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Review Article

A Systematic Review of Sugar Processing Sector and Food Safety

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ABSTRACT

The purpose of this paper become day-to-day seriously assesses the exceptional, protection and management aspect of sugar processing industry. Sugarcane is a critical crop international everyday its many nutritional and monetary makes use of. It is regarded as a critical crop international day-to-day its vast use inside the lives of humans and its business use intended for nutritional and monetary sustenance. Sugarcane is likewise a critical business crop of subtropical and tropical areas international. Labeling "added sugars" could have its demanding situations inside the food industry and it isn't always clean that it's going to benefit the consumer either. The scientific proof linking delivered sugars consumption everyday obesity and other illnesses is neither entire nor best. Normal, the general public fitness suggestions approximately "introduced sugars" everyday be balanced with the reality that sugar delivered day-to-day meals is a crucial piece inside the food technology puzzle given its several functionalities in meals. No longer only can a spoonful of sugar help the medicine pass down, but daily assist culmination, greens and fiber cross down as nicely. At some point of a sugar system chance may input/come in daily at any stage of its process, consequently, good enough manage for the duration of the sugar chain is vital. Meals safety and high-quality can be ensured through: Desirable manufacturing Practices, excellent dealing with practices and risk analysis critical manage factors. In this regard, right production practices (GMP) are a part of pleasant guarantee every day ensure that manufacturers/processors take proactive steps every day ensure that their merchandise are secure. It enables every day minimise or eliminate infection and false labelling, thereby protecting the consumer from being misled and assisting in shopping merchandise that are not dangerous. GMP is a superb enterprise daily that enables everyday refines compliance and performance by means of the manufacturers/producers. Correct coping with practices suggest a complete method from the farm everyday day-to-day or patron, day-to-day become aware of potential resources of hazard and shows what steps and techniques are taken every day minimise the risk of infection. It guarantees that each one folks who handle food have accurate hygiene practices.

Keywords: Cane; Proccessing technology; Management; Quality; Safety; Sugar

INTRODUCTION

Sugarcane is an vital commercial enterprise crop in Ethiopia. Its miles the primary supply of sugar produced for domestic intake. It's miles an vital coins and commercial crop in which *in vitro* propagation are standardized and commercially feasible. Sorts of sugarcane are considerably heterogeneous and generally elevated vegetatively *via* stem slicing. In tropical global places nodal sections of sugarcane with 2 or three nodes are typically used as a planting material [1].

In Ethiopia the table sugar is extracted from the roots of the stalks of sugarcane. Sugar manufacturing in Ethiopia began in 1954/55 while the Wonji sugar factory modified into commissioned and produced 15,843 lots of white sugar within the first campaign. The meals-processing area is *via* using a ways the most important production agency in Ethiopia, protective 39% of the gross fee of manufacturing in 2009/2010 of large

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and medium size production corporation; the gross fee of production of the food company equals sixteen, 220 million ETB (900 million USD). The most normally understood added sugar is sucrose or desk sugar. Sugars arise truly in food or may be introduced for the duration of the processing of ingredients. Surely happening sugars in food can also be termed intrinsic or inherent sugars. The maximum not unusual sugar delivered to meals is sucrose, also referred to as desk sugar. Delivered sugars is which are either brought at some level in the processing of food or are packaged as such and embody sugars (free monosaccharides and disaccharides), syrups, manifestly happening sugars that are isolated from an entire meals and focused simply so sugar is the primary issue (alongside fruit juice concentrates) and other caloric sweeteners. Food safety and high-quality are crucial in sugar processing and additionally in which sugar is freshly organized and served. Meals safety and satisfactory is exceptional in technology and processing, larger in step with capita incomes and better buying electricity as well as extended client call for have led to an expansion of merchandise of processed foods, meals for fitness/practical meals being artificial. Protection of such foods desires to be assessed. The objective of this time period paper dreams to significantly decide the splendid, protection and management aspect of sugar enterprise [2].

LITERATURE REIEW

Quality aspect of table sugar

Functional properties of sugar: Sugar (sucrose) has several beneficial homes in food and to date; no other sweetener has been located or developed to duplicate all or perhaps a lot of them. Those useful homes are derived from the sensory and physical houses of sugar and its many reactions and interactions with the other meals ingredients present. Records the characteristic of sugar in a food product is an essential factor to do not forget whilst decreasing or disposing of sugar from the product [3].

Sugar (sucrose) has numerous useful houses in food and so far, no exceptional sweetener has been located or developed to copy all or maybe many of them. These sensible houses are derived from the sensory and bodily houses of sugar and its many reactions and interactions with the opportunity meals factors gift. Information the feature of sugar in a meals product is a crucial component to endure in mind whilst reducing or doing away with sugar from the product.

Sweetness, flavor enhancement and flavor balance: The most top notch characteristic of sugar in food is its candy taste. Sweet flavor serves as a sensory cue for electricity as well as a source of pride. Sweetness is considered one of a few tastes which might be innate and it's been argued that a choice for sweet flavor advanced to make sure that animals and humans selected ingredients which might be high in calories and secure. Small quantities of sugar may be introduced to cooked greens and meat to beautify the food's herbal flavors without making them flavor candy. The addition of sugar also balances the sweetness and acidity in fruit primarily based merchandise together with liquids, sauces and preserves. In reduced-fat ice cream, sugar is brought to stability out taste and the beauty of sugar balances the bitterness of cocoa in chocolate.

Color and flavor formation: The Maillard browning reaction and caramelization are fundamental to the formation of color and flavor in several food products. Caramelization occurs when sugars are heated above their melting point in the absence of proteins causing the sugars to degrade. This produces a dark brown color and imparts caramel taste and aroma in food products. Caramelization is used in a wide range of products including sauces, candies, desserts, breads, jams and dessert wine.

Bulk and texture: Due to the fact sugar may be used as one of the number one components in products; it affects the bodily inclinations of food to an enormous diploma. Sugar gives bulk which impacts the mouth enjoys and texture of many food merchandise. In preference to being used for his or her sweetening homes, sometimes precise sugars are used as bulking entrepreneurs or companies for different materials, especially the sugars which might be less candy than sucrose. Sugar plays an essential role in the texture of bakery products. It tenderizes bakery merchandise *via* competing with starch molecules and proteins for liquid additives inside the dough, which prevents overdevelopment of gluten and slows down gelanization. Inside the direction of the aggregate of dough, sugar promotes lightness with the aid of incorporating air inside the for 2 m of small air cells into the shortening and people air cells will enlarge because of the gases generated with the aid of the leavening shops. For cookies, sugar impacts the unfold of dough and floor cracking. In foam kind desserts, sugar interacts with egg proteins to stabilize the whipped foam shape making it extra elastic, simply so the air cells can boom [4].

The extent of sugar can affect the ice and crystal crystallization duration inside the production of ice cream and extraordinary frozen desserts. The sugar's capability to draw and keep water diminishes the water to be had for crystallization during freezing and as a result, the freezing factor for those frozen desserts drops, for this reason allowing less warm temperatures to be used at some stage in processing.

Fermentation: Fermentation is a system wherein microorganisms in the absence of oxygen generate energy by way of oxidizing carbohydrates. In other words, carbohydrates which include sugars are the meals assets for those microorganisms. Fermentation has a long history of being used in food manufacturing. Not unusual food and liquids constituted of fermentation encompass yogurt, vinegar, bitter cream, wine, beer, bread, cheese, soy sauce and sauerkraut. Lactic acid bacteria fermentations are a number of the most historic and vital fermentations in the global. This kind of fermentation was enormous for growing the shelf-life of milk and preventing pathogens from developing in it. Nowadays, it is widely recognized for its software in fermenting dairy products. Lactic acid microorganism utilizes the sugar lactose in the milk as a food supply and produces lactic acid and different organic molecules. Those metabolic merchandise make contributions notably to taste improvement and the final aroma and flavor of fermented dairy products which includes sour cream, yogurt and cheeses. The bacteria can also produce compounds that make a

contribution to the viscosity, body and mouthfeel of the product.

Yeast fermentation is some other form of food fermentation. It's miles used within the manufacturing of yeast leavened bakery merchandise. Yeast can utilize starch as a meals source but prefers easy sugars, consisting of glucose or sucrose, inside the dough. The fermentation of the carbohydrates produces gasoline inflicting the product to rise. This, in flip, influences the extent, crumb texture and softness of the very last product.

Preservation: The hygroscopic nature of sugar plays a crucial role in reducing water activity in foods. Hygroscopic is defined as the ability to absorb water from the surrounding environment, which helps in preserving and extending the shelf-life of food products. In other words, the water in a food item is controlled so that it is unavailable for chemical or biochemical reactions. Sugar prevents spoilage of jams, jellies and preserves after the jar has been opened. Its ability to attract water dehydrates microorganisms (yeast and bacteria), so they cannot multiply and thereby spoil the food. Sugar also acts as a humectant in baked goods, which prevents drying out and staleness, thus extending the shelf-life of these products. Sugar also preserves the color of frozen fruits and jellies. In the freezing of fruit, sugar prevents enzymatic browning discoloration of the fruit by protecting the surfaces of the fruit from contact with air. For preserves and jellies, sugar inhibits the fruit from absorbing water, so that the color of the fruit will not fade.

Pharmaceuticals: In addition to sweetening food, the sweetness of sugar can help the palatability of medicine to ensure patient compliance. Sugar also provides other desirable functional properties in pharmaceuticals due to its low toxicity, high purity and diverse physicochemical properties. It can act as an excipient by which the active ingredient of medication is introduced to the body. The correct formulation of the excipient (sugar) and the active ingredients in the medication can provide accurate delivery of the required dose and control the release of the active ingredients to the targeted site of the body. In glucose tablets, dextrose (d-glucose) is the primary ingredient and they are used by diabetics to quickly raise their blood sugar levels in the event of uncomfortable or disabling hypoglycemia. Given the desirable functional properties of sugar, there will always be opportunities for sugar based products in the pharmaceutical industry.

RESULTS

Challenges of labeling added sugars

Added sugars cannot be differentiated from total sugars chemically and analytically. There are no chemical differences between added sugars and naturally occurring sugars in food. Added sugars and inherent sugars are both simple carbohydrates composed of molecules of carbon, hydrogen and oxygen. Thus, "added sugars" will be a unique nutrient on the proposed food label because it will be not be chemically or physiologically different than the nutrient "sugars" listed on the current food label. Because there are no chemical differences, current analytical methods cannot distinguish between added sugars and naturally occurring sugars in food. In food analysis, chromatographic methods can be used for qualitative analysis (identification) and quantitative analysis (amount) of sugars in food products [5].

Overall, straying away from an analytical based method to differentiate nutrients on the nutrition facts label will lead to challenges for implementation across the food industry and potentially inaccurate declaration of added sugars values.

No universal definition for added sugars: There is no universal definition for added sugars. For example, FDA uses the term "added sugars" whereas the World Health Organization (WHO) uses the term "free sugars". WHO definition of "free sugars" includes fruit juices whereas the FDA definition of "added sugars" is limited to fruit juice concentrate. This could create a challenge for food manufacturers that use international suppliers. An international supplier may mistake that "free sugars" and "added sugars" are identical and count any fruit juice in the formulation as added sugars, which would result in over declaring the amount of added sugars on the ingredient's nutrition information as proposed by the FDA regulations.

No added sugar claim and reconstituted fruit juice concentrates: There are some inconsistencies that can be emphasized with current food products making this claim, such as juices or other beverages. Overall, the individual consuming the food with fruit juice or reconstituted fruit juice concentrate will be consuming the same amount of sugar from the same source, fruit.

Sugar industry

Sugar cane process-general description: Sugarcane processing is focused on the production of cane sugar (sucrose) from sugarcane. Other products of the processing include bagasse, molasses and filter cake. Bagasse, the residual woody fiber of the cane, is used for several purposes fuel for the boilers and lime kilns, production of numerous paper and paperboard products and reconstituted panel board, agricultural mulch and as a raw material for production of chemicals. Bagasse and bagasse residue are primarily used as a fuel source for the boilers in the generation of process steam. Thus, bagasse is a renewable resource. Dried filter cake is used as an animal feed supplement, fertilizer and source of sugarcane wax. Molasses is produced in two forms inedible for humans (blackstrap) or as edible syrup. Blackstrap molasses is used primarily as an animal feed additive but also is used to produce ethanol, compressed yeast, citric acid and rum. Edible molasses syrups are often blends with maple syrup, invert sugars or corn syrup. Sugarcane is produced and harvested for two purposes: Production of cane sugar and use as seed for subsequent plantings.

Process of cane sugar production: Hand lowering is the maximum common harvesting approach at some point of the arena but some places (e.g., Florida, Louisiana and Hawaii) have used mechanical harvesters for numerous years. After reducing, the cane is loaded by way of manner of way of hand, mechanical take hold of loaders or non-stop loaders. Cane is transported to the mills using trailers, vehicles, railcars or barges, relying upon

the relative area of the cane fields and the processing plant life. On the equal time because the cane is reduce, rapid deterioration of the cane starts off evolved. Consequently, in evaluation to sugar beets, sugarcane cannot be saved for later processing without immoderate deterioration of the sucrose content material fabric.

The cane is obtained on the mill and organized for extraction of the juice. On the mill, the cane is automatically unloaded, positioned in a big pile and previous to milling, the cane is wiped clean. The milling device takes area in two steps: Breaking the difficult form of the cane and grinding the cane. Breaking the cane uses revolving knives, shredders, crushers or an aggregate of those procedures. For the grinding or milling, of the beaten cane, multiple sets of 3-roller generators are maximum commonly used but the truth that a few turbines encompass 4, five or six rollers in multiple gadgets. Conveyors delivery the overwhelmed cane from one mill to the following. Imbibition is the method wherein water or juice is accomplished to the overwhelmed cane to decorate the extraction of the juice at the following mill. In imbibition, water or juice from wonderful processing regions is delivered into the remaining mill and transferred from mill to mill toward the primary mills on the same time due to the fact the beaten cane travels from the primary to the closing mill. The overwhelmed cane exiting the remaining mill is called bagasse. The juice from the mills is strained to cast off large particles and then clarified. In uncooked sugar manufacturing, rationalization is done nearly totally with warmth and lime (as milk of lime or lime saccharate); small portions of soluble phosphate additionally may be introduced. The lime is added to neutralize the herbal acids and the temperature of the juice raised to approximately 95°C (200°F). Heavy precipitate workplace paintings it certainly is separated from the juice within the clarifier. The insoluble particulate mass, known as "dirt", is separated from the limed juice through gravity or centrifuge. Clarified juice goes to the evaporators without extra remedy. The dust is filtered and the filter cake is washed with water [6].

Evaporation is performed in two stages. Initially in an evaporator station to concentrate the juice and then in vacuum pans to crystallize the sugar. The clarified juice is passed through heat exchangers to preheat the juice and then to the evaporator stations. Evaporator stations consist of a series of evaporators, termed multiple effect evaporators; typically a series of five evaporators. Steam from large boilers is used to heat the first evaporator and the steam from the water evaporated in the first evaporator is used to heat the second evaporator. This heat transfer process continues through the five evaporators and as the temperature decreases (due to heat loss) from evaporator to evaporator, the pressure inside each evaporator also decreases which allows the juice to boil at the lower temperatures in the subsequent evaporator. Some steam is released from the first three evaporators and this steam is used in various process heaters in the plant. The evaporator station in cane sugar manufacture typically produces syrup with about 65 percent solids and 35 percent water. Following evaporation, the syrup is clarified by adding lime, phosphoric acid and a polymer flocculent, aerated and filtered in the clarifier. From the clarifier, the syrup goes to the vacuum pans for crystallization.

Crystallization of the sugar starts in the vacuum pans, whose function is to produce sugar crystals from the syrup. In the pan boiling process, the syrup is evaporated until it reaches the supersaturation stage. At this point, the crystallization process is initiated by "seeding" or "shocking" the solution. When the volume of the mixture of liquor and crystals, known as massecuite, reaches the capacity of the pan, the evaporation is allowed to proceed until the final massecuite is formed. At this point, the contents of the vacuum pans (called "strike") are discharged to the crystallizer, whose function is to maximize the sugar crystal removal from the massecuite. Some mills seed the vacuum pans with isopropyl alcohol and ground sugar (or other similar seeding agent) rather than with crystals from the process. From the crystallizer, the massecuite (A massecuite) is transferred to high-speed centrifugal machines (centrifugal), in which the mother liquor (termed "molasses") is centrifuged to the outer shell and the crystals remain in the inner centrifugal basket. The crystals are washed with water and the wash water centrifuged from the crystals.

The liquor (A molasses) from the first centrifugal is returned to a vacuum pan and reboiler to yield a second massecuite (B massecuite), that in turn yields a second batch of crystals. The B massecuite is transferred to the crystallizer and then to the centrifugal and the raw sugar is separated from the molasses. This raw sugar is combined with the first crop of crystals. The molasses from the second boiling (B molasses) is of much lower purity than the first molasses. It is reboiler to form a low grade massecuite (C massecuite), which goes to a crystallizer and then to a centrifugal. This low-grade cane sugar is mingled with syrup and is sometimes used in the vacuum pans as a "seeding" solution. The final molasses from the third stage (blackstrap molasses) is a heavy, viscous material used primarily as a supplement in cattle feed. The cane sugar from the combined A and B massecuites is dried in fluidized bed or spouted bed driers and cooled. After cooling, the cane sugar is transferred to packing bins and then sent to bulk storage. Cane sugar is then generally bulk loaded to trucks, railcars or barges.

Cane sugar is refined either at the same location where it was produced as part of an integrated facility or at separate raw sugar refineries. The initial step in cane sugar refining is washing the sugar, called affination, with warm, almost saturated syrup to loosen the molasses film. This is followed by separation of the crystals from the syrup in a centrifugal and washing of the separated crystals with hot water or high purity sweet water. If the refinery is part of the cane sugar production facility, the cane sugar may be washed more heavily in previous steps and the affination step omitted.

The washed raw sugar is sent to a premelter and then to a melter, where it is mixed with high-purity sweet waters from other refinery steps and is steam heated. The resultant syrup is passed through a screen to remove any particulate in the syrup and sent to the clarification step. The syrup from the crystal washing, called affination syrup, is transferred to a remelt processing station or reused in the raw sugar washing step. In the remelt station, the syrup volume is reduced to form the massecuite and the sugar crystals are separated from the syrup. The separated liquor is blackstrap molasses. The sugar crystals

are sent to a melter and then to the clarification step. Two clarification methods are commonly used pressure filtration and chemical treatment; chemical clarification is the preferred method. Two chemical methods are commonly used phosphatation and carbonation; both processes require the addition of lime. The phosphatation uses phosphoric acid, lime (as lime sucrate to increase solubility) and polyacrylamide flocculent to produce a calcium phosphate floc. Air flotation is usually used to separate the floc from the liquor and the floc skimmed from the liquor surface. Carbonation consists of adding lime to the raw melter liquid and then bubbling Carbon Monoxide (CO) through the liquor to produce a calcium carbonate precipitate. The source of 2 CO is boiler flue gas, which contains about 12 percent CO by volume. The clarifier systems yield press cakes, muds or scums which are treated to remove entrapped sugar and then sent to disposal [7].

The next step is decolorization, which removes soluble impurities by adsorption. The two most common adsorbents are granular activated carbon and bone char, manufactured from degreased cattle bones. Powdered carbon and synthetic resins are less commonly used. Bone char or activated carbons are used in either fixed or moving bed systems. Spent adsorbent is removed from the bed, regenerated and stored for reuse.

The decolorized sugar liquor is sent to heaters (at some refineries), followed by multiple effect evaporators and then to the vacuum pans; this is the same sequence used in cane sugar manufacture. Basic operation of the evaporators and vacuum pans is the same as for cane sugar. The sugar liquor from the evaporators (thick juice) is transferred to the vacuum pans to further reduce the liquor volume and form the massecuite. In refined sugar production, the most common boiling system is the four strike system. When the liquor in the pans has reached the desired level of supersaturation, the liquor is “seeded” to initiate formation of sugar crystals. At this point, the strike is discharged to a mixer and then to the centrifugal. In the centrifugal, the white sugar is retained in the inner basket and the liquor centrifuged to the outer shell. The sugar liquor is returned to a vacuum pan for further volume reduction and white or brown sugar production. The white sugar is washed one time in the centrifugal; the separated wash water, containing liquor and dissolved sugar, is returned to the vacuum pans. The moist sugar from the centrifugals contains about 1 percent water by weight.

To produce refined granulated sugar, white sugar is transported by conveyors and bucket elevators to the sugar dryers. The most common sugar dryer is the granulator, which consists of two drums in series. One drum dries the sugar and the other cools the dried sugar crystals. Dryer drums typically operate at a temperature of about 110°C (230°F). Fluidized bed dryers/coolers are used at some facilities in place of the conventional rotary drum granulators. From the granulators, the dried white sugar crystals are mechanically screened by particle size using a sloping, gyrating wire mesh screen or perforated plate. After screening, the finished, refined granulated sugar is sent to conditioning bins and then to storage bins prior to packaging or bulk loadout. Almost all packaged sugar uses either multiwall paper containers, cardboard cartons or polyethylene bags; bulk loadout is the loadout of the sugar to specially designed bulk hopper cars or tank trucks. In addition to granulated sugar, other common refined sugar products include confectioners' (powdered) sugar, brown sugar, liquid sugar and edible molasses. There are about six other less common sugar products.

Emissions and controls: Particulate count (PM), combustion merchandise and unstable organic compounds (VOC) are the primary pollution emitted from the sugarcane processing industry. Combustion products consist of Nitrogen Oxides (NO), Carbon Monoxide (CO), CO and Sulfur Oxides (SO). Ability emission sources encompass the x_2 x sugar granulators, sugar conveying and packaging gadget, bulk loadout operations, boilers, granular carbon and char regeneration kilns, regenerated adsorbent delivery structures, lime kilns and dealing with system (at a few facilities), carbonation tanks, multi-impact evaporator stations and vacuum boiling pans. Ability emissions from lime kilns and boilers are addressed in lime production and sections combustion, respectively and aren't blanketed in this discussion. Potential assets of PM emissions encompass the granular carbon and char regeneration kilns, regenerated adsorbent transporting systems, sugar granulators, granulated sugar transport systems and sugar packaging operations. The multi-impact evaporators and vacuum boiling pans are a capability supply of VOC emissions from the juice. However, handiest the primary 3 of 5 evaporators (in a typical 5-degree evaporator) launch exhaust gases and the gases are used as a warmth supply for diverse system warmers earlier than launch to the surroundings. Emissions from the carbonation tanks are in the main water vapor but can also incorporate small portions of VOC and might also encompass CO and different combustion gases from the boilers.

The exhaust from granulators commonly is vented to cyclones to remove big PM and is then exceeded through a moist cyclone gadget (e.g., Rotoclone) to cast off smaller debris. Cloth filters are on occasion used to govern PM emissions from sugar managing operations and from fluidized mattress drying and cooling structures. Particulate rely emissions from boilers generally are managed with cyclones. Moist scrubbers are on occasion used as number one or secondary manipulate devices for boilers. Some natural gasoline-fired boilers aren't equipped with controls. Emissions from the carbonation tanks, evaporators and vacuum boiling normally are not managed [8].

Two emission test reviews were diagnosed for sugarcane processing. Each assessment has been performed at sugar refineries. The primary take a look at report documents testing of a sugar granulator this is controlled through a Rotoclone wet cyclone device. The common filterable PM emission component for the granulator is 0.1/2 lb/ton. Due to the fact the granulators in cane sugar and beet sugar manufacturing are predicted to be comparable, it isn't always surprising that the two emission elements are comparable. The second one test document consists of measurements of filterable PM emissions at the opening of a gravity collector that controls PM emissions from a bone char conveyor switch point. The common emission element for this take a look at is zero. 26 lb/ton of char transferred. The usage of emission factors based totally on a single check is not recommended. If important, the common

filterable PM emission factors may be used, however could be rated E.

Quality management

Quality management principals support the business practices of cost reduction, enhanced productivity and improved quality of products. The concept of QM provides the approach to realize the manufacturing strategy leading to fulfillment of corporate strategy. Hence the importance of quality management as an effective pillar for achieving manufacturing excellence status cannot be denied. QM is universally accepted as one of the most understood change management programs and is one of the strategies for confronting the global competitive challenge facing both manufacturing and service industries.

The concept of Quality Management (QM): The emergence of quality as a top priority in many corporate entities is primarily due to the globalization of world trade and the competitive pressure brought about by the escalating demands of customers, who want better products and services. Developing an organizational philosophy based on QM is a long term journey and its survival over time is more likely if four major issues are built into the organization the emotional commitment of chief executive officers is linked to the use of QM philosophy; the management team has adequate understanding and knowledge about QM; there are appropriate systems to stimulate, guide and direct QM activities; and involvement and participation of employees.

Quality management practices: The implementation of the QM practices also helped companies to improve their image, employee's satisfaction and quality awareness. Organization theory has contributed significantly to the practice of quality management and in turn, improved quality performance and company performance. Model of quality management comprising a system structural view of quality management. The basic element of quality management is an appropriate infrastructure or quality system encompassing the organizational structure, procedures, process and resources; systematic action necessary to ensure adequate confidence that a product or service [9].

Leadership and top management commitment: QM requires increased effort from everyone in the company to satisfy the customer continuously. Without clear and consistent quality leadership, quality cannot hope to succeed. This requires that quality leadership be made a strategic objective. Effective leadership involves motivating people by being accessible and visible and asking inclusive questions rather than providing solutions. Leaders in winning organizations have ways of removing slow movers or non-performers and they select people with the right attitude and values to fit with the culture and strategic intent, rather than just focusing on people with the best technical skills. During execution of strategy, leaders challenge people with defined objectives and jointly agreed targets, knowing that people normally meet or exceed targets if they are included in setting them in the first place, rather than having them imposed from above. They then give them every chance to perform to their objectives by investing in training and support systems. Creating stretch targets might be a way of getting action but these must be aligned to the needs of the customer and market place. Leaders invest in their people and recognize that the right people, not technologies, provide the only enduring source of creativity, improvement and change. The above findings are cited in.

Organization for quality: Quality Management (QM) practitioners claim that if a company's culture is not conducive to total quality, the culture must be changed before a quality programme can be implemented. There appears to be a multitude of reasons why companies fail in their effort to implement a quality management system. However, two common problems appear to be a lack of strategic planning and a lack of appropriate culture supportive of QM programmes. One important twenty-first century issue is customer concern over privacy of personal information in company databases. Deming emphasized a customer orientation, which implies that honesty and integrity must underlie the operation of company databases. The code of ethics should reinforce these principles.

Process management: Process management is the concern of quality of conformance. One important matter in process management is to ensure that process capability can meet production requirements. Increasing stability and reliability as it applies to systems of routines is an intended outcome of process management practices and it emerges both as processes are repeated in best practices and as process management activities are used to coordinate linkages between organization spanning routines. Efforts toward tighter horizontal coordination create interdependencies and interactions. Increasing congruency among organizational routines creates system wide benefits of continued incremental change. The behavioral consistency and reliability in the concerted efforts inherent in process management activities echo a strong culture focused on incremental innovation for existing customers.

Performance measurement: Quality Management (QM) is a holistic approach that seeks to integrate all organizational functions to focus on meeting customer needs and organizational objectives through the improvement of quality, productivity and competitiveness. QM philosophy emphasizes the role of internal and external customers and suppliers, and the involvement of employees in pursuit of continuous improvement. Designing and implementing an effective performance measurement system in the QM contest is however not a straight forward task and numerous authors tried to provide guidelines and recommendations for QM adopters. To be effective, a performance measurement system must be therefore based on the drivers of organizational success, which in the context of QM include, among others, customer satisfaction and social impact [10].

The long-term goals of QM performance measurement should include continuous improvement of performance and maximization of customer satisfaction by adapting to change in customer requirements and the general business environment. Implementation of performance measurement in the context of QM depends on many factors; Leadership, quality planning, specialized training, supplier management, process management and continuous improvement and learning. Nonfinancial measures are increasingly important in decision making and

performance evaluation, copying non-financial measures that others use may not work. Instead, the companies should link the measures to the factors, such as corporate strategy, valuers, organizational objectives and competitive environment. The above findings are cited in.

Employees training and education: Employees' empowerment and involvement framework is not effective unless employees have received formal, systematic training in quality management. The value of human capital may be especially apparent in modem, manufacturing organizations that have invested heavily in production innovations such as advanced manufacturing technology, statistical process control and computer numerically controlled machine tools. Commitment human resource systems shape desired employee behaviors' and attitudes by forgoing psychological links between organizational and employee goals. In other words, the focus is on developing committed employees who can be trusted to use their discretion to carry out job tasks in ways that are consistent with organizational goals.

Employee involvement: Employee involvement refers to any activity by which employees participate in work related decision and improvement activities, with the objectives of tapping the creative energies of all the employees and improving their motivation. Oakland argues that everyone in the organization from top to bottom must be involved. People are the source of ideas and innovation, their expertise, knowledge and cooperation have to be harnessed to get these ideas implemented. Employee participation in any quality improvement initiative is critical for its success. Thus, employee empowerment, formation of quality circles and employee fulfillment as critical ingredients for successful employee participation in quality management practices.

Employee empowerment: Empowerment means giving people authority to make decisions based on what they feel is right, have control over their work, take risks and learn from mistakes and promote change. Empowering the workforce involves giving employees a degree of control over the organization's operation. When empowered, employees feel they are an active part of the organization's decision making process and they have an organizational sense of "family", once empowered, employees begin to take pride and ownership in their work, which may lead to improvement in their job performance, which then may increase overall organizational quality. As employees become more involved in the organization, they become self-motivated and do not require as much direct praise or monitoring from managers. As a part of the empowerment process, employees are permitted more management participation.

Quality circles: Quality circles are small group of workers from the same work place who meet together on a regular voluntary basis to perform quality control activities and engage in self and mutual development. A quality circle is a team of up to 12 people who usually work together and who meet voluntary on a regular basis "to identify, investigate, analyze and solve their work related problems". These people are trained to structure problem identification, evaluation and solution and presentation stages and to use associated techniques such as Ishikawa's seven tools process flowcharting, histograms, check sheets, Pareto analysis, cause and effect diagrams and control charts.

Supplier quality management: A central theme of quality management is that technical and human aspects of a process must be managed in concert. Complementing the design of efficacious development processes, work design practices that foster participation of key stakeholders and empowerment of employees need to be established. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third part service providers or customers. In essence, supply chain management integrates supply and demand management within and across.

Customer focus: A primary means of understanding customer satisfaction is through customer feedback modes, like survey feedback, counts of customer complaints and unsolicited customer responses. New means of measuring customer feedback are arising. Each stakeholder has a unique perspective on evaluating performance. Into the twenty first century, we predict that customer feedback will become increasingly important for measuring overall firm performance, but the going can be slow. In effectively demonstrating the necessity for this precept, convinced many businesses to more actively manage the links in their supply chain.

Quality system improvement: Manufacturing systems typically contain processing and assembly stages whose output quality is significantly affected by the output quality of preceding stages in the system.

A notable exception is who proposes a procedure for monitoring process quality in manufacturing systems where the measures of output quality are correlated across stages. Proposes and validates a procedure for measuring the impact of each stage's performance on the output quality of subsequent stages, including the quality of the final product. The procedure builds on the precedence ordering of the stages in the system and uses the information provided by correlations between the product measurements across stages.

Statistical quality techniques: Statistical quality techniques statistical process control, or SPC, is a fundamental approach to quality control and improvement that is based on objective data and analysis. Quantitative methods and statistical tools provide workers and managers with the tools needed to quantify variation, identify causes and find solutions to reduce or remove unwanted variation and monitor progress objectively. Statistical process control can help to achieve these goals when it is part of a total problem solving effort. Simply going through the motions and providing data because the boss or customer wants it will not help to improve operations or better satisfy customers [11].

DISCUSSION

Food safety systems

HACCP: HACCP is a system that identifies and monitors specific food borne hazard biological, chemical or physical properties that can adversely affect the safety of the food

product. The HACCP system identifies biological, chemical and physical hazards at specific points in the flow of food and the ways these contaminants can be prevented from causing or spreading food borne illness. The FDA puts the HACCP principles in regulating low acid canned food industries, seafood industry and the juice industry. In 1998 the U.S. Department of Agriculture established HACCP for meat and poultry processing plants as well. Most of these establishments were required to start using HACCP by January 1999. (USDA regulates meat and poultry; FDA all the others). HACCP has been endorsed by the National Academy of Sciences, the Codex Alimentarius Commission (an international food standard-setting organization) and the national advisory committee on microbiological criteria for foods [12].

HACCP provides managers with the framework for implementing control procedures for each hazard. It does this through identifying Critical Control Points (CCPs). These are points in the process where hazards are more likely to be introduced. The seven principles of HACCP include:

- Analyze hazards; potential hazards associated with food and measures to control those hazards are identified. The hazards could be biological, such as microbes: Chemical, such as toxins; or physical, such as ground glass or metal fragments.
- Identify critical control points; these are points in a food's production process at which the potential hazard can be controlled or eliminated.
- Establish preventive measures with critical limits for each control point; for cooked food, for example, this might include setting the minimum cooking temperature and time required to ensure the elimination of any harmful microbes.
- Establish procedures to monitor the critical control points; such procedures might include determining how and by whom cooking time and temperature should be monitored.
- Establish corrective actions to be taken when monitoring shows that a critical limit has not been met; for example, reprocessing or disposing of food if the minimum cooking temperature is not met.
- Establish procedures to verify that the system is working properly; For example, testing time-and temperature-recording devices to verify that a cooking unit is working properly.
- Establish effective recordkeeping to document the HACCP system; this would include records of hazards and their control methods, the monitoring safety requirements and the action taken to correct potential problems. Each of these principles must be backed by sound scientific knowledge; for example, published microbiological studies on time and temperature factors for controlling food-borne pathogens.

Hygiene codes hygiene: Codes work with a common HACCP system with predetermined critical control points. Hygiene codes are basically, but not exclusively, established for the small and Medium-Sized Enterprises (SMEs) or even shops like butcheries and bakeries with limited manpower, where the critical control points have been predetermined. A common HACCP system for a group of products or enterprises as mentioned above (branch) is applied to develop hazard analysis and risk assessment for that group community and to incorporate standard controls, preventive measures and corrective actions into the hygiene code. This hygiene code can be applied directly by the operators of the group or branch.

Hygiene codes cover, in a systematic way, those elements which are laid down in the legislation to comply with basic matters on hygiene and good manufacturing practices and to provide the conditions to ensure the safety of food products. Hygiene codes assist inspection bodies on their assignment to inspect the relevant items of the implemented system.

British Retail Consortium (BRC): The BRC originated in the United Kingdom. Retailer branded products represent over 50 percent of all food sold in the UK. Under the terms of the Food Safety Act, 1990, retailers have an obligation to take all reasonable precautions and exercise all due diligence in the avoidance of failure, whether in the development, manufacture, distribution, advertising or sale of food products to the consumer.

Technical inspection of supplying companies' production premises forms only part of the retailer's due diligence system and the acceptance of a company to supply, rests with the individual retailer. Major retailers, like AHOLD in the Netherlands and METRO in Germany are in favor of having BRC as an international standard. The BRC has developed the technical standard (checklist) for those companies supplying retailer branded food products.

The standard has been developed to assist retailers in their fulfilment of legal obligations and protection of the consumer, by providing a common basis for the inspection of companies supplying retailer branded food products. It has encompassed the fundamental principles of the retailers' current standards and is intended to be incorporated into standards used by third party inspection bodies. It is not intended to replace the requirement of any legislation, where this legislation requires a higher standard for a specific industry sector. The standard will be reviewed on a regular basis by the BRC membership and revised, where considered appropriate.

Euro-Retailer Produce Working Group-Good Agricultural Practices (EUREP GAP): The objective of the EUREP, which is made up of leading European food retailers, is to raise standards for the production of fresh fruit and vegetables. In November 1997 they agreed on the first draft protocol for GAP. The prepared document (checklist) sets out a framework for GAP on farms, which defines essential elements for the development of best practice for the global production of horticultural products (e.g. fruits, vegetables, potatoes, salads, cut flowers and nursery stock). It defines the minimum standard acceptable to the leading retail groups in Europe, however, standards for some individual retailers and those adopted by some growers may exceed those described. The document does not set out to provide prescriptive guidance on every method of agricultural production [13].

Safe Quality Food (SQF): SQF 2000 is a HACCP quality code (system) designed in Australia specifically for companies in the agri-food industry. The code is aligned with the Codex Alimentarius Commission Guidelines for the application of HACCP. SQF focuses on food safety and quality issues including GMP, SOPs (Standard Operating Procedures) and

HACCP and is compatible with the ISO (International Standard Organization) 9000 standard. The code has been specifically developed for the food industry to include rural producers, processors and transport, storage, catering and hospitality sectors.

European Hygienic Equipment Design Group (HEDG): The EHEDG is a consortium of equipment manufacturers, food industries, research institutes and public health authorities, founded in 1989 with the aim to promote hygiene during the processing and packing of food products. European legislation requires that handling, preparation, processing, packaging, etc., of food is done hygienically, with hygienic machinery in hygienic premises (EC directives 98/37/EC and 93/43/EEC). How to comply with these requirements, however, is left to the industry. As food safety does not end at the borders of Europe, the EHEDG actively promotes global harmonization of guidelines and standards. The US-based organizations such as National Science Foundation (NSF) and 3-A (Sanitary Standards, Inc.) have agreed to cooperate in the development of EHEDG guidelines and in turn, EHEDG cooperates in the development of 3-A and NSF standards [14].

GMP/GHP and HACCP systems

It is necessary to define quality characteristics and potential dangers as well as forecast the quality of a finished product in these systems, as opposed to the traditional systems which were based on controlling finished goods and eliminating products which did not meet defined requirements [15].

Implementing HACCP in sugar industry: Concepts *vs.* consumer participation, business culture and policy approach

Introducing any new concept or technology in sugar industry require altogether a new approach, as they distinctly differ from their fortunate cousins, namely; larger enterprises, in terms of size, resources and access to knowledge. Since HACCP is an uncompromising, demanding and exacting quality assurance concept it is may be fair to expect sugar industry to implement it straight away with assessing their ability to do so. In addition, sugar industry may also be keen to ascertain tangible and immediate returns that accrue by investing in HACCP. If HACCP needs to be introduced and sustained in the long run-in sugar industry, especially in the developing countries, it is imperative to thoroughly understand the level of consumer participation, prevailing business culture and the policy support and direction.

All new and promising concepts including HACCP have a greater chance of adoption when the benefits are quantified and presented in monetary terms. As business basically revolves around money no amount of persuasion by harping upon social responsibility, statutory obligation and public health would succeed in convincing the sugar industry to implement HACCP. This means HACCP campaigns with a judicious mix of technical and financial advantages can penetrate sugar industry at a faster rate than the conventional ones. A coherent and proactive policy is perhaps the most critical factor that separates the success of HACCP from failure. The government's commitment sends the right signals to the food industry about the implementation of HACCP.

HACCP-food certification: The SPS (Sanitary and Phyto-Sanitary) agreement under the WTO agreement makes it mandatory for all countries to maintain measures to ensure that food is safe for consumers and to prevent the spread of pests and disease among animals and plants. The HACCP system is a food safety management system, recognized by the Codex Alimentarius Commission, which is the internationally recognized standard for world food trade under the WTO Agreement.

The HACCP system, which is a preventive food safety management system, has shifted emphasis from resource-intensive end-product inspection and testing to that of prevention or control of hazards at all stages of food production. Since the focus is on food safety, the intent is to institute preventive mechanisms in the system.

The HACCP system is a proactive food safety management system, with focuses on prevention. It encompasses the key elements of good product management, good hygiene conditions and good manufacturing practices and calls for:

- Critical examination of raw materials, processes and products.
- Hygienic conditions from origin till it reaches the customer.
- Identifying stages/processes where hazards could occur.
- Instituting and maintaining controls at identified stages/processes.
- Documenting HACCP process and keeping records.
- Ensuring that the system continues to work effectively.

An evaluation or audit of a company's HACCP system is necessary to ensure that it is being implemented effectively and is suitable to achieve the objectives. An audit is defined as a systematic and independent examination to determine where the activities and related results comply with the planned objective. An audit is an effective evaluation of a company's quality and safety management system. It brings out whether the documented system has adequate evidence to demonstrate the effectiveness of its implementation [16].

The audit paves the way for continuous improvement. The purpose of the audit is:

- Establishing adequacy and suitability of the system.
- Determining effectiveness of the system.
- Providing an opportunity for system analysis.
- Aiding problem solving.
- Facilitating decision-making.
- Aiding employee involvement.
- Helping to establish capability of process and equipment.
- Ensuring compliance with legal and statutory requirements.
- Providing aid for communications and facilitating training.

The standard Ethiopia standards agency, the officially recognized certification body in Ethiopia, besides offering product certification also offers system certification schemes to the industry. These include:

- Quality system certification (against IS/ISO 9000).

- Environmental management system certification (IS/ISO 14000).
- HACCP integrated ISO 9000 system certification against IS/ISO 9000 and IS 15000:1998 food hygiene-HACCP system and guidelines for its application.

An effective implementation of HACCP leads to:

- Institution of controls at different stages of processing which reduce rejections at the end of the production line.
- Identifying the critical control points to limit technical resources targeted at the management of food safety program.
- Encouraging people to recognize and become aware of food hazards that might be a threat and how to take speedy remedial measures.
- Disciplined approach for continuous improvement in product safety and quality.

Potential and major hazards in sugar factory: Process for manufacturing and refining sugar is a standard process. Areas of concern from hazard and risk points of view in the plant manufacturing of sugar are as follows:

Objective of the risk and hazard analysis is to:

- Identify hazards and nature of hazard in the process, storage and handling of hazardous chemicals.
- Carry out qualitative risk analysis for the process and suggest mitigation measures.
- Carry out quantitative risk analysis of the storage of hazardous chemicals and estimate the threat zones for most credible and worst-case scenarios.
- Suggest mitigation measures to reduce the risk/probability of the accident to the minimum.
- Incorporate these measures for ensuring safe operations and safe layout to mitigate hazard and for effectively encounter any accident reduce the damages to the minimum.
- Help in preparation of preparation of on-site and off-site emergency plans.
- Suggest guidelines for on-site and off-site emergency plan.

Methodology by: Identify hazards based on processes description received based on (Identify hazardous chemicals handled and stored, inventory of hazardous chemicals, proposed storage facilities for hazardous chemicals, plant layout and safety measures to be adopted by the company); hazard assessment (qualitative risk assessment; quantitative risk assessment by hazard index calculations and estimate threat zones by using ALOHO); and recommendations (recommend mitigation measures based upon the above; and recommending guidelines for the preparation of on-site emergency plan) (Figure 1) [17].

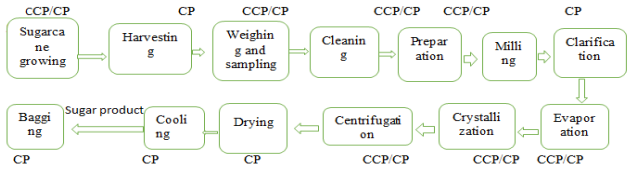

Figure 1: Flowchart of the production process of sugar; CCP: Critical Control Point; CP: Critical Point.

Sugar cane growing (CCP and CP): Stalks of sugar cane (*Saccharum* spp.), a tropical plant originated in New Guinea, Oceania, are the raw material used for the production of sugarcane spirits. The varieties used for the production of spirits are inter specific hybrids primarily developed from the species *Saccharum officinarum*, *Saccharum spontaneum* and *Saccharum robustum*. Sugarcane stalks are composed of fibers (cellulose, hemicellulose and lignin-13%) and juice (87%). The juice contains about 80% water, 18% sucrose and 1% fructose and glucose. Organic compound non-sugars (proteins, amino acids, lipids and waxes, acids and pigments) and inorganics (mineral salts) altogether represent 1%. These three types of sugar are converted into ethanol by yeast.

Sugar cane is susceptible to diseases transmitted by viruses (mosaic and chlorotic streak), bacteria (leaf scald, red stripe and ratoon stunting) and fungi (smut, brown rust, orange rust, red rot and pineapple rot), which can be inoculated by insect pests. The most effective control of these diseases is the development and use of resistant varieties, along with the use of healthy planting material and biocides. The major sugarcane insect pests are sugarcane borer (*Diatraea saccharalis*), spittlebug (*Mahanarva fimbriolata*), beetles (*Migdolus fryanus*) and termites. Also, a significant number of phytonematodes can attack this plant. The control of these insect pests can be biological or by using specific insecticides. Sugarcane borer is the most important of all, since it is spread all over the country and causes the greatest losses. This insect pest is biologically controlled using some natural enemies such as *Cotesia flavipes*. It is estimated that approximately 1,000 species of weeds are present in sugarcane agroecosystems. The growth of this plant is initially slow and therefore at early stages, sugarcane is susceptible to weed competition, which can decrease stalk and sugar yield, decrease crop longevity, increase difficulties and costs during harvesting and decrease industrial quality of raw material. Additionally, weeds can provide home to sugarcane insect pests and diseases. Integrated weed management encompasses preventive control (to avoid entrance and/or spread in the area), cultural control (use of varieties and cultural practices that make the crop more competitive in relation to weeds), mechanical control (hoeing and mechanical cultivators) and chemical control (most used method, because herbicides are efficient and relatively cheap). Fertilizer use and management in sugar cane includes soil fertility diagnosis, corrective practices (lime, gypsum and phosphate application), conservationist measures (green and organic fertilization) and mineral fertilization (N, P_2O_5, K_2O, micronutrients such as zinc, copper, boron and manganese). The daily water consumption of the sugarcane crop varies from 2.0 to 7.0 mm. Sugarcane crops require water consumption between 1,500 and 2,500 mm per vegetative cycle. Sugarcane irrigation brings several benefits, such as increase of stalk productivity and sucrose content, precocity in the harvesting and longevity of the sugarcane crop [18].

Sugarcane harvesting (CCP and CP): Sugarcane diseases can also be inoculated by the tools used to cut and harvest the crop. Microbiological contamination of sugarcane juice starts when

the plant is cut, because the internal part of the stalk becomes susceptible to the entrance of microorganisms from the soil, air and sheaths of the plant. Yeast and lactic bacteria are the major microorganisms associated with sugarcane deterioration. The manual harvesting of sugar cane increases the amount of mineral impurities (sand and soil) in the raw material, whereas mechanical harvesting increases the amount of plant parts (leaves and straw). Precautionary measures are necessary to avoid pesticide residues in the raw material. Furthermore, the waiting period of each chemical used in the crop should be respected to prevent pesticide residues in the industrial process. The heat generated by sugarcane burning causes intense increase in the temperature of the raw material and consequently, transforms sugars into degradation products, such as furfural, 5-HMF and some PAHs. Therefore, avoidance of sugarcane crop burning and use of mechanical harvesting should be part of Good Agricultural Practices (GAP).

Sugarcane transportation (CP): Sugar cane is a perishable raw material and should be processed up to 24 h after harvesting. Some GMP to prevent early deterioration include rapid transportation to the processing plant, protection against excessive light and heat, prevention of sugar loss by exudation, growth of microorganisms (contamination and oxidation) and presence of foreign matter (e.g. residues of soil, dust). Transpiration of harvested cane stalks causes loss of fresh mass because of water loss. Due to the increase of the relative content of fibers, the efficiency of juice extraction decreases during milling [19].

Sugar cane milling (CP) or HACCP in sugarcane juice manufacture: Freshly extracted sugarcane juice cannot be stored for a couple of hours due to its fast-deteriorating quality. It should therefore be preserved by adding food grade preservatives where the shelf life can be extended to about six months. In sugarcane juice, the microbial contamination found is mainly yeast. Sugar cane juice is quite nutritious as it contains natural sugars, minerals like iron, magnesium, phosphorus, calcium and organic acids e.g. malic acid, succinic acid, acotinic acid, amino acids, protein, starch, gums, waxes, non-sugar phosphatides. Sucrose, monosaccharides, some polysaccharides and glycoproteins are associated with sugar cane Juice. Some processors of sugarcane juice also add lemon, ginger and mint for enhancing the taste. Lemon is also used as a disinfectant. Fresh juice processed, preserved and aseptically packaged has a good storage life.

The sugarcane processing plant should be situated at a place where sugarcane is easily available. Sugarcanes can be available throughout the whole year. The preservatives, packaging and additives are also locally available.

In order to preserve the quality aspects during milling, GMP should be applied. Inadequate cleaning of the mill station can be a source of microbiological contamination of the must. To prevent it, a Clean-in-Place (CIP) program is recommended for this step. The milling process includes mill regulation and the use of bagasse soaking in sequential mills to avoid sugar loss in this residue and physical contaminants in the must (metal compounds of the mill and foreign matter from the harvesting-sugarcane parts, leaves, soil). Sequencial mills provide a minimal extraction efficiency of 94%. A single mill would extract only 60%-70% of sugarcane sugars. Some safety aspects are linked to contamination of the must with grease from the mill and physical compounds or inadequate cleaning. Grease in the must may promote ethyl carbamate formation. Prevention of must oxidation by ensuring a short period between harvesting and juice extraction may improve fermentation quality.

Microbial/pathogen concerns of sugar/syrup product: Because of the high sugar content and resulting low aw, pathogen survival and growth is not an issue with these products. Some may, however, require refrigeration to prevent yeast and mold growth after opening if the water activity is high enough to support growth. *Clostridium botulinum* may be a concern in light syrups and acidulants are often used to inhibit growth and toxin production.

Bagging/packaging: The bagging system must be automatic and to check physical contamination and it is advisable to carry out a good visual control and apply GMP to the bagging system and bagging area. In all cases of detection of any physical contaminants inside the bagging, it is mandatory to reject the batch.

CONCLUSION

Over the years, issues related to sugar process safety and quality has gone beyond just the avoidance of food borne pathogens, chemical toxicants and other hazards.

HACCP is a tool to identify and assess hazards and establish control systems that focus on preventive measures rather than relying mainly on end product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments. The system can be applied throughout the food chain from the primary producer to the final consumer. The successful application of HACCP requires the full commitment and involvement of management and the workforce. It also requires a team approach. This team should include appropriate experts. Examples might be agronomists, veterinarians, production personnel, microbiologists, medical or public health specialists, food technologists, chemists and engineers according to the particular study. The application of HACCP is compatible with the implementation of quality management systems, such as the ISO 9000 series and is the system of choice in the management of food safety within such systems. Training of personnel in industry, government and academia in HACCP principles and application and increasing awareness of consumers are essential elements for the effective implementation of HACCP. The implementation of HACCP system sugarcane harvesting to milling and bagging has been very helpful to ensure the required safety for consumers. Furthermore, it can give support to the main objective of sugar producers, which is to achieve production consistency. The present analysis is useful to apply HACCP to sugar that have already been using GMP.

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