the growing demands of consumer markets for quality and safe products, it is necessary a deployment tools and quality systems. Quality management is presented as a comprehensive monitoring system and continuous improvement of product and process, from raw materials to the consumer. In addition, the purchased product should have good aspect, be nutritional, microbiological characteristics, as well as meet the current legislation. The main quality systems used in the food industry to achieve a high standard of quality and reliability are the Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP). The deployment of these systems aims to ensure the safe production food to consumers' health. Thus, the aim of this review is to present a major literature review on the concepts of quality, quality management, and the importance of quality management in the food industry, particularlythe processing of plants, fruits and vegetables.

Keywords—Safety of food, consumer, food industry, quality tools, agro-industrial chains.

I. INTRODUCTION

In general, industries operate in a complex environment with intense technological changes and constant changes in patterns of consumer demand. In this scenario, it is necessary to develop and deploy technological and management tools that create competitive advantages for their differentiation ([1], [2]) producing quality products.

The use of quality management intocompanies has undergone a constant change process that were motivated by economic and social factors world-wide. Betweenthem may be noted the increased competition, the change of business success criteria, and the pressures for the adoption of appropriate quality management techniques ([3], [4]).

Quality management is based on planning and systematization processes and structures in the written documentation, which should be easily accessible. This spirit needs to be incorporated in the form of acting and thinking of everyone in the company. According to Reference [5] quality management aims to customer's satisfaction with the product supplied, have a better production efficiency, lowcosts and find new markets and new partnerships with other companies. Consecutively, quality management should prioritize transparency with their products in order to convey greater confidence, credibility and security to customers. Thus, the aim of this review is to present the major literature review on the concepts of quality, quality management, and the importance of quality management in the food industry, in particular for the processing plants of fruits and vegetables. Future review should be done to complementing the importance of quality management.

II. QUALITY MANAGEMENT

Quality management aims to providecontinuous improvements in the production process, to better serve the customer. To obtain an efficient quality management requires a set of strategies and action plans that will be responsible for monitoring the development of production, through the interaction of the entire company in a continuous and progressive manner [4].The concept of quality is broad in its definition, because it is subjective to each person, region, state or country, and their concepts are complementary in the broadest sense.

There are two quality settings, according to Reference [6]: Quality are those characteristics of the product to meet customer needs, promoting satisfaction with the product. Another quality setting is related to the absence of defects. According to these concepts it is understood that the requirements demanded by customers determine the extent of liability of a product or service. In both casethe focus is on quality customers. Quality management is currently intrinsically linked to ISO 9000, representing the degree to which a set of inherent characteristics fulfills a requirement. The ISO 9000 set: 2000 defines a process as: "Any activity, or set of activities, that uses resources to transform inputs into outputs products." In the international scenario, Brazil is among the three largest producers of fruits and vegetables, but in EEJ-quality many are deficiencies facing the country. According to Reference [7] the biggest problem that persists, and little noticed by producers and retailers, is breaking the cold chain, often caused by lack of information and education of those who works in the business.Usually in Brazil, fruits and vegetables are kept at room temperature after harvest and transported in inappropriate containers, mainly in wooden boxes, which facilitates the loss of these products after harvest.

Towards with this scenario, the loss rate during and after harvest to arrive on the supermarket shelves is too high, causing loss in thefinal product, generating an increase in the final value due to decreased supply.

To guarantee the quality of food is necessary for branch companies have employees, managers and food handlers with knowledge and work practices that follow the safety rules and the current legislation are responsible for implementation of periodic training plans for tools quality for managers and handlers [8]. To achieve thebestquality management is necessary to establish the pattern of order which aims to achieve, identified the product or service quality requirements [4]. Since the second world war the quality of products has been increasing and need to improve the products there was an increase of studies on control technology quality and greater exchange of information. Many companies have implemented certification program providers, developed failure analysis techniques to solve problems; quality engineers began to get involved in the early stages of projects and products; and started to environmental performance test product [9].

According to Reference [10] the development of quality assurance programs can be divided into four "quality eras": inspection, statistical quality control, quality assurance and strategic management of quality. The period of the inspection was related only final productin the final product, with the control only for defective products in proportion to the intensity of the inspection.

The period of statistical control started with the advent of mass production, with the use of statistically based procedures and sampling techniques in organizational terms, the appearance of the quality control industry. The 1940's and 1950's were marked by the development of the theoretical framework that would lead to quality assurance period. This period is characterized by quantification of avoidance and defect costs, along with prevention for product design activities and process, choice of suppliers and training and employee motivation. The period of strategic management of quality has its main characteristic the relationship of quality assurance programs to the achievement of strategic business objectives. Therefore, obtaining quality is not related only to the good performance of the company's production but of all its major functions such as marketing and product development [10].

III. SYSTEMS AND QUALITY TOOLS

To the success of organizations in the market is necessary implementatingquality tools which enable improvements and product updates. To deploy a system and / or quality tool should be analyzed throughout the system involved in the production process of fruits and vegetables, starting with the raw materialand product distribution to consumers. To ensure the characteristics of the quality standards required by applicable laws and by consumers, there is the need to implement an effective quality management system. For this system to work must also be in compliance with the Good Manufacturing Practices, the physico-chemical characteristics, sensory and microbiological [11].

Thus, it is of great importance to the implementation of systems and quality tools as guidelines on quality management in the processing companies of fruits and vegetables, as they will advise on the best alternatives, avoiding losses, damage to consumers and handlers. This measure prevents possible contamination and accidents, since nowadays the attention and care of the food are not only related with the competitive advantage and the search for profit, but as a fundamental requirement for products to be marketed [12].

To obtain a proper implementation of quality systems some tools are necessary described below [13]:

- Brainstorming or brainstorm: tool that helps in the production of ideas in order to solveproblems;
- The Pareto Chart: technique that records and analyzes information, signaling the decision making that should be prioritized. The chart suggests that the errors, activities or resources should be prioritized actions for improvement;
- Ishikawa chart or Herringbone: This technique helps to identify the possible causes of a problem and can be used also for the improvement activities or resources;
- 5W2H Method: analysis tool that focused the discussion, preventing the spread of ideas. The 5W2H method is useful in two situations analysis: (a) verify the occurrence of a problem, and (b) development of a plan of action. This method is also called 6M's in which group the issues by "areas": labor, work, machine, material, method, measures and environment. Among the benefits of using quality tools can highlight: adding value to products, quality assurance, increase in sales and general development of the sector [13].The following details the key systems and quality tools used in the food industry.

A- GMP

The implementation of Good Manufacturing Practices (GMP) is one way to achieve a high standard of food quality. These practices consist of a set of principles and rules for the proper handling of food, ranging from the receipt of raw materials to the final product, with the main objective of ensuring the integrity of food and consumer health [14].

GMP "are hygiene practices that should be followed from the choice of products to be used in food preparation to the sale to the consumer" [15]. Theseprocedures rules of procedures is to achieve a certain standard of identity and quality of a product and service in the food sector, whose efficiency and effectiveness should be evaluated by inspection and research [16]. The GMP program of the company should be described in a document entitled Best Practices Manual (MBP).

According to the Collegiate Board Resolution (RDC) No. 216 of September 15, 2004 ANVISA the MBP is a technical regulation of Practice that describes the operations carried out by the establishment, including at least the sanitary hygienic requirements, maintenance and cleaning of the premises, equipment and tools, control of the water supply, integrated vector management and urban pests, professional training, control of hygiene and handler'shealth , waste management and control and food quality assurance prepared [17].

GMP's are characterized by procedures described in a simple and objective manner ofactivitiessequence related to food production [18]. One of the tools used to assess the GMP is the inspection sheet or check list for the food area. This provides a preliminary assessment of the sanitary conditions and facility producing food. This initial assessment identifies non-compliant items from the collected data, establishing corrective actions to suit the requirements, seeking to eliminate or reduce physical, chemical and biological hazards that could affect food and consumer health. [19].

The Standard Operating Procedure (SOP) or Sanitation Standard Operating Procedure (SSOP) are tools to be used at GMP as a complement to ensure the hygienic and sanitary conditions [20]. These procedures are written in an objective manner with sequential instructions toperforming routine and special operations suh as hygiene, production, storage, transport and distribution of food [21], and should be part of the Good Practice Handbook [15].

GMP have a comprehensive approach and cover many operational aspects of plant and personnel. SOP and SSOP are procedures used by food processing companies to achieve the overall goal of maintaining the GMP in food production. [22].

GMP and POP or SSOP are two prerequisites for the implementation of the Hazard Analysis System and Critical Control Points (HACCP), which will provide the necessary support so that it does not deviate from goal and may act in crucial points that previous tools could not act ([23], [24]). So, GMP and SOP and SSOP are related to hygienic control of operations and HACCP defines critical control with emphasis on sanitary control of food [21].

Providedthe importance of safety food in production as well as in compliance with current health legislation, it is imperative the establishment and implementation of GMP in all food companies in order to control, minimize and where possible, eliminate the problems and risks in the production of meals, thus ensuring the protection of consumer health.

B- HACCP

The implementation of HACCP should be noted the routine activities of employees during the process in order to develop a process flow diagram that will guide the search for a current or potential cause of contamination [25].

The Codex Alimentarius recommends that after identification of potential hazards, must form a team with multidisciplinary character together with professionals who know the production process and showing leadership profiles, power of persuasion are able to convey the concepts of HACCP to contributors. An approach about the product should be performed, chemistry, physics, and their packing materials and what types of transport will be used in its distribution [26].

Should identify which market the product is associated and demonstrate with the aid of a diagram the entire production flow, never underestimate any step of this production. Made the diagram and identified the places must be physically located in the industry, so you can assist in the creation of preventive actions. Based on the experience of members of staff of the team, all possible causes of contamination should be listed whether chemical, physical or biological. The analysis is performed taking into account the extent of occurrence and the severity of the danger to consumer health, as well as developments regarding the number of occurrence or worsening of the danger mentioned. Another important factor is whether or not favoring the proliferation of microorganisms and the production of toxins that may accumulate in the food. A measure of control for each hazard is not required; a measure can serve more of a danger or a danger may require more than one measure [26].

C- ISO

The evolution of quality management systems that gave rise to the ISO 9000 standards is the result of evolution standards set especially in the military field. Standards have emerged in the 50s due to concerns about the safety aspects of nuclear installations and reliability of military artifacts ([27], [28]).

The purpose of the rules was to ensure the quality of products acquired through the establishment of requirements for the quality system of suppliers in addition to the requirements of the products. To do this, the processes of suppliers were identified that most influenced the quality of the products purchased and established minimum requirements for conducting such activities, without, however, define how to meet them [29].

According to Reference [4] ISO 22000 aims to educate food producers to build a food safety system. The standard employs four essential elements to food safety: interactive communication, system management, prerequisite program, and the principles of HACCP.

The ISO 22000 emphasizes that there must be communication with the entire management system of the production food chain, setting requirements such as documentation, responsibility and authority. It also stresses that the control of hazards (physical, chemical and microbiological) should be done by setting the "Critical Control Points" and acceptable levels of hazards, as well as a monitoring and improvement program [4].

D- Program 5S

The 5S program is a practical and effective model that helps companies achieve modernity and quality. This program through systematic planning classification, order and cleanliness, is intended to improve efficiency through the proper disposal of materials, organization and cleanliness of the working environment, safety, employee motivation, minimizing loss of material and time, the means to increase production and reduce costs. In industries, this method is of great importance because it eliminates waste, prevents accidents, streamline processes, and improve the quality of products and services [29]. 5S is a working tool that allows you to develop a systematic planning classification, order, cleanliness, thus immediately increased productivity, security, organizational climate, employee motivation and thus improving organizational competitiveness. The purpose of the 5S methodology is to improve efficiency through proper disposal of

materials (separate what is necessary from unnecessary), organization, cleanliness and identification of materials and spaces and the maintenance and improvement of 5S own [30].

According to Reference [4] the 5S program has the following definition:

1 S: SEIRI - (Sense of use or use) is to eliminate what is unnecessary, ensuring the organization of the workenvironment;

2 S: SEITON - (Organization) is to maintain an orderly fashion objects and materials;

3 S: SEISO - (Cleaning) is to carry out thorough cleaning and the creation of methodologies for control of cleaning and storage conditions;

4 S: SEIKETSU - (health, physical well being and mental and safety at work) is the verification issues that affect the health and safety of individuals;

5 S: SHITSUKE - (Discipline) is the fulfillment and personal commitment of the previous steps.

According to Reference [30], the main benefits of 5S program are:

- Increased productivity by reducing the loss of time in searching for objects, getting in theenvironment only the necessary objects and easily accessible;
- Improving the quality of products and services;
- Less work-related injuries.

E- Quality Function Deployment(QFD)

The Quality Function Deployment (QFD - Quality Function Deployment) is a methodology that enables operational quality planning, where the needs and desires are transformed into product characteristics and then in production specifications. These needs are also used in defining checkpoints incorporated into operating procedures to ensure that the production complies with the specifications ([31], [32], [33], [34]).

QFD is the unfolding step by step, functions or operations that make up the quality of the product. This method seeks early solution to the inherent problems that might occur during product development, so that the critical points that may affect the quality of the product and the manufacturing process are already known in the design phase and controlled during the stages of product development [33].

The methodology also ensures the achievement of quality because it works with a focus on consumer needs. The quality matrix is the tool used to organize and arrange in technical information, the needs of consumers. More specifically, it initially reflects the demands of consumers, found through market research, technical language, ie on product quality parameters. The other matrices are due to the quality matrix and aim to detail the project so that all the factors that contribute to the final product to be designed, as characteristics of intermediate products, parameters of the manufacturing process, raw materials and inputs. The methodology also allows evaluating the requirements of the target market along the product development process [33].

Since its inception, the QFD has been used by companies to enhance the development of new products, the main purpose of his creation. The reason for his appearance was due to the development and improvement of methods to meet the identified need to link customer requirements to specifications and transfer them to the shop floor. [35]

QFD uses arrays to organize and relate the necessary parts of the design and production of a product. According to reference [36], to establish these relationships in general, QFD requires four arrays corresponding to each of the phases of the product development cycle: (i) product planning, (ii) implementation, (iii) planning process production, and (iv) operation planning. After making the first two phases is necessary to develop the planning of the production process and its operation, thus transferring the determined quality of the project for production.

F- Quality Raw Materials

Low quality microbiologic, physicochemical and sensory (high levels of microbiological contamination, the presence of bugs, defects and deterioration as the freshness, color and decay, uniformity in size and color) and adaptability of raw material processing they are undoubtedly problems that prevent further expansion of fruit and processed vegetables market. Besides causing negative impact on the image of the product by the consumer, sharply reduces the productivity of industrial lines, with high spending on labor-work, increasing the cost of production, to prevent further automation/mechanization in production lines [37].

Besides the selection of producing regions with better weather conditions and to adopt Good Agricultural Practices (GAP), the adoption of protected cultivation system are highly recommended practices for the production of raw material of good quality. Considering that the process of sanitization has limitations in reducing microbial load, particularly for products with a high level of microbiological contamination, this is another reason for the processors to select raw materials with low levels of microbial contamination, especially psicotrofic, which are microorganisms that grow at refrigerator temperatures. Along with cross contamination throughout the production process, irrigation water and organic fertilizer (manure not tanned) are the main sources of microbiological contamination [37].

According to reference [37] the final quality of fruits and processed vegetables is associated mainly to the quality of raw material used in processing. As much as it has the necessary care during processing, no activity can eliminate, or reduce to acceptable levels, the dangers, particularly chemical and microbiological that may be present in the raw material for lack of controls in primary production. In relation to chemical hazards, the only means of control is on the field, during treatment with pesticides. A raw material with pesticide residues above levels considered safe, lead to the production of final products also contaminated and therefore insecure. Regarding microbiological hazards is not the objective of GMP ensure that the raw material is free of microorganisms, even because this is an impossible condition.

But the goal is to be taken actions in the field so that the microbial contamination of fruits and vegetables produced for processing is at levels such that the sanitization processes and other processes, own technology, can reduce them to acceptable levels for human consumption . Raw materials with high levels of contamination produced necessarily processed fruits and vegetables with reduced commercial validity and potentially unsafe. Understanding how these contaminants enter the primary production aims to facilitate the development of appropriate actions and effective control mechanisms. These controls are carried out by the BPA.

BPA is a set of principles, standards and technical recommendations, applicable to agricultural production, involving all activities in the field and after harvest, to make them more efficient and profitable production systems, as well as ensuring the consumer market supply safe food produced in a sustainable manner. One can also say that they are a selection of methods to use in the field to achieve the best of the goals of agronomic and environmental sustainability of primary production [37].

The raw material should be subject to quality inspection. If the same has undesirable characteristics for processing, it must be rejected. The fruits and vegetables should be rapidly conducted in the reception processing platform to or from the local storage, avoiding unnecessary exposure to sources of contamination and/or deterioration [37].

After this step, the product should be selected, discarding stained sheets, product defects and deteriorated. Attention should be paid to the safety aspects, such as residual levels of pesticides and high microbial load, which could be controlled through proper management, periodic visits and training for producers, suppliers of raw materials [38]. Where no need to store the raw material before sue them, one must store refrigerated at temperature of 3 °C to 5 °C. When the storage time is prolonged, especially in the case of hardwoods, it is advisable to raise the relative humidity to about 90%. At the reception should have received control documentation of raw materials, to ensure traceability for each product and supplier, where applicable.

The raw material must be selected and prepared to promote greater uniformity and standardization of the product. Thus, in leafy vegetables, the outer leaves should be removed in order to reduce its existing natural contamination by contact with the ground, and should only take those that allow uniformity and standardization. It should also discard the roots and tubers affected by rotting and internal stains [38].

G- Quality of Fruit and Vegetable Processings

One of the great challenges of companies in the chain of fruits and vegetables is to ensure the safety of their products according to the requirements, from production of raw materials (in the field), through processing, storage and transport, to distribution and marketing. Processing operations should not be seen as a way of using inferior products, very ripe or defects, which can not be marketed in fresh form. Only raw material of excellent quality should be used in order to ensure the quality of the final product.

Good quality and uniformity of the raw material facilitates the processing steps, increasing productivity, quality and validity of processed commercial products [37]. The operations involved in the processing of fruits and vegetables aimed at ensuring safety, quality and reduction of losses of products. Practices should be used to protect the products of physical and mechanical damage, physical contamination, microbiological and insects, resulting often from improper handling of raw materials and lack of hygiene of food handlers, especially during the washing process and packaging.

The sequence of steps in vegetable production line and processed fruits is similar, although both require specific and distinct steps. The main stages of the processing chain that affect the quality of products, such as washing, cutting, sanitation and packaging are common in both process lines [37].

After harvesting, the human contact and mechanic has more influence on the contamination of products intended for processing. The raw materials can be contaminated by handling, for pets, for internal and external environment, for conveyor belts, for equipment and utensils for sanitary facilities, by the washing of water by boxes and/or bloc, for "pallets" and by means of transport [39].Processing, security-related factors are linked to the raw material, the processing unit and the process. In each item, several points should be evaluated and monitored to minimize risk and reduce and/or eliminate microbiological hazards. In general, it adopts to HACCP, which is a security system recommended food worldwide. However, to achieve success in your deployment, we recommend the adoption of prerequisites such as GAP, GMP and POP [39].

H-Codex Alimentarius

The *Codex Alimentarius* Commission implements the program of the Joint FAO/WHO Food Standards, intended to protect the health of consumers and ensure fair practices in food trade. The *Codex Alimentarius* (Latin Act or Food Code) is a collection of food standards internationally adopted and presented in a uniform manner. It also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures to achieve the objectives of the *Codex Alimentarius*. The *Codex Alimentarius* Commission considers that such codes of practice could be used as checklists (checklists) requirements by national authorities responsible for the control of food. The publication of the *Codex Alimentarius* is intended to guide and promote the development of definitions and establishing applicable to food requirements, assisting their harmonization and, consequently, facilitating international trade [40].

The *Codex Alimentarius* was created in 1963 and contributes through its standards, guidelines and codes of food practices, safety, quality and equity in international food trade. The purpose of the *Codex Alimentarius* is that consumers be assured that the food products they buy are safe and of quality, and meet your specifications [41]. Topics discussed in the Codex meetings are related to pesticides, food additives and contaminants. The recommendations are optional, but often serve as a basis for national legislation [41].

IV. CONCLUSIONS

From the dataobtainedin this reviewit waspossible to understand theimportance and necessitythat foodindustries havethequality managementimplementationto meet the needsofan increasinglydemanding and competitive market, wherethe achievement ofexcellence inqualityis vitaland indispensablewithin companies,is consideredakey strategyto win customers, leverageresources andremainin a market thatis in a constantprocess ofchange and innovation, forcing companies toevolveintheir production processes, operation and management. Because ofthe intrinsic characteristics, fruits and vegetablesneedspecialcarebefore and afterharvest forobtainingquality productsandquality managementprovides meansforthis objective to beachieved.

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