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How to Apply ISO 22000 in the Production of Strawberry Concentrates "A Practical Study"

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ABSTRACT

The historical development of ISO 22000 FSMS began with the principles of Hazard Analysis Critical Control Points (HACCP) that were published by the World Health Organization (WHO) in the Codex Alimentarius in 1963. These principles aimed originally to produce zero-defect products for the astronauts who went into space with NASA in 1973. After that, in 1985, the American National Academy of Sciences advised food producers about the application of the HACCP system, followed by the adoption of the HACCP in the laws of the European Union countries in 1993. By 1996, a legal obligation to apply HACCP standards in all of the food industry in Europe was introduced. On 1 September 2005, food safety management systems (FSMS), currently used, emerged and were published as "ISO 22000 Food Safety Management Systems - Requirements for the Establishments Involved in Food Chain". In this chapter, the main objective of ISO 22000 is to provide harmony on the international level between the requirements for FSMS for corporations within the entire food supply chain. The aim of this work is present a methodology to carry out hazard and control measures assessments to properly establish operational prerequisite programs (OPRPs) and the HACCP plan in the Strawberry concentrates industry in accordance with ISO 22000 standards, this study focus on the production of concentrated strawberry, which was sold as raw materials to juice-filling factories

Keywords: ISO 22000, HACCP, Strawberry, FSMS, NASSA, OPRPs.

INTRODUCTION

Because of their high nutrient content and pleasant flavor, one of the berries with the greatest economic value is the strawberry. One of the berries that people eat the most is the strawberry, which belongs to the Rosaceae family. Because of its prized sweet, fragrant, and juicy fruit, it is grown commercially all over the world. Over 36 billion pounds of strawberries were grown in the United States in 2012, accounting for 29% of the world's total production [1]. California, Florida, and Oregon produce the majority of this berry crop for commercial use in the United States. Strawberry yields per acre in California are higher than in any

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other growing region due to its 12-month growing season. Mexico, Turkey, Spain, Egypt, and Turkey are the other major strawberry producers. Fresh strawberries make up the majority of the crop [2]. Strawberries are juicy, sweet, and bright red. They are a good source of manganese and vitamin C, and they also have some potassium and folate (vitamin B9). Strawberries contain a lot of plant compounds and antioxidants that may help regulate blood sugar and improve heart health [2]. Therefore, the aim of this chapter application of ISO 22000:2005 methodology for producing strawberry concentrates in order to protect the health of consumers.

History

Delegates from 25 nations gathered in 1946 at the Institute of Civil Engineers in London to make the decision to form a new international organization with the mission of "facilitating the international coordination and unification of industrial standards." This was the beginning of the International Standards of Organization (ISO) story. On February 23, 1947 officially began operations, which has members from approximately 160 nations, there are currently 783 technical committees and subcommittees in charge of overseeing the development of various standards. The Egyptian organization for standardization EOS was established in 1957 and In the same year, they joined ISO as well, The EOS is the official and competent authority for all aspects of quality control and standardization in Egypt [3,4].

World production

According to the table, China accounted for 38% of the world's strawberry production in 2020, followed by the United States and Egypt as other significant producers (Table 1).

Table 1. Strawberry production-2020

Country	(Millions of Tonnes)	Country	(Millions of Tonnes)	Country	(Millions of Tonnes)
China	3.3	United States	1.1	Egypt	0.6
Mexico	0.6	Turkey	0.5	Spain	0.3
World	8.9				

Source: FAO/STAT of the United Nations [5]

NUTRITION FACTS

100 grams of raw strawberries contents: Calories: 32, Water: 99.1 %, Protein: 0.7%, carbohydrates: 7 grams; 4.99 g of fiber and 2.0 g of fat. Strawberries are one of the best sources of manganese (18% DV), the best sources of vitamin C (71% DV), and a small source of numerous additional minerals and vitamins. Essential unsaturated fatty acids can be found in small amounts in strawberry (seed) oil [5]. Furthermore, enhancing your digestive health. Additionally, they can aid in weight loss and disease prevention.

Vitamins and minerals

Strawberries are abundant in the following vitamins and minerals: C vitamin: Vitamin C can be found in abundance in strawberries, an antioxidant that is important for the health of the skin and immune system. In nature, we can find three major types of antioxidants: phytochemicals, enzymes, and polyphenols. So, when we eat fresh fruits such as berries, we are absorbing all the antioxidants it contains. Legumes, fruits, and vegetables, in addition to whole grains frequently contain high concentrations of this element, which is essential for numerous bodily functions. Folate and B9 vitamin. Folate, one of the B vitamins, is necessary for elderly people and pregnant women and elderly people because it is necessary for normal cell and tissue growth. Potassium numerous essential body functions, like controlling blood pressure, involve this mineral. Strawberries also contain vitamins E, K, and B6, as well as iron, copper, magnesium, and phosphorus to varying degrees [6,7].

Bio active Plant compounds

One of the beneficial plant compounds and antioxidants is strawberry pelargonidin.. This compound, which is the primary anthocyanin in strawberries, is to blame for the red color [8]. Strawberry high levels of Ellagic acid, polyphenol antioxidant, may provide numerous health benefits. These are antioxidants that are typically found in strawberry seeds and flesh and may be beneficial to one's health.

Benefits of strawberries for health

Strawberries are linked to a lower risk of numerous chronic diseases. Strawberries may aid in cancer prevention, improve

heart health, and lower blood sugar levels. Worldwide, the most common cause of death is heart disease. Berries, or berry anthocyanins, have been linked in large observational studies involving thousands of people to improved heart health.[8]. Berries are linked to a lower risk of death from heart disease that is caused by heart disease. The effects of freeze-dried strawberry supplements on metabolic syndrome or type 2 diabetes have been extensively studied, primarily in overweight or obese individuals. Several significant risk factors, including oxidized LDL particles, were significantly reduced in participants, inflammatory markers, and LDL (bad) cholesterol, after taking supplements for four to twelve weeks [8].

Cancer prevention

Primarily because of their capacity to reduce oxidative stress and inflammation, berries may aid in the prevention of several types of cancer, according to a number of studies [9]. Strawberries have been shown to prevent tumor growth in animals with mouth cancer and human liver cancer cells. Ellagic acid and ellagitannins have been shown to halt cancer cell growth [9], maybe responsible for strawberries' protective effects.

Adverse effects

Primarily because of their capacity to reduce oxidative stress and inflammation, berries may aid in the prevention of several types of cancer, according to a number of studies [10].Strawberry juice contains a protein that can aggravate allergies to birch pollen [11].

Organic strawberry recall

Food and Drug Administration (FDA), the Public Health Agency of Canada, and the Canadian Food Inspection Agency are investigating a Hepatitis A outbreak that has been linked to strawberries. The infection has spread across multiple states and has mainly been related to Fresh Kampo and HEB's strawberry brands [12]. According to the FDA, an outbreak of hepatitis A has been linked to fresh organic strawberries. The brands stored between March 5 and April 25, 2022, of these strawberries should be thrown away by anyone who purchased them and frozen them for later consumption. Additionally, the FDA has advised consumers who are unsure of their fruit's brand to discard them and talk to your doctor if you think you've eaten these strawberries in the past few weeks or if you have hepatitis A symptoms after eating these organic strawberries [12,13].

STORAGE AND FOOD SAFETY

Pick through your package of strawberries before storing them to remove any damaged fruit, store strawberries in the coldest part of your refrigerator. Use within one week or, ideally, within a few days. Fresh strawberries must be washed under running water before eating or slicing (but wait until you're ready to use to wash). If you don't have a chance to eat all of your fresh strawberries before they go bad, you can freeze them individually on a baking sheet and transfer them to a freezer bag for later use [14].

Strawberries are sold by volume or by weight. The volume containers hold approximately 0.25, 0.5 or 1 l. A small container would hold approximately 225 g; some of the larger containers may hold up to 3 kg. Fruit for the fresh market is generally harvested directly into the retail container. These are placed in fiberboard or corrugated trays, or masters, each holding a convenient multiple of the smaller harvesting containers.

Good commercial practice is to hold harvested fruit out of the sun and protected from warm winds and blowing dirt. Growers following recommended practices move their fruit to cold storage within 1 or 2 h of harvest. Warm fruit bruises easily and must be transported gently [15].

Field heat must be removed rapidly to reduce losses from rot, caused by fungi such as Botrytis cinerea (grey mold), *Phytophthora cactorum* (leather rot), and *Rhizopus nigricans* (black whisker rot). These fungi either grow very slowly, or not at all, at fruit temperatures of 0–2 °C. Changes in the fruit associated with senescence, e.g., skin darkening, softening of the flesh, and loss of flavor, occurs more slowly at lower temperature. Forced-air cooling is the preferred method of removing field heat in many strawberry-producing areas. In these coolers, the fruit can be cooled from 25–35 °C to 2–4 °C within 1–2 h. In these coolers, trays of fruit are placed so as to form the side walls of a plenum, open to a wall with an exhaust fan. With the open top and end covered with fabric, chilled air is drawn from the cold room through the trays of fruit. To retain the best quality, the chilled fruit is held at 0–2 °C and 90–95% relative humidity. Fruit treated in this manner can be stored for 5–7 days and retains its quality during 3–5 days of marketing after storage [15].

Fruit Juices

The fruit juice defined as the unfermented but fermentable liquid obtained from the edible part of sound, appropriately mature and fresh fruit, or of fruit kept in sound condition by appropriate means including the post-harvest surface

treatments. Thus, the juice shall be prepared through the appropriate processes that shall maintain the essential physical, chemical, organoleptically and nutritional characteristics of the juices of the fruit. CODEX, S. STAN (247-2005). In this context, the juice could be cloudy or clear and could have restored aromatic substances and volatile flavor components, all of which must be obtained through the appropriate physical means, and all of which must be obtained from the same fruit.

The concentrated fruit juice is defined as the product that conforms to the above definition, but the water has already been removed in sufficient amount to increase the level of concentration to a value more than 50% of the Brix value prepared for the reconstituted juice of the same fruit. The suitable processes shall be used in the production of concentrated juice [16].

Fruit Juice Concentrates

The fruit juice concentrates are basically produced through the evaporation of the super flours water quantity of fruit juices; thus, the withdrawal of water could be done through the following:

1. Heating and evaporation of water at boiling temperature, generally under vacuum at low temperature in a multi-stage evaporator; in addition to the preliminary separation of the aroma content by distillation for re-usage.
2. Freezing the juice and separating the crystallized ice by centrifuging (freeze-concentration), or sublimation of ice crystals under vacuum (lyophilization or freeze-drying).
3. Reverse osmosis (separation of water by a semipermeable membrane).

In light of the above, the natural fruit juice shall be cleaned of any fiber content and colloids, through clarification and sieving; however, it is possible to concentrate the opal juice as well. In addition, the soluble solid content of the concentrate shall reach 62–65 ◦ Brix in order to get a long-life product. The solids' sugar ratio shall be variable based on the sort and ripeness of the fruit. Furthermore, the sweetening effect of the concentrate might also vary in case of an equal sugar concentration due to the sugar interactions. The fruit juice concentrates shall include nearly all valuable components of the fresh juice, i.e. sugars, organic acids, minerals, colorings and natural antimicrobials. Hence, they represent popular additives in the bakery, confectionery and dairy industry as natural sources of colorants and sweeteners [16].

There are several public health concerns, with which we have to deal on daily basis. In this regard, [17] think that food safety is considered as one of the most prominent major public health concerns. Thus, it is a real challenge to provide food supplies that are safe and conforming.

Therefore, the aim of this chapter application of ISO 22000:2005 methodology for producing strawberry concentrates in order to protect the health of consumers.

Manufacture of Strawberry Concentrate

The processing of fruit concentrate involves a number of steps, including receiving the raw materials, first washing, sorting, final washing, crushing, and extraction, Pre-heating, Filtration, Concentration, Pasteurization, Filling, and Storage. Processing steps can be summarized in Figure (1) [18].

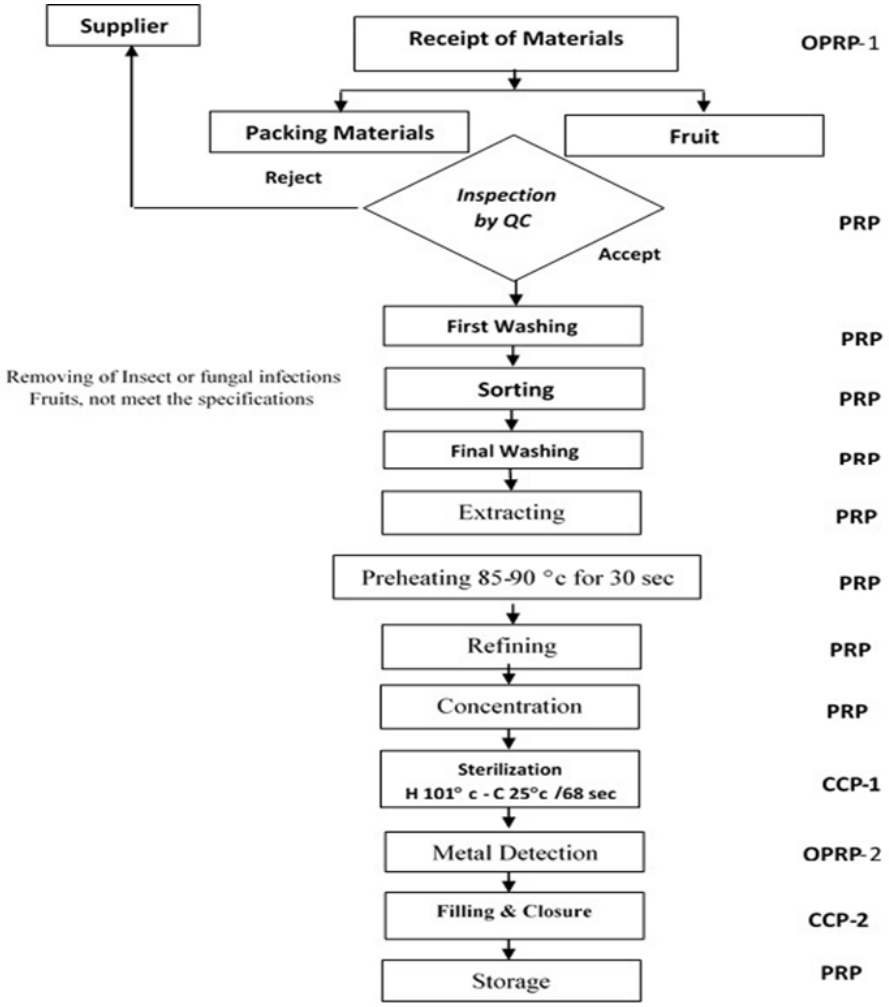

Figure 1. Flow Diagram for the manufacture of Strawberry Concentrate.

APPLICATION OF ISO 22000 FOR MANUFACTURING OF STRAWBERRY CONCENTRATE

The implementation of the food safety system (ISO 22000) is a continuous process based on the management concepts of iterative four-step management methods; the PDCA cycle (plan, Do, Check, and Act) [19].

ISO 22000 Surveys

The ISO 22000 Survey is an annual examination of certifications for management system standards. The results of this survey show how many valid certificates for ISO management standards like ISO 14001 and ISO 9001 have been reported for each nation worldwide. However, ISO does not carry out certification; However, businesses seeking ISO certification should contact an independent certification body. The ISO Survey, which includes the number of ISO 22000 certificates issued worldwide by certification bodies the International Accreditation Forum (IAF)'s members have approved between 2007 and 2017, can be found in Tables 2 & 3 [20].

Table 2. The number of ISO 22000 certificates issued in Egypt from 2007 to 2017

Years	Total
2007	8
2008	68
2009	67
2010	276
2011	136
2012	233
2013	296
2014	288
2015	301
2016	308
2017	328

Table 3. The number of ISO 22000 certificates issued in the world from 2007 to2017

Years	Total
2007	4122
2008	8185
2009	13838
2010	18580
2011	19351
2012	23278
2013	24207
2014	27685
2015	32056
2016	32136
2017	32722

What does ISO 22000:2005 add to Codex HACCP?

ISO 22000:2005, as stated by the Codex Alimentarius Commission (2015), adds the following to Codex HACCP:

-As a management system standard with requirements for policy, planning, application and operation, performance assessment, and management review and improvement, ISO 22000 enhances the Codex HACCP system in numerous ways.

-ISO 22000 makes the conventional notion of separating control measures into GHPs and CCPs into a reality by categorizing control measures into the following three groups:

1. The PRPs to manage the main conditions and activities, as they are not selected in order to control specific identified hazards, but for the purpose of maintaining a hygienic production, processing and/or handling environment.
2. An HACCP plan to manage the application of control measures that the hazard analysis process has identified as necessary in order to control significant hazards; and that is within the time frame of controlling the influenced products, and
3. An OPRP plan to manage the application of those control measures that the hazard analysis process has identified as necessary to control the significant hazards, and which are not managed by the HACCP plan.

The hazard analysis procedure thus links these three categories together; Additionally, ISO 22000 demonstrates

how to integrate the HACCP plan, PRPs, and OPRPs into a single integrated food control system; and Codex HACCP focuses on the internal system, whereas ISO 22000 promotes the use of the food supply chain; When developing and implementing the food safety management system, ISO 22000 mandates that the effects of the food supply chain be taken into account prior to and after its operations [21].

The main changes of ISO 22000 compared with HACCP

In this regard, [22] identifies the following as the primary distinctions between HACCP and ISO 22000 FSMS:

1. The scope encompasses all food industries, from farm to fork, as well as corporations that are involved indirectly in the food chain, such as those that provide equipment, food packaging, insecticides, veterinary medicines, and detergents/disinfectants; which might be the source of potential dangers in food chain, whether they come from the supply of raw materials or the services they provide.
2. Hazards that need to be controlled are those managed by prerequisite programs (PRPs) in addition to CCPs (either with constant monitoring or at a suitable frequency for an immediate application of corrective actions).
3. In the event of external risks or hazards that are not included in the hazard analysis, such as power outages, environmental pollution, and natural disasters, there are crisis management procedures.
4. Beyond the requirements for internal communication, there are additional external communication requirements between food companies and relevant authorities concern on food safety.

The corporation's decision to implement a FSMS, as stated in [23], is regarded as a strategic one. because it might be able to help it perform better overall in the area of food safety. By implementing an ISO 22000-based FSMS, the company stands to gain the following potential advantages:

1. The capacity to consistently offer safe foods, goods, and services that meet customer expectations and all applicable statutory and regulatory requirements.
2. The capacity to deal with risks that are related to its goals.
3. The capacity to demonstrate compliance with the specified FSMS requirements.

Audit

According to ISO 9000, an audit is a methodical, documented, and independent procedure for acquiring records, statements of fact, or other relevant evidence and evaluating them objectively to determine the extent to which specified requirements are met. The following are the three types of audits, as stated in [24]:

1. First-Party Audits: a self-evaluation that provides internal evidence that management strategies and procedures adhere to a standard and represent business goals.
2. Second-Party Audits: These audits, also referred to as proprietary audits, evaluate the performance of suppliers or contractors.
3. Third-Party Audits: These audits often result in certification and are carried out by independent auditors who are not employed by the auditee.

Food safety audits, regardless of their nature, typically follow the following procedures: 1) Planning, 2) Execution, 3) Corrective and preventative measures, 4) Verification, and 5) Audit evaluation.

The order in which food safety systems are put into place is shown in Figure (2) [25].

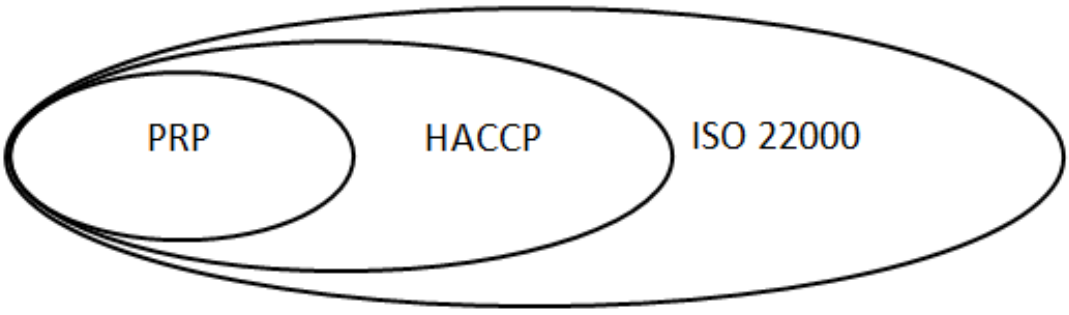

Figure 2. Description of the Implementation Order of Food Safety Systems.

The PRPs are based on good manufacturing practices or good hygienic practices, As shown in Figure (3)., Food safety experts have found that well-functioning PRPs simplify and strengthen the HACCP plan, in general Prerequisite programs (PRPs) provide the foundation for HACCP to function. According to [26] PRP include Facilities, including construction and layout , Personal hygiene, training and competencies, waste and sewage disposal, air, water and energy control, Cleaning and sanitizing, Preventive maintenance, Calibration, Prevention of cross contamination, Pest control, Glass and hard plastic control, Chemical control, Environmental monitoring, Product traceability and recall, Complaint investigation and Labeling.

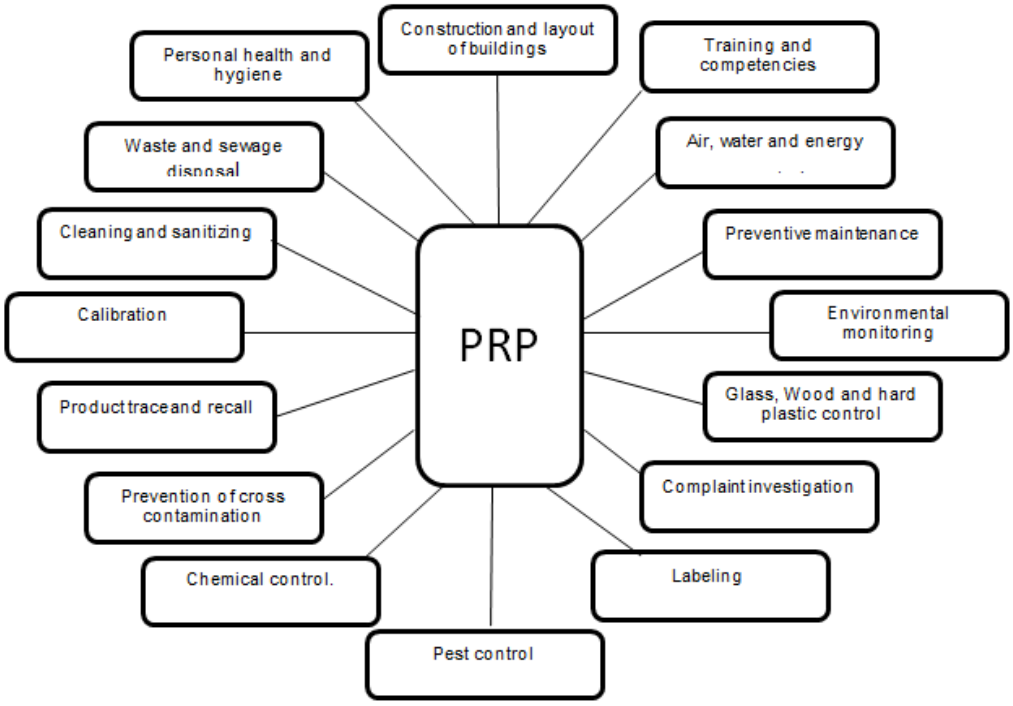

Figure 3. Pre-requisite programs.

Application of HACCP system in strawberries concentrates

Use of the HACCP system: Observing food preparation to identify sources and modes of contamination was part of the HACCP process, which was based on the following seven principles: 1. Conduct a hazard analyses, 2. Identify the critical control points (CCPs), 3, Establish critical limits for preventive measures associated with each identified CCP, 4. Establish CCP monitoring requirements, 5. Establish corrective actions to be taken when monitoring indicates then a deviation from an established critical limit, 6. Establish verification procedures and 7. Establish record-keeping and documentation procedures.

PHYSICAL AND CHEMICAL ANALYSIS OF STRAWBERRY CONCENTRATE

This part of study was planned to through some lights on quality and safety of Strawberry concentrate by three types of sample according to storage period; zero time, 6 months and 12 months, the chemical and physical analysis presented in Table [4].

The Color of the strawberry Pulp samples was characterized objectively

The L*, a* and b* values of a pasteurized non-stored strawberry Pulp were 23.89, 25.26 and 9.36, respectively. After concentrate the results were as follows L*, a* and b* 31.24, 26.94, and 12.20 (at Zero time) [27], Vitamin C: High temperature has effects on vitamin C content, Strawberry pulp has a vitamin C content of 84, while strawberry concentrates have a vitamin C content of 148 (at zero time). and decreased after storage 6 months and 12 months to 125, 115, respectively.

Heavy Metals

The concentrations of heavy metals in strawberry pulp, Fe, Zn and Mn, was 3.1, 0.85 and 2.12 ppm; respectively but As, Cd, Hg and Pb, were negative. Strawberry concentrated Fe,

Zn and Mn, was 4.79, 1.15 and 3.3 ppm; respectively, after storage for 6 months and 12 months the value of Fe decreased after concentration with continued decrease 25%, 9% and 20% of the initial value; respectively. While Zn decreased by 5%, 9% and 24%; respectively and Mn decreased by 22%, 16% and 22% %; respectively.

Table 4. Physical and Chemical Analysis of Strawberry Concentrate

Items	pPul	Concentrate Storage time (Month)		
		0 Time	6M	12M
Chemical Analysis				
Brix	8.00b	16.60a	16.63a	16.65a
PH	3.84c	3.74a	3.72a	3.68a
ACIDITY	0.84c	1.72b	1.75b	1.84a
POSTWICK (cm/30sec.)	14.50a	11.50b	11.50b	11.80b
BLACK SPECS	None	None	None	None
Vitamin C	84d	148a	125b	115c
Color				
L (lightness)	23.88c	31.24b	34.12a	35.49a
a (redness)	25.26a	26.94a	25.45a	25.11a
B (yellowness)	09.36d	12.23c	14.88b	15.90a
Heavy Metals				
Iron Fe	3.10c	4.79a	3.60b	2.88c
Zink Zn	0.85c	1.15a	1.05b	0.80c
Manganese Mn	2.12c	3.30a	2.80b	2.20c
Arsenic As	ND	ND	ND	ND
Lead P b	ND	ND	ND	ND
d Cadmium c	ND	ND	ND	ND
Mercury Hg	ND	ND	ND	ND
Pesticide Residues				
Iprodione	0.01a	ND	ND	ND
Malathion	0.02a	ND	ND	ND
Omethoate	ND	ND	ND	ND
Dimethoate	0.16a	ND	ND	ND

Mean value in row not followed by the same letter are significantly different (P>0.05).

M: month, ND: not detected

Source [18].

Pesticide residues

Defined the Pesticide as chemical substances applied to crops at various stages of cultivation and during the post-harvest storage of crops. The use of pesticides is intended to prevent the destruction of food crops by controlling agricultural pests or unwanted plants and to improve plant quality. Different processing operations like washing, peeling, frying, freezing and cooking of fruits and vegetables can be effectively applied on fruits and vegetables to minimize the risk of pesticides on human health, cooking under open conditions resulted in 85 to 98 percent losses by volatilization. Cooking under closed conditions resulted in hydrolysis with 50 percent of the chlorothalonil being recovered unchanged on the crop [28,29]

The concentrations of pesticides residues found in Strawberry concentrated samples analyzed were lower than the respective EU established MRLs, thus complying with the European legislation and Pesticide residues in food: toxicological evaluations. [30].

Microbiological examination of Strawberry concentrate

Table (5) shown results of microbiological analysis of Strawberry Pulp for Total bacteria count, Yeast & Mold counts were 2.08, 2.48 cfu/cm^2; respectively while E-Coli, Salmonella sp. Hepatitis A Virus and Aflatoxin were not detected both in pulp and concentrates during the storage period.

Table 5. Microbiological examination of Strawberry concentrate

Microbiological Analysis	Microbiological counts (log cfu/cm^2)			
	Concentrate			
	Pulp	0	6M	12M
TBC	2.08a	ND	ND	ND
Y&M	2.48a	ND	ND	ND
E-Coli	ND	ND	ND	ND
Salmonella sp.	ND	ND	ND	ND
Hepatitis A Virus	ND	ND	ND	ND
Aflatoxin (Patulin)	ND	ND	ND	ND

Mean value in row not followed by the same letter are significantly different (P>0.05).

T.B.C : total bacterial counts, Y&M: yeast and mold counts, ND: not detected,

*: Average of three samples

Source [18].

Sensory evaluation of Strawberry concentrate

The sensory quality attributes of reconstituted Strawberry concentrated samples are stated in Table (6).

Table 6. Sensory quality attributes of Strawberry concentrate

	Quality attributes				
Items	Taste	Color	Flavor	Textures	Over all acceptability %
Pulp	9.00a	8.00a	8.00a	9.05a	85.00 a
0 time	8.50a	7.10b	8.35a	7.00cd	81.50 b
6 M	7.25b	7.50ab	7.10b	7.00cd	71.75 c
12M	6.00c	6.55c	5.10c	6.50d	60.00 d
X1	9.00a	8.00a	8.05a	7.45dc	81.25 b
X2	7.50b	7.50ab	7.10b	8.00b	75.00 c

Mean value in column not followed by the same letter are significantly different (P>0.05).

X 1,2 : Samples of competing companies

Appendices and Nomenclature

NASA	National Aeronautics and Space Administration
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration (USA)
HACCP	Hazard Analysis of Critical Control Point
ISO	International Organization for Standardization

CONCLUSIONS

The purpose of the present study was to apply food safety management system as 1SO 22000 and HACCP as a safety tools in concentrated fruit industry; from receiving raw materials (Strawberry & Packaging materials) to produce their final product (Strawberry concentrates). , critical control points were sterilization, packing, and firm closure as well as the presence of (Magnetic trap, pesticide residues at the receiving stage) as Operational Pre-Requisite Program Points : we recommend the need to apply the ISO 22000 system to all fruit concentrates to avoid many health and environmental problems.

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CONFLICT OF INTEREST

Author declares that there is no conflict of interest.

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