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Food Safety Management System Implementation in Manufacturing of Tomato Concentrates and Evaluation of Certain Contaminants in the Final Products

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ABSTRACT

The current work studies the implementation of Food Safety Management System in production of tomato concentrate products and evaluates their content of certain contaminants. The established system was implemented based on the guidelines of the Codex Alimentarius and International Food Safety Standards. After implementation, and to verify the quality and safety of final tomato concentrate products, microbiological tests were carried out and the levels of certain heavy metals using atomic absorption spectrometry and pesticide residues using LC-MS/MS, GC-MS/MS, were evaluated. It was found that, total bacterial, mold & yeast, coliforms and *Staph aureus* counts were less than 10cfu/gm while salmonella was not detected in 25 gm in all the tested products. Heavy metals mean values for Pb, Cd, Cu and Sn in Cold Break tomato concentrates were 0.0111, 0.0162, 3.1822, and 5.5555 mg/kg respectively. The corresponding values were 0.0144, 0.0063, 1.4056 and 8.3333 mg/kg respectively in Hot Break tomato concentrates. While, as and Hg were not detected in all the tested tomato concentrate products. On the other hand, 24 pesticide active ingredients were detected in Cold Break tomato concentrates with levels less than the MRLs except in case of chlorfenapyr (0.03 mg/kg) in one sample, while 19 pesticide active ingredients were detected in the Hot Break tomato concentrates with levels less than the MRLs except in case of chlorpyrifos (0.02 mg/kg) and chlorfenapyr (0.07 mg/kg) in one sample in 2017 season, and propargite (0.04 mg/kg) in two samples in the 2015 season. In general, it could be concluded that the effective implementation of Food Safety Management System in production of tomato concentrates plays a vital role in producing quality and safe products whereas it prevents, eliminates or reduces potential hazards and contaminants to an acceptable level.

Keywords: Food safety, Tomato Concentrates, Contaminants.

Introduction

Implementation of comprehensive food safety management system in food manufacturing sector is a very effective method. It plays a vital role for producing high quality and safe food. Accordingly, this helps in preventing food poisoning and food borne illnesses. Food borne illnesses are any disease of an infectious or toxic nature caused by consumption of food as defined by the WHO, (2008). Food borne diseases are classified into two broad groups namely intoxication and infection. Intoxication is caused by ingestion of toxin produced by pathogens, while infection is caused by ingestion of food containing viable pathogens (Addis and Sisay, 2015). Sanitation and personal hygiene in the food processing and preparation firms reflect the quality and safety of the food item, hence restaurant or food manufacturing or processing plants with poor sanitary conditions contributed to food poisoning outbreak (Abdul-Mutalib *et al.*, 2015). Microbial pathogens cause millions of cases of food borne disease all over the world and result in many hospitalizations and deaths (Mahmoud and Hayajneh, 2015). Beside the microbiological contamination of food, chemicals represent the other main side of food contamination. Heavy metals and pesticide residues are chemical contaminants which can reach the food products through any stage of the food chain from field, through transportation and handling to manufacturing, storage and distribution. Several studies have reported the adverse effects of heavy metals and pesticide residues on human health. Human exposure to toxic chemicals and nutritional imbalances is suspected to be responsible for a wide range of human health disorders (Nasreddine *et al.*, 2006). The term heavy metal refers to any metallic chemical element that has a relatively high

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density and is toxic at low concentrations. Metals are widely distributed throughout nature and freely occur in soil and water. Among the heavy metals mercury, lead, arsenic and cadmium are toxic metals and have mutagenic effects even at very low concentrations. Several cases of human disease, malfunction and malformation of organs due to metal toxicity have been reported (Shaban, Abdou and Hassan, 2016). The other main types of the chemical contaminants of food ingredients or food products are pesticide residues. The concern has been given to pesticide and its effect on public health especially with the globally widely usage. There is a huge body of evidence on the relation between exposure to pesticides and elevated rate of chronic diseases such as different types of cancers and diabetes. There is also circumstantial evidence on the association of exposure to pesticides with some other chronic diseases like respiratory problems, cardiovascular disease, chronic nephropathies, autoimmune diseases, chronic fatigue syndrome, and aging (Mostafalou and Abdollahi, 2013).

Pesticide residues can also lead to many symptoms such as headache, dizziness, body weakness, and itching, burning sensation, catarrh, stomach pain, unconsciousness, itching of eyes and body pains as side effects from pesticides application as reported by Afari-Sefa *et al*. (2015). Nowadays, there are many food safety management systems that are implemented to assure the quality and safety of food throughout the food chain. These systems prevent the food to be a cause of illness, poisoning or any adverse effect on human health. Such systems Food Safety Management System “ISO 22000”, Global Standard for Food Safety of the British Retail Consortium “BRC”, International Featured Standard “IFS Food”, Food Safety System Certification “FSSC 22000” and many other systems aim to implement an integrated and effective procedures. However, the effectiveness of these systems in many food manufacturing firms requires a lot of effort, awareness and full understanding of the requirements from all the employees and food handlers within the institutions in order to ensure the effective implementation and thus assure the quality and safety of the produced products. Tomato (*Solanum lycopersicum L.*) is an important crop cultivated and consumed worldwide. It provides a wide range of nutrients and many health-related benefits to the human body. These nutrients include protein, carbohydrates, fibers, vitamins (C & A, thiamin, niacin and pantothenic), phenolic compounds, lycopene, and minerals as reported by Burton-Freeman and Reimers (2011), Dias (2012), Arah *et al.,* (2015), Makki and Ziarati (2014), Jeffery (2005) and Jafari *et al.,* (2017).

Tomatoes and tomato products are from the most important commodities in Egypt and due to its multiple uses in preparation of many dishes, tomatoes are almost found in every house. Tomatoes are found in different types as tomato paste, tomato puree, pizza sauce, pasta sauce, ketchup, juice as well as fresh fruits and almost daily consumed. On the manufacturing scale tomato fruits are processed to produce tomato concentrates which are produced into two main products Cold Break “C.B” with final concentration of 36-38 Brix degree and Hot Break “H.B” with final concentration of 28-30 Brix degree. These two main tomato products are produced in bulks and used as raw materials for producing tomato based products. Egypt is considered one of the biggest worldwide producers of tomatoes and ranks from the top ten producer countries “the 5^{th}” as reported by the Food and Agriculture Organization “FAO” rankings indicators (FAOSTAT, 2016).

The present study aimed to implement an effective food safety management system based on the requirements of the Codex Alimentarius and International Standards in manufacturing of tomato concentrates and to evaluate their contents of heavy metals and pesticide residues to produce high quality and safe products.

Materials and Methods

Cold Break “C.B” and Hot Break “H.B” tomato concentrate samples were collected in aseptic sample bags from aseptic filler in different days through different seasons (2015, 2016 and 2017) at leading concentrate manufacturing company in Sadat City, Menoufiya, Egypt, and analyzed after sampling.

Food Safety Management System

The Food Safety Management System was implemented based on the Codex Alimentarius guidelines (2003), ISO 22000/2005 standard and British Retail Consortium “BRC 2015” requirements. The scope of this system includes production of tomato concentrates, cold and hot break products. The system consists of three main parts, the managerial requirements procedures, the Prerequisite Programs "PRPs" and the Hazard Analysis Critical Control Point "HACCP" Plan.

Prerequisite Programs "PRPs":

Prior to the Hazard Analysis Critical Control Point "HACCP" system implementation many Prerequisite Programs "PRPs" were developed, documented and implemented to provide good hygienic and sanitary environment. Such programs include, Good Manufacturing Practices "GMP", Personal Hygiene, Sanitation Standard Operating Procedures "SSOP", Pest Control, Preventive Maintenance, Waste Disposal, Product Protection, Operation and Facilities, Transportation and Storage, Layout for workers and Products Movement, Purchasing, Prevention of Cross Contamination, and Recall Procedures.

HACCP Plan:

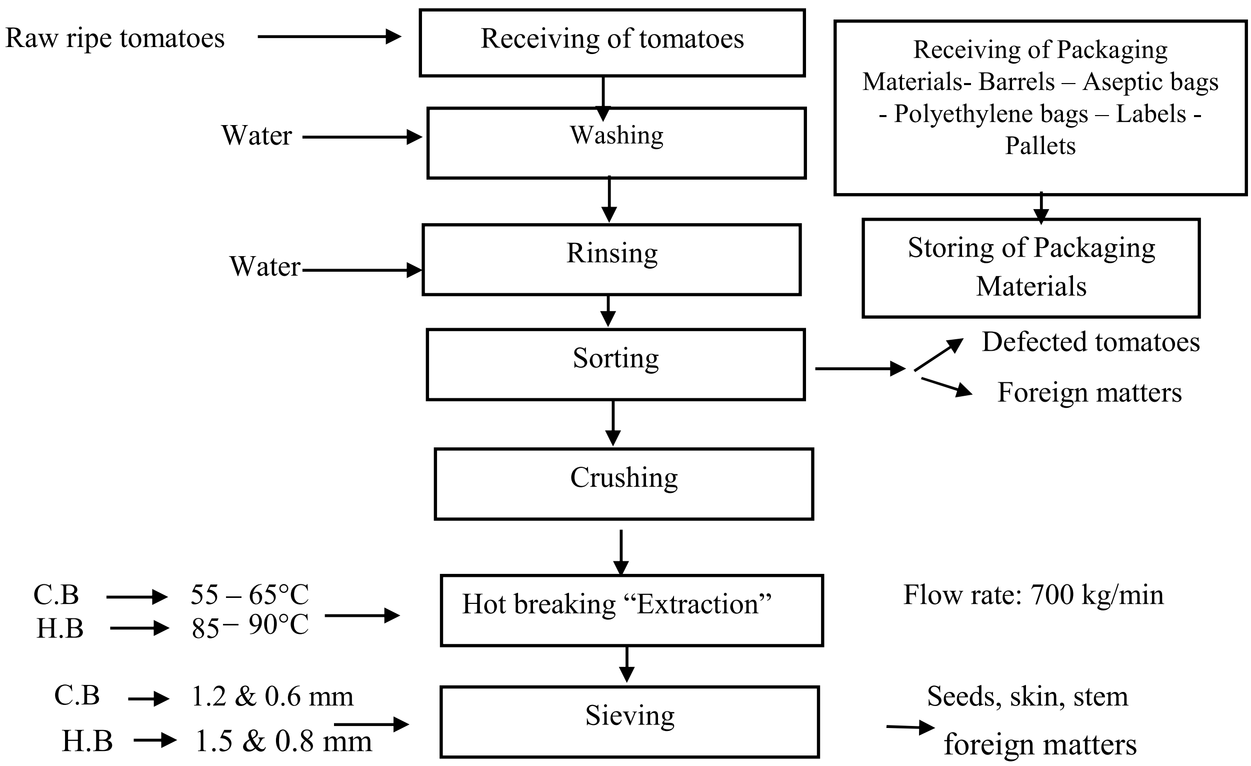
HACCP Plan was implemented based on the Codex Alimentarius (2003) and the International Standards requirements (ISO 22000/2005 – BRC 2015) through 12 steps as follow:

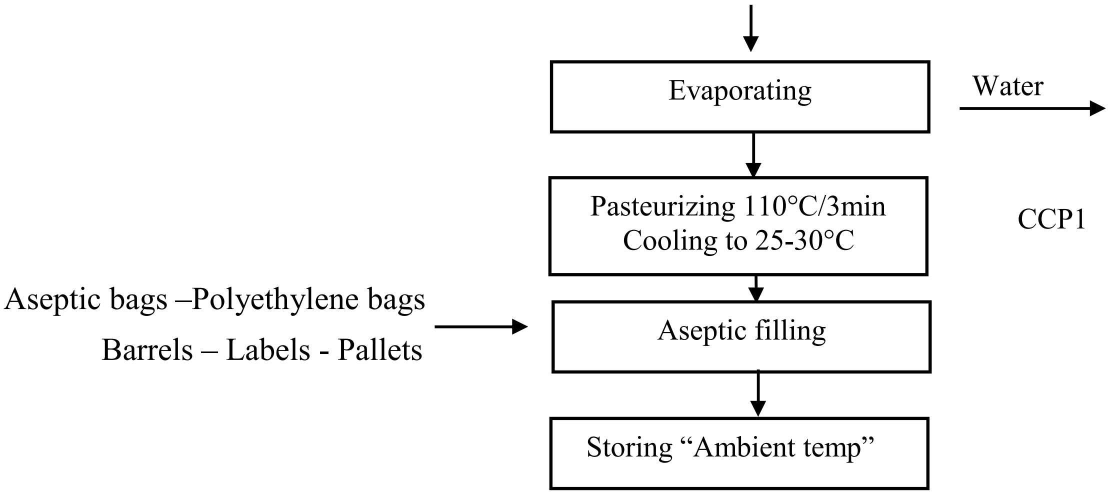
1- Assembly of HACCP team
2- Description of the product
3- Intended use
4- Construction of flow diagram
5- Verification of flow diagram on site
6- Hazard Analysis
7- Determination of Critical Control Points "CCPs"
8- Establishment of Critical Limits
9- Establishment of Monitoring Procedures
10 - Establishment of Corrective Actions
11 - Establishment of Verification Procedures
12 - Documentation and record keeping.

Manufacturing of Tomato Concentrates.

Tomato concentrate products were manufactured through different sequential steps as shown in the following flow chart:-

Fig 1. Tomato Concentrates Manufacturing Flow Chart.





Microbiological Analysis:

Tomato concentrate products (C.B and H.B) were microbiologically tested for aerobic total plat count, mold and yeast count, coliforms, *Staphylococcus aureus*, and Salmonella according the methods described in the international methods for microbiological food and water analysis as follow:-

Aerobic total plat count: ISO 4833-2003, Mold and Yeast count: ISO 21527-2:2008,
Coliforms: ISO 4832- 2006, *Staphylococcus aureus*: ISO 6888-1 1999 &AMD – 1:2003, and Salmonella: ISO 6579-2002.

Chemical Analysis:

Heavy Metals:

Heavy metals, lead (Pb), Cadmium (Cd), Tin (Sn), Mercury (Hg), and Copper (Cu) were analyzed according to the method described by Sepe *et al.* (2003) in foods using Inductively Coupled Plasma Optical Emission Spectrometry "ICP-OES" axialy viewed Perkin Elmer Optima 8000 ICP-OES equipped with a meinhard nebulizer, a glass cyclonic spray chamber and ICP WinLab software Data System after high pressure microwave digestion" using a commercial high-pressure laboratory microwave oven (Milestone Ethos 1600 Microwave Labstation, Sorisole, Italy). While the Arsenic (As) metal was determined by Atomic Absorption Spectrometry after high pressure microwave digestion.

Pesticide residues:

Pesticide residues were determined using Quick and Easy method (QuEChERS) Using LC-MS/MS, GC-MS/MS as described by European Standard Method, EN 15662 (2008) and compared with those of the E.U pesticides data base (last updated 2016).

Statistical analysis:

The mean and standard deviation of the results obtained through seasons of production and system implementation were calculated using MS Excel software.

Results and Discussion:

The implementation of Food Safety Management System (FSMS) in a food producing firm is an effective way to produce a high quality and safe food. The HACCP Plan as a main part of the implemented FSMS for manufacturing of tomato concentrates was developed and implemented based on the Codex Alimentarius guidelines (2003) and the International Standard ISO 22000/2005 and BRC/2015 requirements and can be summarized as shown in Table (1).

Table 1: HACCP Plan Summary for manufacturing of tomato concentrates.

Step CCP	Hazard(s)	Critical Limits	Monitoring Procedure	Corrective Actions	Verification	Records
Pasteurization	Microbiology “pathogenic bacteria”	110°C/3min	Temperature is recorded every 30 min by Quality Control “Q.C” personnel	Re-pasteurize the products	*Review of CCP records *Product testing *Internal audit *HACCP Plan review	CCP Log Sheet

The previous table showed that the pasteurization step was the determined critical control point “CCP” through processing steps which controls the microbiological hazards of the pathogenic microorganisms. The critical limit of pasteurization step was 110°C for 3min. As monitoring procedure, quality control “Q.C” personnel were responsible for recording of the pasteurization temperature each 30 min in the CCP log sheet form. In case of any deviation from the critical limits, filling of the product is stopped and the product is re-pasteurized as a corrective action. The verification procedures included the review of CCP temperature records, product testing, internal auditing and HACCP plan review. The obtained results are compatible with Ameyapoh, *et al.,* (2008) who mentioned that the critical control point (CCP) of tomato puree processing line is the pasteurization stage. Tomato concentrate products C. B and H. B were microbiologically analyzed and the results are shown in Tables (2 & 3). The results show that the total plate count, mold and yeast, coliforms and *Staphylococcus aureus* counts were less than 10cfu/gm while Salmonella was not detected in all the tested products which reveal the efficiency and effectiveness of pasteurization step in controlling the microbiological hazard of pathogenic bacteria. These results are closed to Djadouni, *et al.,* (2015) who indicated that thermal treatment and cold storage inhibited the growth and development of pathogenic microorganisms as salmonella, *S. aureus* and clostridium which were absent in tomatoes and tomato paste, while the obtained results were far lower in total aerobic bacterial count and total Coliform than the results of the same author who determined total aerobic bacterial count and total Coliform by $55x10^5$ and $17x10^5$ cfu/ml respectively. The results are also in agreement with Garg *et al.*, (2013) who reported that Salmonella, *E. coli* and *Staphylococcus aureus* were absents in the tested tomato puree.

Table 2: Microbiological Analysis of Cold Break “C.B” Tomato Concentrate CFU (No. of Cells/gm).

Microorganism	Season 2015	Season 2016	Season 2017
Total Count	<10	<10	<10
Mold &Yeast	<10	<10	<10
Coliforms	<10	<10	<10
Staphylococcus aureus	<10	<10	<10
Salmonella	N.D*/25g	N.D/25g	N.D/25g

*N.D= Not Detected

Table 3: Microbiological Analysis of Hot Break “H.B” Tomato Concentrate CFU (No. of Cells/gm).

Microorganism	Season 2015	Season 2016	Season 2017
Total Count	<10	<10	<10
Mold &Yeast	<10	<10	<10
Coliforms	<10	<10	<10
Staphylococcus aureus	<10	<10	<10
Salmonella	N.D*/25g	N.D/25g	N.D/25g

*N.D= Not Detected

The obtained results also meet the requirements of the Egyptian Standard (2015) of the preserved tomato products – tomato concentrates and the International Food Standards of the Codex Alimentarius (1981) amended (2017).

Chemical Contaminants:

Chemical contaminants such as heavy metals and pesticide residues can transfer to tomatoes and accordingly to tomato based products from the field as a result of improper Good Agricultural

Practices “GAP” and may be through transportation or bad handling in farms or in processing factories as well.

Heavy Metals:

The heavy metals lead, cadmium, arsenic, mercury, copper and tin were analyzed in tomato concentrate products (C.B and H.B). Data in Table (4) showed that the heavy metal range and the mean concentration levels of cold break “C.B” tomato concentrate through seasons of production and system implementation. Lead content ranged from 0.00 to 0.07, cadmium from 0.00 to 0.022, copper from 1.2 to 4.6, tin from 0.00 to 25, while arsenic and mercury were not detected in all the tested products.

Table 4: Heavy Metal Contents (mg/kg) of Cold Break “C.B” Tomato Concentrate

Metal	LOQ	MRLs	Season 2015	Season 2016	Season 2017	Range	Mean ± SD
Lead	0.03	0.1	0.07 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.03	0.00-0.07	0.0111 ± 0.0242
Cadmium	0.005	0.05	0.022 0.013 0.00	0.019 0.015 0.022	0.03 0.02 0.005	0.00-0.022	0.0162± 0.0092
Arsenic	0.03	-	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00	0.00 0.00 0.00
Mercury	0.03	-	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00	0.00 0.00 0.00
Copper	0.5	5	4.6 3.7 3.6	2.9 4 4.2	2 1.2 2.44	1.2-4.6	3.1822± 1.1244
Tin	25	200	0 25 0	0 0 0	25 0 0	0.00 -25	5.5555± 11.0239

Values are mean concentrations ± Standard Deviation ‘SD”, LOQ= Limits of Quantification, MRLs = Maximum Residue Limits based on the ES7136/2010 and EC 1881/2006, Obtained results with values less than LOQ were calculated as LOQ value, (-) No assigned As and Hg MRLs for tomato products in standards.

Table (5) shows the heavy metal range and the mean concentration levels of hot break “H.B” tomato concentrate through seasons of production and system implementation. Lead content ranged from 0.00 to 0.03 with mean of 0.0144± 0.0151 mg/kg, cadmium from 0.00 to 0.017 with mean of 0.0063± 0.0057 mg/kg, copper from 0.00 to 3.6 with mean of 1.4056± 1.4200 mg/kg, tin from 0.00 to 25 with mean of 8.3333± 12.5 mg/kg, while arsenic and mercury were not detected in all the tested products.

From the data summarized in Tables 4 and 5, it could be noticed that the highest metal levels were in tin followed by copper while the lowest levels were in cadmium followed by lead. All the produced products of tomato concentrates have levels of heavy metals less than the maximum residue levels “MRLs” and hence they meet the requirements of the Egyptian Standards (2015) & (2010) and the European Commission (2006) whereas they are lower than the maximum levels recommended by these standards. The obtained results are close to that reported by David *et al.*, (2008) who revealed that lead content ranged from less than detection limit to 2.1 mg/kg, cadmium from 0.007 to 0.017 mg/kg, arsenic less than detection limits, and tin from 4.51 to 12.875 mg/kg in tested tomato paste. The obtained results are also in range of that reported by Erhunmwunse *et al.* (2016) who found that lead content ranged from 0.00 to 0.68 mg/kg, while in the range and slightly higher in copper content (0.35 to 2.01 mg/kg) and cadmium content (0.00 mg/kg, below detection limits). On the other hand, it was lower than the study of Makki and Ziarati (2014) in Lead (0.0932±0.11 mg/kg), cadmium (0.0443±0.054 mg/kg) and Tin (120.011±42.77 mg/kg) concentrations.

Table 5: Heavy Metal Contents (mg/kg) of Hot Break "H.B" Tomato Concentrate.

Metal	LOQ	MRLs	Season 2015	Season 2016	Season 2017	Range	Mean ± SD
Lead	0.03	0.1	0.03 0.03 0.00	0.03 0.03 0.00	0.00 0.01 0.00	0.00-0.03	0.0144± 0.0151
Cadmium	0.005	0.05	0.007 0.009 0.00	0.017 0.009 0.00	0.005 0.00 0.01	0.00- 0.017	0.0063± 0.0057
Arsenic	0.03	-	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00
Mercury	0.03	-	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00
Copper	0.5	5	0.00 0.5 3.6	3.4 0.5 1.95	2.2 0.00 0.5	0.00-3.6	1.4056± 1.4200
Tin	25	200	0.00 0.00 25	0.00 25 0.00	25 0.00 0.00	0.00-25	8.3333± 12.5

Values are mean concentrations ± Standard Deviation 'SD", LOQ= Limits of Quantification, MRLs = Maximum Residue Limits based on the ES7136/2010 and EC 1881/2006, Obtained results with values less than LOQ were calculated as LOQ value, (-) No assigned As and Hg MRLs for tomato products in standards.

Pesticide residues:

Pesticides are used to control insects "insecticides", herbs & weeds "herbicides" and diseases "fungicides" of agricultural crops. The misuses of pesticides lead to contaminate produces and its processed products accordingly. Contaminated products will affect the consumers' health whereas pesticide residues have accumulated effect and their presence with amounts higher than the maximum residue limits will lead to adverse effect on consumer health especially in case of high consumption commodities as tomatoes and tomato based products in Egypt. Hence, this type of hazard should be controlled from the source by implementing Good Agricultural Practices and should be in agreement with the suppliers of commodities. Beside that, processing steps can reduce the level of pesticide residues such processing steps washing, rinsing, cooking, sieving and heating. Tomato concentrate products "CB and HB" were analyzed for more than 400 pesticide active ingredients and the obtained results (detected compounds) are shown in Tables 6 &7.

Data in Table (6) shows the detected active ingredients of pesticide residues in C.B tomato concentrate products through different sequential seasons of processing and system implementation. All the detected pesticide active ingredients had mean concentration values less than the maximum residue limits "MRLs". The mean concentration value of chlorfenapyr (0.0044± 0.0101 mg/kg), a halogenated pyrroles insecticide was higher than the MRL value (0.01 mg/kg) in one sample in the 2015 season only (0.03 mg/kg). While the highest detected value was propamocarb, a systemic fungicide which was 0.1411± 0.1984 mg/kg followed by the fungicide thiophanate-methyl 0.0633± 0.0922 mg/kg through the seasons of processing and system implementation but values were within the accepted limits. The lowest mean concentration values were detected in the insecticides dimethoate and indoxacarb, and the fungicide myclobutanil which were 0.0011± 0.0033 mg/kg for each.

The detected active ingredients of pesticide residues in H.B tomato concentrate product through different sequential seasons of processing and system implementation are shown in Table 7. All the detected pesticide active ingredients had a mean concentration levels less that the maximum residue limits "MRLs" except in one sample for Chlorpyrifos (0.02 mg/kg), an organophosphate insecticide in 2017 season, and for Chlorfenapyr (0.07 mg/kg), a halogenated pyrroles insecticide and in two samples in the 2015 season for propargite which have the same values (0.04 mg/kg), a sulphite ester insecticide, which were higher than the MRLs value (0.01 mg/kg) of the collected samples for each. The highest detected concentration values were Thiophanate-methyl which was 0.2644± 0.3189 mg/kg followed by propamocarb 0.1478± 0.1810 mg/kg through the seasons of processing and system implementation but values were within the accepted limits. Four active ingredients the acetamiprid, indoxacarb, phenthoate and pyridaben out of 19 had the lower concentration levels which were 0.0011± 0.0033 mg/kg for each.

Table 6: Pesticide Residues Contents of Cold Break "C.B" Tomato Concentrate (mg/kg).

Pesticide residue	LOQ*	MRLs**	Season 2015	Season 2016	Season 2017	Range (mg/kg)	Mean ± S.D
Acetamiprid	0.01	0.5	0.00 0.00 0.00	0.02 0.01 0.01	0.02 0.01 0.01	0.00-0.02	0.0089± 0.0078
Azoxystrobin	0.01	3.0	0.01 0.00 0.00	0.01 0.00 0.01	0.00 0.00 0.01	0.00-0.01	0.0044± 0.0053
Bifenazate	0.01	0.5	0.00 0.00 0.00	0.04 0.00 0.00	0.00 0.00 0.00	0.00-0.04	0.0044± 0.0133
Boscalid	0.01	3.0	0.02 0.00 0.01	0.02 0.00 0.00	0.01 0.00 0.00	0.00-0.02	0.0067± 0.0087
Carbendazim	0.01	0.3	0.04 0.00 0.04	0.00 0.03 0.01	0.00 0.04 0.01	0.00-0.04	0.0189± 0.0183
Chlorpyrifos	0.01	0.01	0.01 0.00 0.01	0.01 0.01 0.00	0.00 0.01 0.00	0.00-0.01	0.0056± 0.0053
Chlorfenapyr	0.01	0.01	0.03 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.00	0.00-0.03	0.0044± 0.0101
Cypermethrin	0.01	0.5	0.01 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0022± 0.0044
Difenoconazole	0.01	2.0	0.01 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.01	0.00-0.01	0.0033± 0.005
Dimethoate	0.01	0.01	0.00 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Dimethomorph	0.01	1.0	0.02 0.00 0.01	0.00 0.00 0.01	0.01 0.00 0.01	0.00-0.02	0.0066± 0.0071
Enrofloxacin	0.01	-	0.00 0.00 0.01	0.00 0.00 0.00	0.01 0.00 0.00	0.00-0.01	0.0022± 0.0044
Flubendiamide	0.05	0.2	0.00 0.00 0.02	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.02	0.0022± 0.0067
Imidacloprid	0.01	0.5	0.02 0.00 0.00	0.01 0.00 0.02	0.00 0.00 0.02	0.00-0.02	0.0078± 0.0097
Indoxacarb	0.01	0.5	0.01 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Lambada-Cyhalothrin	0.01	0.1	0.00 0.00 0.00	0.02 0.01 0.00	0.00 0.00 0.00	0.00-0.02	0.0033± 0.0071
Metalaxyl	0.01	0.2	0.01 0.00 0.02	0.01 0.01 0.00	0.02 0.00 0.00	0.00-0.02	0.0078± 0.0083
Myclobutanil	0.01	0.3	0.00 0.00 0.01	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Phenthoate	0.01	-	0.01 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0022± 0.0044
Profenofos	0.01	10	0.05 0.00 0.01	0.06 0.01 0.00	0.01 0.00 0.00	0.00-0.06	0.0155± 0.0229
Propamocarb	0.01	4.0	0.35 0.00 0.43	0.03 0.03 0.00	0.43 0.00 0.00	0.00-0.43	0.1411± 0.1984
Propargite	0.01	0.01	0.01 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0022± 0.0044
Pyridaben	0.01	0.3	0.01 0.00 0.00	0.01 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0022± 0.0044
Thiophanate-methyl	0.01	1.0	0.29 0.00 0.08	0.06 0.06 0.00	0.08 0.00 0.00	0.00-0.29	0.0633± 0.0922

*LOQ= limits of quantification, **A maximum residue level (MRL) based on EU Pesticides Database last update 2016.

Table 7: Pesticide Residues Contents of Hot Break "H.B" Tomato Concentrate (mg/kg).

Pesticide residue	LOQ*	MRLs**	Season 2015	Season 2016	Season 2017	Range	Mean ± S.D
Acetamiprid	0.01	0.5	0.00 0.00 0.01	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Azoxystrobin	0.01	3.0	0.00 0.01 0.02	0.00 0.00 0.00	0.01 0.00 0.00	0.00-0.02	0.0044± 0.0073
Boscalid	0.01	3.0	0.02 0.02 0.01	0.01 0.00 0.02	0.01 0.00 0.01	0.00-0.02	0.0111± 0.0078
Carbendazim	0.01	0.3	0.12 0.04 0.02	0.08 0.00 0.12	0.04 0.00 0.08	0.00-0.12	0.0556± 0.0467
Chlorpyrifos	0.01	0.01	0.01 0.01 0.00	0.01 0.00 0.01	0.02 0.00 0.01	0.00-0.02	0.0078± 0.0067
Chlorfenapyr	0.01	0.01	0.00 0.01 0.00	0.01 0.00 0.00	0.07 0.00 0.01	0.00-0.07	0.0111± 0.0226
Cypermethrin	0.01	2.0	0.00 0.00 0.00	0.03 0.00 0.00	0.00 0.00 0.03	0.00-0.03	0.0067± 0.0132
Difenoconazole	0 .01	3.0	0.00 0.01 0.00	0.01 0.00 0.00	0.03 0.00 0.01	0.00-0.03	0.0067± 0.01
Dimethomorph	0.01	1.0	0.00 0.00 0.00	0.02 0.00 0.00	0.03 0.00 0.02	0.00-0.03	0.0078± 0.0120
Imidacloprid	0.01	0.5	0.00 0.00 0.02	0.01 0.00 0.00	0.03 0.00 0.01	0.00-0.03	0.0078± 0.0109
Indoxacarb	0.01	0.5	0.00 0.01 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Lambada-Cyhalothrin	0.01	0.1	0.01 0.00 0.00	0.01 0.00 0.01	0.01 0.00 0.01	0.00-0.01	0.0056± 0.0053
Metalaxyl	0.01	0.2	0.02 0.02 0.01	0.01 0.00 0.02	0.01 0.00 0.01	0.00-0.02	0.0111± 0.0078
Phenthoate	0.01	-	0.00 0.00 0.00	0.00 0.00 0.00	0.01 0.00 0.00	0.00-0.01	0.0011± 0.0033
Profenofos	0.01	10	0.00 0.00 0.00	0.05 0.00 0.00	0.03 0.00 0.05	0.00-0.05	0.0144± 0.0224
Propamocarb	0.01	4.0	0.09 0.00 0.35	0.40 0.00 0.09	0.00 0.00 0.40	0.00-0.40	0.1478± 0.1810
Propargite	0.01	0.01	0.00 0.04 0.04	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.04	0.0089± 0.0176
Pyridaben	0.01	0.3	0.00 0.01 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00-0.01	0.0011± 0.0033
Thiophanate-methyl	0.01	1.0	0.75 0.53 0.09	0.12 0.00 0.75	0.02 0.00 0.12	0.00-0.75	0.2644± 0.3189

*LOQ limits of quantification, **A maximum residue level (MRL) based on EU Pesticides Database last update 2016.

The obtained results are lower than that of Kariathi *et al.,* (2017) for chlorpyrifos, chlorfenapyr, cypermethrin, dimethoate and profenofos. But lower than that of (Kwon *et al.*, 2015) for thiophanate-methyle (0.18±0.04 mg/kg) in C.B but higher than in H.B tomato paste. The mean concentrations of chlorpyrifos are in the same range of Chavarri *et al.*, (2005) which were less than 0.004 mg/kg for tomato puree and (Yalçin and Turgut, 2016) which were ranged from ND to 0.4 mg/kg in tomatoes.

The low level of pesticide residues in both the C.B and H.B tomato concentrates attributed to the low levels in the received tomatoes from suppliers and the contracted farms whereas the company started its own planting which based on complete program including the pests and diseases control programs and the pesticide monitoring. Beside that the processing steps which included washing, rinsing, sieving and heating may have led to the reduction of the levels of pesticides.

Levels of some systemic pesticides present in tomato pulp can be decreased by decomposition or vaporization, but levels of others may not be reduced by boiling, the effect of which is dependent on the physicochemical characteristics of pesticides (Kwon *et al.*, 2015). In most cases, canning operations led to a gradual decrease in residue levels in the finished products, particularly through washing, blanching, peeling and cooking processes (Chavarri *et al.,* 2005).

The obtained results reveal the effectiveness of the Food Safety Management System in controlling the Food Safety Hazards and in producing of high quality and safe foods.

An important note in this study is that there are many pesticides with different active ingredients are used through tomato planting but not found in the list of pesticide active ingredients of the Codex Alimentarius standards for tomato and tomato products (Paste) which draw the attention to the need to standardize the actually used pesticides.

Conclusion:

The effective implementation of Food Safety Management System in production of tomato concentrates plays a vital role in producing high quality and safe products whereas it prevent**s**, eliminate**s** or reduce**s** potential hazards and contaminants to an acceptable level.

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