

Application of the HACCP System during the Production of Tomato Paste

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Abstract

Food Safety is a fundamental public health concern, and achieving a safe supply poses major challenges for organisations involved in the food chain. A wide number of food borne hazards, both familiar and new, pose risks to health and obstructions to international trade in foods. These hazards must be properly analysed, assessed and managed to meet growing and increasingly complex sets of global food chain. Proper implementation of food hygiene principles across the food chain in conjunction with Hazard Analysis and Critical Control Points system will ensure food safety. In this study, microbiological, pesticide residuals and heavy metals qualities of a tomato (*Lycopersicon esculentum*) paste (36-38%) production line (ripe tomato, washing, sorting, crushing, refining, concentrating, sterilization and aseptic filling) and its preservation in UCI company was studied using the HACCP method. Samples generated during the steps described previously were analyzed by determining microbiological characteristics. Samples were analyzed for total aerobic bacterial count, coliform count and yeast & mould count. The microorganisms involved in spoilage of products were *E. Coli*, *Bacillus*, *Staphylococcus*, *Salmonella* and *Clostridium* bacteria. Results of the critical control points (CCPs) of tomato paste processing line. The analysis of selected microbiological parameters during production tomato paste that was down gradually until get the finally product within agreement for the Egyptian Standards. The preserved tomato paste exhibited a pesticide residue was lower than those presented in the Egyptian and the EU Standards. On the other hand, Results of heavy metals was not detected for finally proudeted.

Key words: Hazard analysis, HACCP, tomato paste, Microbiological qualities, Heavy metals, Pesticide residues, critical control points, CCPs.

Introduction

HACCP is defined as a system that identifies, evaluates and controls of hazards which are significant for food safety. HACCP was first designed by the Pillsbury Company, together with NASA and the US Army Laboratories at Natick (Motarjemi, 2013). They developed the HACCP system to ensure the safety of food for astronauts. For many years after its adoption by NASA, the system was accepted by international organizations such as the World Health Organization and was applied on a voluntary basis in certain food industries (Motarjemi *et al.*, 1996).

In 1993, the Codex Alimentarius Commission embraced the HACCP system as a powerful tool to improve food safety and established the Codex guidelines for the Application of the HACCP system. This had major implications on the widespread implementation of the HACCP system. In 1995, with the establishment of the World Trade Organization (WTO) and the coming into force of the Agreement on Sanitary and Phytosanitary Measures, the work of Codex guidelines and recommendations became the international reference for national requirements in food safety. This suggested that WTO member states needed to take the work of the Codex Alimentarius into consideration and align their national legislation with the provisions of the Codex Alimentarius Commission. This meant that automatically, the application of the HACCP system became an international requirement for food safety assurance.

Currently, the principles of HACCP are found in the national legislation of many countries, (ISO, 2005).

Food quality assurance systems of one sort or another are necessary at every segment of the food chain and in every sector of the food industry to ensure the quality and safety of food. On the one hand governments have the responsibility of establishing the standards, legislation and enforcement programs necessary to control food quality and safety. On the other hand, industry has the responsibility on implementing quality assurance systems, including HACCP, where necessary to ensure compliance with the standards and legislation, Orriss and Whitehead (2000).

Food safety is of paramount importance. The World Health Organization (WHO), recognizing that unsafe food has great health and economic consequences, has from its inception promoted food safety. The conventional approach to ensuring food quality and safety, which depends on inspection and testing of end products, has proved to be inadequate in controlling food-borne disease outbreaks. This may be particularly so in the case of traditional foods, because of their diversity and the great number of personnel involved in their production. A new approach seems to be needed. The HACCP system, which is based on training, developing systems for food hygiene and safety, and monitoring/auditing to confirm proper implementation, has evolved into the system of choice internationally to ensure food safety. The HACCP system identifies, evaluates and controls hazards that

are significant for food safety, is logical, practical and preventive in nature, and may be implemented at all stages of the food production process, (**Codex Alimentarius Commission, 2003**).

The use of HACCP by food establishments as a methodology to assure the safety of food is increasing worldwide. Although the fundamentals of HACCP have been constant, the application of HACCP continues to be refined to meet the challenges of a dynamic food system. These changes can be seen in the impact on government regulations affecting the industry. Establishments must then work with the government agencies to define how these regulatory actions will impact their operations and refine what they do in order to comply, **Garcia, (2009)**.

Tomato represents an essential part of human diet, it is a good nutritional resource rich in vitamin C and antioxidant mainly lycopene, carotenes, organic acids and phenolics (**Giovanelli and paradise, 2002**).

The cultivated tomato (*Lycopersicon esculentum Mill*) is a member of the night shade family solanaceae. The genus *Lycopersicon*, comprises of nine species (**Wikipedia, 2013**). The tomato is consumed mainly for its contribution to provide provitamin A. This pigment responsible of the red color of tomatoes is mainly present in two forms: Lycopene and Beta carotene these are two powerful antioxidants involved in cellular detoxification process and help in preventing various cancers (**Agarwal and Rao, 2000; Gerber, 1999 and Giovannucci, 1999**).

The total area of tomato cultivated in Egypt was 208189 feddans yielding an annual production of about 3487345 tons in 2011 (Statistical Agricultural Administration, Ministry of Agriculture, Egypt).

The soluble solids content is important preserving factor. The refraction of tomato is used for determination of maturity and suitability for tomato paste production because it affected spending of tomato at concentration on various concentrated tomato paste. The soluble solids content is one of the most important quality parameters in processing tomato. 50 to 65 % of soluble solids contents are sugars, glucose and fructose and their amount and proportion influences the organoleptic quality of tomatoes (**Adedeji et al., 2006**). The remaining soluble solids are mainly citric and malic acids, lipids and other components in low concentrations.

The aim of present work was to assess the microbiological, heavy metals and pesticide residues qualities of tomato paste production line using the HACCP system.

Materials And Methods

2.1.Materials:

The fresh raw fruit and vegetable used throughout this study were:

2.1.1.Tomato (*Lycopersicon esculentum*): Vegetable at ripe stage were obtained from Ismailia Governorate, Egypt.

Technological treatments:

a- Tomato paste (36: 38° Brix) cold break extraction at UCI company:

The tomato paste cold break extraction was manufactured and processed at UCI Company in Badr city, Cairo, Egypt. The cold break processing was applied for preparing the tomato paste 36: 38 ° Brix.

2.2.Methods:

2.2.1.HACCP approach:

The term "HACCP plan" implies the Codex HACCP methodology (**Codex Alimentarius Commission, 1999**)

2.2.2.Application of HACCP system:

Horchner et al., (2006) recommended these steps to apply the HACCP system.

2.2.3.Microbiological examination:

Ten grams of each food sample was added to a culture medium/diluent (1:10 and homogenized for 2 min in a Stomacher), in agreement with standard methods for total microbial count (**ISO 4833:2013-1 protocol**), Yeast & mould count (**ISO 21527-2:2008**), coliforms (**ISO 21528-2:2004**), *E. coli* (**ISO, 16649-2:2001**) and *staphylococci* (**ISO 6888-1:1999; 2003**), *Bacillus cereus* (**ISO 7932:2004**), *Clostridium count* (**ISO 7937:2004**) and twenty five grams of each food sample was added to a culture medium/diluent (1:10 and homogenized for 2 min in a Stomacher), *Salmonella* (**ISO 6579:2002**). Hepatitis A Virus (**ISO-TS 15216-2:2013**). were isolated and enumerated at each of the five steps of tomato paste production line and product preservation.

2.2.4. Determination of Heavy metals:

In tomato paste samples by using, Atomic absorption spectrometry after wet digestion according to **A.O.A.C (2016)**.

2.2.5.Pesticide Residues (QuEChERS Method):

Method description: Quick and Easy Method (QuEChERS) for Determination of Pesticide Residues in Foods Using GC-MS according to **European Standard Method EN 15662:(2008)**.

Results and Discussion

3.1. HACCP plan for tomato paste (Brix: 36-38%) processing line:

3.1.1. Assemble the HACCP team (Step1):

A multidisciplinary group of individuals are established to carry out HACCP studies; the team is comprised of different departments all of the HACCP team members have the training HACCP prerequisites, studying and implementation. The HACCP team has technical knowledge of the process covered by the HACCP study, knowledge of hazards associated with malting and experience within the scope of hazard analysis, developing HACCP plans, implementing

and reviewing HACCP. The team (team leader, deputy team leader and members) as well as the supporting functions have been officially assigned by the plant manager, and the team organization has been communicated through the plant to department & section heads. Training Records for the HACCP team should be available.

Team members away from their job responsibilities have the responsibilities of product description developing, updating the HACCP study, determining CCPs /PRP with their critical limits monitoring procedures and corrective action, verifying the flow charts and notify the rest of the team and meet to discuss/review the previously mentioned issues; this meetings are conducted as minimum once per quarter and whenever needed in case of any issue threatening the food safety of the product and/or after any process changes to decide whether it will affect food safety or not.

The HACCP team leader lead and direct the HACCP team meeting to conduct the hazard analysis, follow up the results of monitoring, review, internal audit, HACCP Complaints and any food safety related issues.

The core HACCP team includes Quality Assurance manager, Production manager, Engineering manager, QC sec. head, Microbiologist, Warehouse Keeper and HACCP Consultant (Expert).

3.1.2. Product description (Steps 2) & Identify intended use (Step 3):

Tomato paste product is a natural product, manufactured with fresh tomatoes, healthy and mature, which are washed, sorted, crushed, refined, concentrated, sterilized and filled in an aseptic bags to ensure safety and conservation. This product does not contain flavorings, preservatives or others. All the equipment and processes involved in the preparation of the product accomplish with strict sanitary conditions and with all current and applicable laws of General Principles of Foods Hygiene “Codex Alimentarius”, Hazard Analysis and Critical Control Points (HACCP) and Good Manufacturing Practices (G.M.P.). Product information.

3.1.3. Construct flow diagram (Steps 4) & On-site verification of flow diagram (Step 5):

The process flow diagram provided is a detailed description of the process to help the HACCP team carry out the hazard analysis. The process flow diagram of tomato paste (36-38%) prepared and assured that, it cover all process steps of product from first step to final product, including re-work routes. The HACCP team has confirmed that the on-site

process steps match the diagrams in plant on tomato paste (36-38%) processing line flow diagram **Figure (1)**.

3.1.4. Principle 1: Conduct a hazard analysis (Step 6):

Hazards analysis for tomato paste (36-38%) processing steps was conducted. The potential hazards (physical, chemical and biological) associated with tomato paste (36-38%) production at all steps, and the preventive measures for their control were identified.

a) Physical hazards:

The physical hazards associated with fresh tomato fruits were identified and the obtained results were as follow:

- Unripe Fruits: 1.35%
- Unripe Fruits (Yellow): 3.25%
- Unripe Fruits (Green): 0.50%
- Mechanical Damage: 1.80%
- Sunburn: 0.75%
- Pest Damage: 1.50%
- Small Fruits (> 40 mm): 2.10%
- Moldy Fruits: 0.30%
- Insects fragments represent: 0.25%
- Sand%: 0.20%
- Plant parts represent from tomato tree: 0.30%
- Critical Harmful Foreign Bodies (Physical Hazards): Zero

These results are within limits of the fresh tomato fruits specification (internal standard).

b) Chemical Hazards:

Fresh Tomato fruits and Tomato paste (36-38%) was mainly examined for pesticides residual and five heavy metals (Cadmium, Arsenic, Lead, Mercury, and Tin).

1) Pesticide residues:

The pesticides are dangerous and toxic to human health, any pesticide residues remaining in fruits and vegetables can pose hazard to humans and cause confident diseases. It is important to classify and measures the pesticide residues which can be swallowed by fruits and vegetables after treatment with pesticides spray.

Fresh tomato fruits and tomato paste (36-38%) a finished product were analyzed for chlorfenapyr, fludioxonil, cypermethrin, lambda-Cyhalothrin, chlorpyrifos-Methyl and pyridaben pesticide residues are followed during the processing steps of tomato paste. The obtained results are hereafter showing in **Table (1)** revealed that pesticide residues contents were lower than those presented in the **Egyptian Standard (132-1/2015)** for the maximum limits of pesticide residues in foods and **the EU MRLs (EC No. (396/2005)**.

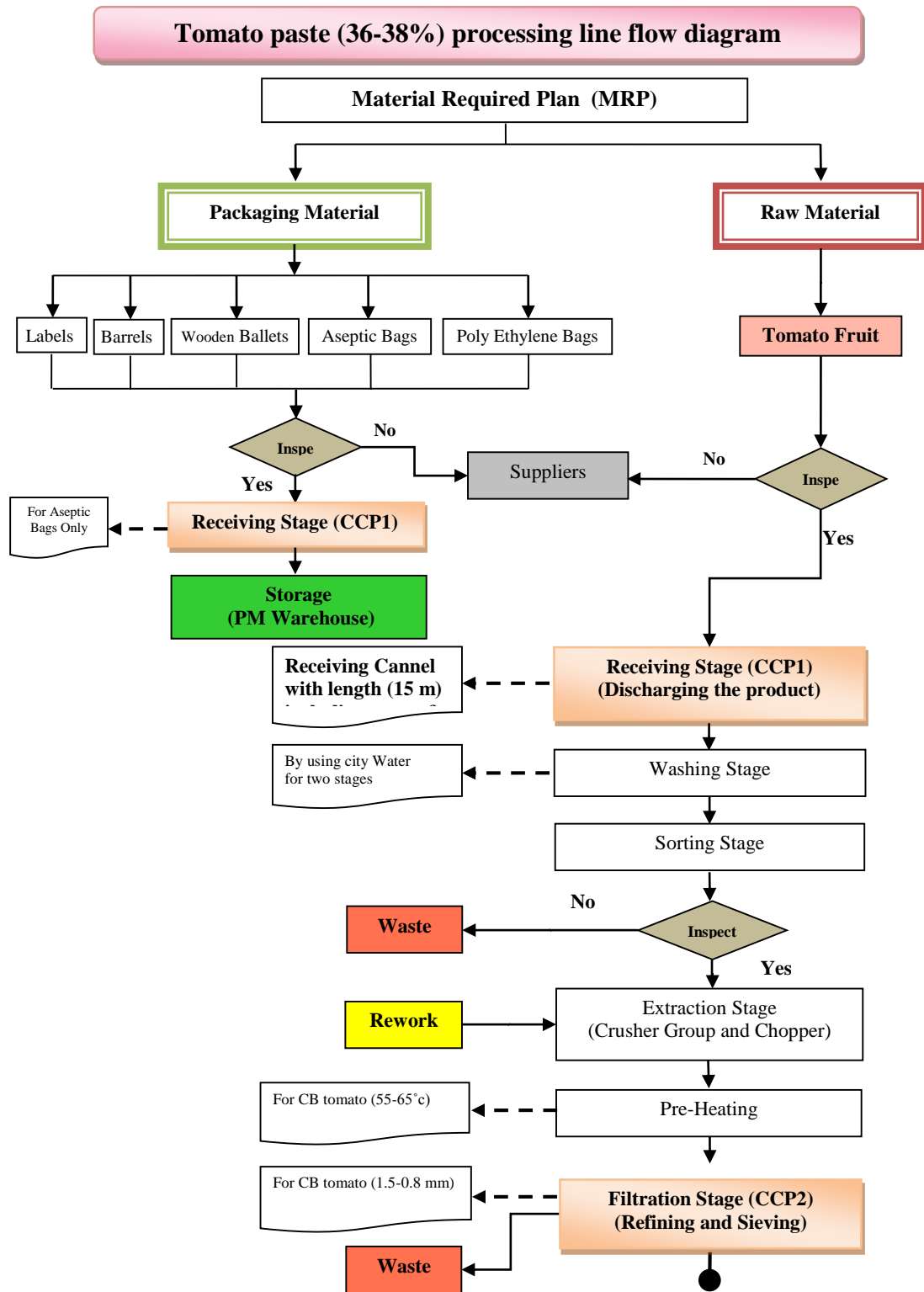


Figure (1): Tomato paste (36-38%) processing line flow diagram

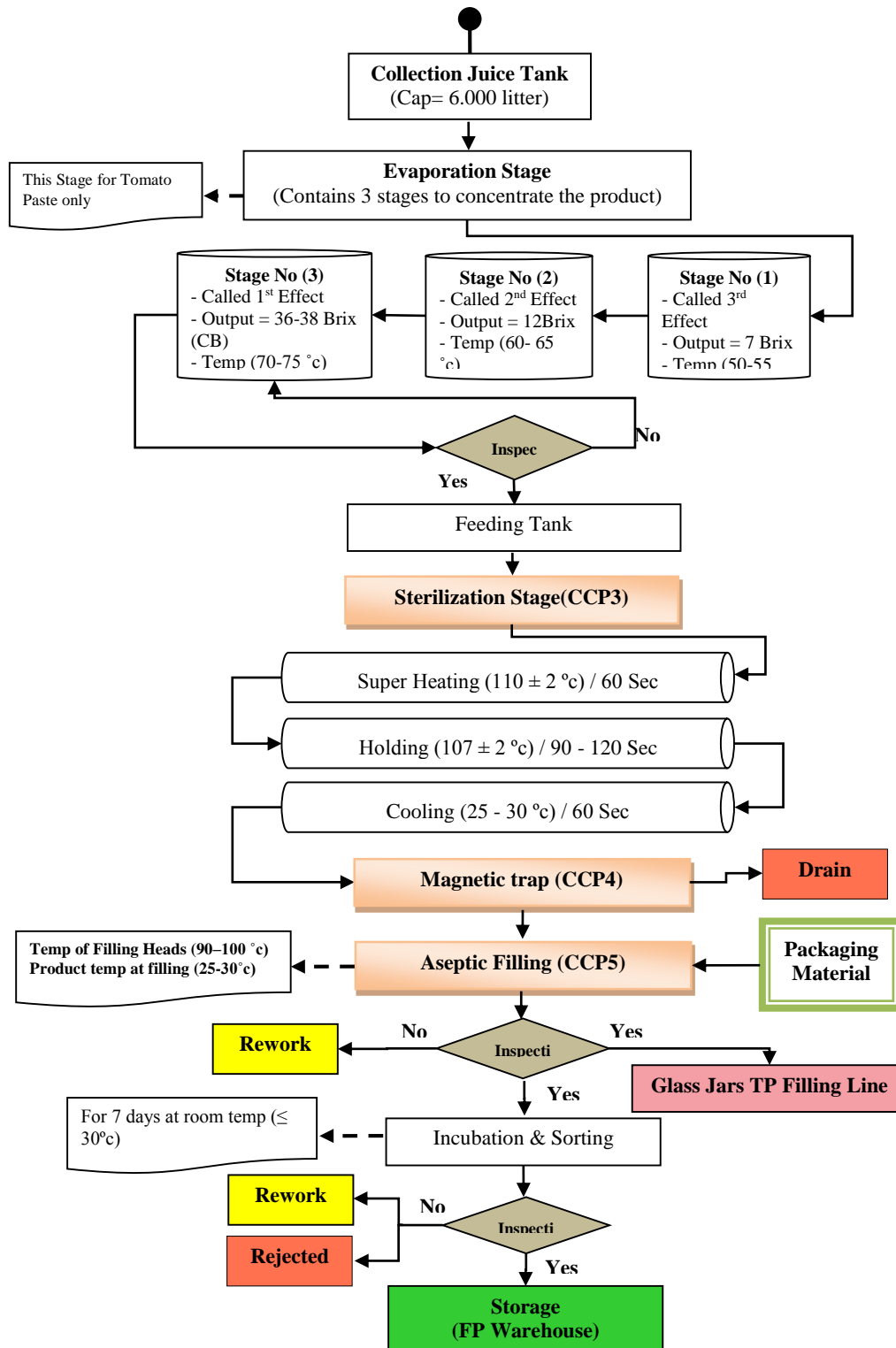


Figure (1): Continued - Tomato paste (36-38%) processing line flow diagram

Table 1. Pesticide residues in fresh tomato fruits and tomato paste (36-38%).

| Components | Unit of measurement | Fresh tomato fruits | | | Tomato paste (36-38%) | | |
|---------------------|---------------------|---------------------|-------|-------|-----------------------|-------|-------|
| | | *S. 1 | S. 2 | S. 3 | S. 1 | S. 2 | S. 3 |
| Chlorfenapyr | mg/kg | 0.010 | - | - | 0.010 | - | - |
| Fludioxonil | mg/kg | 0.010 | - | - | < LOQ | - | - |
| Cypermethrin | mg/kg | 0.010 | < LOQ | 0.020 | 0.010 | < LOQ | 0.010 |
| Lambda-Cyhalothrin | mg/kg | - | - | 0.010 | - | - | < LOQ |
| Chlorpyrifos-Methyl | mg/kg | - | - | < LOQ | - | - | < LOQ |
| Pyridaben | mg/kg | - | < LOQ | - | - | < LOQ | - |

N/D: Not Detected, < LOQ: Lower of quantity, * S.: Sample no.

2) Heavy metals:

Fresh tomato fruits and tomato paste (36-38%) a finished product were analyzed for cadmium, lead, tin, mercury and arsenic heavy metals are followed during the processing steps of tomato paste.

The obtained results are hereafter showing in **Table (2)** revealed that heavy metals contents were not detected than those presented in the **Egyptian Standard (2360/2007)** for the maximum limits of heavy metals in foods.

Table 2. Heavy metals in fresh tomato fruits and tomato paste (36-38%):

| Components | Unit of Measuring | **CCP1 | #Tomato paste (36-38%) |
|------------|-------------------|--------|------------------------|
| Cadmium | mg/kg | 0.02* | N/D |
| Lead | mg/kg | N/D | N/D |
| Tin | mg/kg | < LOQ | < LOQ |
| Mercury | mg/kg | N/D | N/D |
| Arsenic | mg/kg | N/D | N/D |

N/D: Not Detected, < LOQ: Low of quantity

* Each values from 3 samples at 3 different time at zero time, 2 hours and 4 hours of the production shift .

** CCP1: Fresh tomato fruits, # Tomato paste (36-38%): as a finished product.

3) Genetically Modified Organism (GMO):

Fresh tomato fruits & Tomato paste (36-38%) was determined for GMO (P-FMV), GMO (T-NOS), and GMO (35S); the obtained results could be noticed that all results were not detected (ND).

c) Biological Hazards:

Biological Hazards were evaluated by testing samples of raw (fresh) tomato fruits microbiologically for total aerobic bacterial count, mold and yeast, coliform group, *E. coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridia sp.*, and *Salmonella sp.* as well as through every processing steps along the processing line of tomato paste (36-38%) to identify the biological hazards that might associate with the final Products and the results are shown in **Table (3)**. The obtained results revealed that the fresh tomato fruits was contaminated with pathogenic bacteria (Coliform, *E. coli*, *Staphylococcus aureus*, *Clostridia sp.*, *Bacillus cereus* and *Salmonella sp.*), but the tomato fruits after washing was still contaminated with pathogenic bacteria without *salmonella sp.*. The tomato juice after preheating (at 65 °C), refinement and the tomato paste before sterilization were free from pathogenic bacteria.

* Hepatitis A virus:

Fresh tomato fruits & Tomato paste (36-38%) was determined for Hepatitis A virus; the obtained results are shown in **Table (3)**. It could be noticed that the result was not detected (ND).

3.1.5. Principle 2: Determine Critical Control Points (CCPs) (Step 7):

Critical control points (CCPs) in the production processes of tomato paste (36-38%) were identified through the use of a CCP decision tree (NACMCF, 1998). **Figure (2)** and are shown in **Sheet (1)**.

3.1.6. Principle 3: Establish critical limits for each CCP (Step 8):

The critical limits were the Egyptian Standards, Codex, and EU Standards for raw and packaging materials and final product. Whereas, the critical limits for manufacturing steps were the legal limits which admitted by the HACCP team. The established critical limit for CCP1, CCP2, CCP3, CCP4, and CCP5 were established and shown in **Sheet (1)**.

Table 3. Microbiological analysis of tomato during the CCPs on tomato paste (36-38%) processing line (on wet weight basis):

| Components | Reference Methods | CCP1 | CCP2 | CCP3 | CCP4 | CCP5 | Tomato paste (36-38%) |
|---|-----------------------|------------------------|----------------------|----------------------|------|----------|-----------------------|
| Total aerobic bacterial count <i>cfu/g</i> | ISO 4833:2013 | 6.10×10 ⁷ * | 5.50×10 ⁵ | 3.80×10 ³ | ---- | <10 | <10 |
| Yeast & mould count <i>cfu/g</i> | ISO 21527-2:2008 | 8.25×10 ⁴ | 4.50×10 ³ | 5.10×10 ² | ---- | <10 | <10 |
| Coliform count <i>cfu/g</i> | ISO 21528-2:2004 | 43 | <10 | <10 | ---- | <10 | <10 |
| <i>Escherichia coli</i> detection <i>cfu/g</i> | ISO 16649-2:2001 | Positive | Negative | Negative | ---- | Negative | Negative |
| <i>Bacillus cereus</i> <i>cfu/g</i> | ISO 7932:2004 | 23 | <10 | <10 | ---- | <10 | <10 |
| <i>Staphylococcus aureus</i> detection <i>cfu/g</i> | ISO 6888-1:1999; 2003 | Positive | Negative | Negative | ---- | Negative | Negative |
| <i>Clostridium</i> count <i>cfu/g</i> | ISO 7937:2004 | 13 | <10 | <10 | ---- | <10 | <10 |
| <i>Salmonella</i> detection <i>cfu/ 25 g</i> | ISO 6579:2002 | Negative | Negative | Negative | ---- | Negative | Negative |
| Hepatitis A Virus <i>cfu/g</i> | ISO-TS 15216-2:2013 | Negative | ===== | ===== | ---- | ===== | Negative |

*Each values from 3 samples at 3 different time at zero time, 2 hours and 4 hours of the production shift .

CCP1: Receiving Fresh tomato fruits, CCP2: Tomato juice after filtration stages, CCP3: Tomato paste during sterilization stage, CCP4: Tomato paste after magnetic trap, CCP5: Tomato paste after aseptic filling stage and Tomato paste (36-38%): as a finished product.

3.1.7. Principle 4: Establish CCP monitoring requirements (Step 9):

Monitoring procedures for each CCP through tomato paste (36-38%) processing line were established as shown in **Sheet (1)**. Monitoring procedures included the following work sheets were developed for monitoring of each CCP processing steps of tomato paste (36-38%).

3.1.8.

Principle 5: Establish corrective actions (Step 10):

Corrective actions to be taken when monitoring results show any deviation from the established critical limits at a CCP through tomato paste (36-38%) processing steps were developed and shown in **Sheet (1)**. Corrective action work sheet was developed for recording the non-conformities and the corrective action needed.

3.1.9 Principle 6: Establish verification procedures (Step 11):

Verification procedures were established to verify that HACCP system is working correctly through tomato paste (36-38%) processing.

HACCP team is responsible for verification of HACCP system and that will achieve through:-

- Ensure that the HACCP plan is functioning effectively.
- Review of records, accuracy, and non-compliance and corrective actions taken.
- Equipment and utility checks e.g. temperature
- Audit the supplier for adherence to guarantee.
- Calibration of monitoring sensors and devices.
- Samples inspection to validation with Iron Ped-dles.
- Microbiological finished product testing.
- Chemical finished products testing.

Verification procedures for each CCP were developed and shown in **Sheet (1)**.

In our investigation from **Figure (1)**, which presented flow diagram for manufacture of tomato paste (36-38%) with estimating the CCPs, we determined 5 critical control points, including:

- 1) Receiving stage raw and packaging material (Fresh Tomato fruits and Aseptic bags).
- 2) Filtration stage.
- 3) Sterilization stage.
- 4) Magnetic trap.
- 5) Aseptic filling stage.

To monitor system and insure that the HACCP system is working correctly and effectively (able to finding any deviation when occur and control it) and insure that the final product in agreement with The **Egyptian Standard (ES) (132-1/2015)** and **Codex Standard (CXS) (57/1981)**, finally produced high safety and quality products for consumers.

3.1.10. Principle 7: Documentation and record keeping (Step 12):

Documentation and record keeping of HACCP system for tomato paste (36-38%) was completed previously by:

- Listing of the HACCP team.

- Product information and its intended use.
- Flow diagram for the product.
- The entire process indicating CCPs.
- Hazards and preventive measures for each CCP.
- Critical limits for each CCP.
- Monitoring systems for every process steps and CCPs.
- Corrective actions for deviations from critical limits.
- Procedures for verification of HACCP system.
- Records keeping.

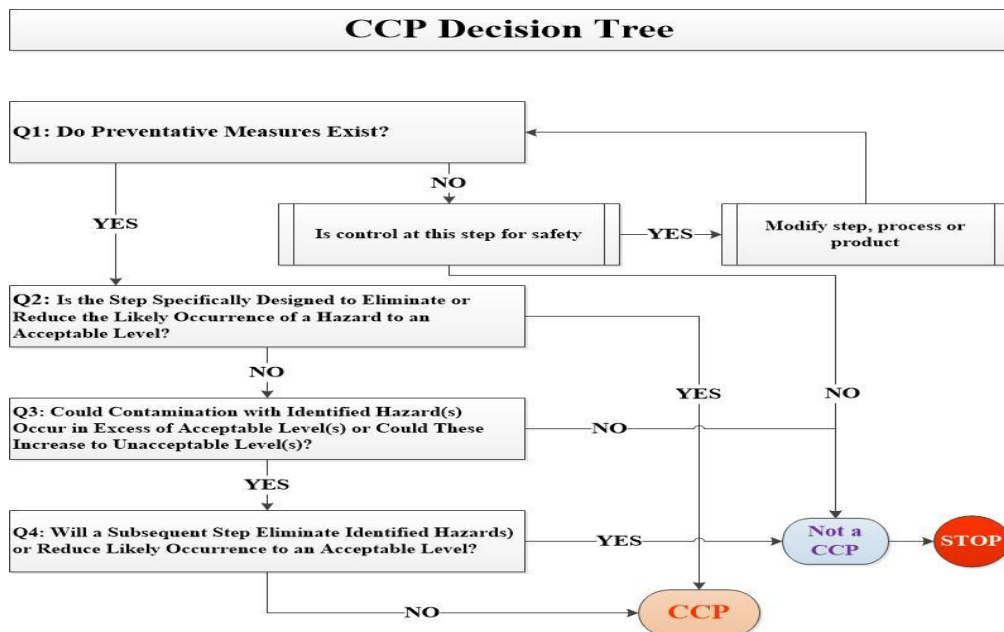


Figure (2): CCP decision tree:

Sheet 1. Tomato Paste (36-38%) Critical Limits, Monitoring, Corrective Actions, Verification & Records sheet:
Critical Limits, Monitoring, Corrective Actions, Verification & Records keeping Sheet

Product Name: Tomato Paste (36-38%)

| CCP No. | Process Step | Significant Hazards | | Critical Limit for each Preventive Measure | Monitoring | | | | Corrective Actions | Verification | Records |
|---------|-------------------------------------|---------------------|--|--|--|---|--|--------------------|---|--|--|
| | | Type | Hazard | | What | How | Frequency | Who | | | |
| 1 | (a) Receiving of RM (Tomato fruits) | Ch. | Pesticide residual and heavy metals | According to Codex Alimentary for tomato fruits and EU STD | Fruits contaminated with pesticides residual and heavy metals | Take random sample from raw material and sending to Certified Lab. | one sample each month from each supplier | by QC/QA Engineers | Stop receiving who supplied fruits contaminated with pesticide residual | One sample each month from finished Product; Audit the supplier for adherence to guarantee | Analysis report of any certified Lab.; Supplier audit report |
| | | Ph. | Foreign bodies (Sand, Stones, Wood, Plastic piece....) | Sand % = Not more than 1% | Foreign bodies with the received tomato | Take random sample from raw material | One sample from each truck | by QC Engineer | Reject the tomato fruit truck | Check with take random samples after washing and sorting | Receiving tomato fruit report |
| | | Bi. | None | | | | | | | | |
| | (b) Receiving of PM (Aseptic Bags) | Ch. | Contamination with Heavy metals | Food grade bags | Certificate from supplier | Take random sample from Packaging material | Each incoming shipment | | Reject the materials; stop receiving from suppliers who supplied the aseptic bags; or Re-Sterilization with irradiation | Obtain certificate of conformance from suppliers. | Microbiological Analysis report of any certified Lab.; supplier certificates |
| | | Bi. | Cross contamination with pathogenic bacteria | Free of pathogens and contamination | Ensure supplier guarantee exists for each incoming shipment; Take random sample from it. | Supplier guarantee Certificate is visually confirmed; and send the sample to certified Lab. | Each incoming shipment | by Lab. Specialist | | | |

Sheet (1): Continued - Tomato Paste (36-38%) Critical Limits, Monitoring, Corrective Actions, Verification & Records sheet:

| CCP No. | Process Step | Type | Significant Hazards | Critical Limit for each Preventive Measure | Monitoring | | | | Corrective Actions | Verification | Record Keeping |
|---------|---------------------|------|--|--|--|---|--|--|---|---|---|
| | | | Hazard | | What | How | Frequency | Who | | | |
| CCP 2 | Filtration Stage | Ch. | None | 1- Juice have peel, seeds 2- parts go to not acceptable from traditional 3- No critical foreign bodies | Ensure that Sieving machine is ok | 1- Damage in screen or fault in adjusted 2- Visual inspection for juice in Lab. 3- No critical foreign bodies | Daily - Filter is checked before starting product ion and every 12 hours after finishing product ion | 1- Checked by QC Engineer - Adjusting the machine maintenance and production tech. responsible | Samples inspection in lab. | - Daily in check list. - Production processes report - Lab. inspection report | |
| CCP 3 | Sterilization Stage | Ch. | Caustic Soda or Sanitizer residue | No traces of caustic soda | Ensure that CIP parameters during washing the sterilizer | take sample from the washing water | For each CIP Washing and rinsing to the sterilizer | QC Engineer & Sterilizer Tech. | Re-washing the sterilizer | Lab. check | Machine cleaning report |
| | | Ph. | None | | | Check and record temperature and holding time "Flow rate" from PLC | Each one hour | QC Engineer & Sterilizer Tech. | Auto stop of filling and recycling until the high temperature attained. | Calibration of the heating sensors | Production processes report; and chart of temperature treatment |
| | | Bi. | Microbial contamination due to unclean equipment * improper temperature of the product | Sterilization temp.: 112°C / 4 - 6 min. ok | Ensure that Sterilization temp. is ok | | | | | | |

Sheet (1): Continued - Tomato Paste (36-38%) Critical Limits, Monitoring, Corrective Actions, Verification & Records sheet:

| CCP No. | Process Step | Significant Hazards | | Critical Limit for each Preventive Measure | Monitoring | | | Corrective Actions | Verification | Record Keeping | | |
|---------|-----------------|---------------------|----------|--|--------------------------------------|---|---|------------------------------|---|--|---|---|
| | | Type | Hazard | | What | How | Frequency | | | | Who | |
| CCP 4 | Magnetic Trap | Ch. None | Ph. None | Foreign bodies, pieces of metal (≤ 0.8 mm) | Ensure that magnetic trap is working | Check that it switches on and Control is done | Each one hour | QC Engineer | Rejected the quantity and refine it second time - Adjusting the machine by maintenance tech. and production tech. | - Daily in check list - Periodically calibration results and certificates of Iron Peddles | | |
| CCP 5 | Aseptic Filling | Ch. None | Ph. None | Cross Contamination of filling chamber | Chamber temp. ≥ 94 °C | Ensure that sterilization temperature of chamber have a fault setting | Check to heat treatments and no bad control or leakage in one/many point in sterilization pipe. | Each one hour during process | Prod. Technician | Auto stop of filling and recycling until the low temperature attained | Check for Microbiological analysis to Certified Lab. & calibration of sensors | Production and Quality inspection report; Calibration certificate |

References

- Adedji, O.; Taiwo, K.A.; Akanbi, C.T.; and Ajani, R. (2006).** physicochemical properties of four tomato cultivars grown in Nigeria. *Journal of Food processing and Preservat*, 30:79-86.
- Agarwal, S. and Rao, A.V. (2000).** Tomato lycopene and its role in human health and chronic diseases. *Canadian Medical Association Journal (CMAJ)*, 163 (6): 739-744.
- A.O.A.C. (2016).** Association of Official Analytical Chemists. *Official Methods of Analysis*. (20th Ed.) Maryland, USA.
- Codex Alimentarius Commission (CAC) (1981).** Standard for processed tomato concentrates. CXS (57) Adopted in 1981. Revised in 2007, 2017. Amended in 2013.
- Codex Alimentarius Commission (CAC) (1999).** Recommended international code of practice general principles of food hygiene. CAC/RCP 1-1969, Rev. 3-1997, Amd. (1999).
- Codex Alimentarius Commission (CAC) (2003).** Recommended international code of practice - general principles of food hygiene. CAC/RCP 1-1969, Rev. 4-2003. Rome, Joint FAO/WHO Food Standards Programme, Food and Agriculture Organization of the United Nations, (http://www.codexalimentarius.net/download/standards/23/cxp_0_Ole.pdf, accessed 27 June, 2007).
- Egyptian Standard (2007).** Maximum levels of heavy metal contaminants in food. Egyptian Organization for Standardization and Quality Control. E.S., No. 2360 parts (1:5).
- Egyptian Standard (2015).** Preserved tomato products. Egyptian Organization for Standardization and Quality Control. E.S., No. 132 part (1).
- European Commission, 2005.** Regulation (EC) No. 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC.
- European Committee for Standardization, (2008).** Foods of plant origin determination of pesticide residues using GC-MS and/or LC-MS/MS following acetonitrile extraction/partitioning and clean-up by dispersive SPE-QuEChERS-method, EN 15662.
- Garcia, J. S. (2009).** *Microbiologically safe foods*. John Wiley & Sons.
- Gerber, M. (1999).** A role tomatoes and lycopene in the protection from chronic degenerative diseases? The result of epidemiological studies. In: Role and control of antioxidants in the tomato processing industry, second bulletin on the advancement of research. A European Commission concerted Action program FAIRCT 97.3233.6p.
- Giovanelli, G. and Paradise, A. (2002).** Stability of dried and intermediate moisture tomato pull during storage. *Journal Agricultural and Food Chemistry*, 50:7.
- Giovanucci, E. (1999).** Intakes of carotenoids and retinol in relation ship to risk to prostate cancer. *Journal of National Cancer Institute*, 87: 1767-1776.
- Horchner, P. M.; Brett, D.; Gormley, B.; Jenson, I. and Pointon, A. M. (2006).** HACCP-based approach to the derivation of an on-farm food safety program for the Australian red meat industry. *Food control*, 17(7), 497-510.
- ISO 21527-2 (2008).** Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of yeasts and moulds — Part 2: Colony count technique in products with water activity less than or equal.
- ISO 21528-2 (2004).** Microbiology of the food chain - Horizontal method for the detection and enumeration of Enterobacteriaceae Part 2: Colony-count technique
- ISO 4833-1 (2013).** Microbiology of the food chain — Horizontal method for the enumeration of microorganisms — Part 1: Colony-count at 30 degrees C by the pour plate technique.
- ISO 6579-1 (2017).** Microbiology of the food chain – Horizontal method for the detection, enumeration and serotyping of *Salmonella* - Part 1: Detection of *Salmonella* spp.
- ISO 6888-1(1999; 2003).** Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (*Staphylococcus aureus* and other species) — Part 1: Technique using Baird-Parker agar medium
- ISO 7932 (2004).** Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of presumptive *Bacillus cereus* — Colony-count technique at 30 °C.
- ISO 7937 (2004).** Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of *Clostridium perfringens* — Colony-count technique.
- ISO, 16649- 2 (2001).** Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of β -glucuronidase-positive *Escherichia coli* — Part 2: Colony-count technique at 44 °C using 5-bromo-4-chloro-3-indolyl β -D-glucuronide.
- ISO, 2005.** ISO 22000. Food safety management systems – requirements for any organization in the food chain. International Organization for Standardization: Geneva .
- ISO-TS 15216-2(2013)** Microbiology of food and animal feed - Horizontal method for determination of hepatitis A virus and norovirus in food using real-time RT-PCR — Part 2: Method for qualitative detection.
- Motarjemi, Y. (2013).** *Hazard Analysis and Critical Control Point System (HACCP)*. In: Motarjemi, Y. and Leliveld, H. (Eds). *Food Safety Management:*

- A Practical Guide for the Food Industry.* Academic press. pp 845-871.
- Motarjemi, Y.; Käferstein, F.K.; Moy, G.; Miyagawa, S. and Miyagishima, K. (1996).** Importance of HACCP for public health and development: the role of the World Health Organization. *Food Control* (7): 77–85.
- National Advisory Committee on Microbiological Criteria for Foods (NACMCF) (1998).** Hazard Analysis and Critical Control Point Principles and Application Guidelines. *Journal of Food Protection*, Vol. 61, No. 6, 762-775.
- Orriss, G. and A. Whitehead. (2000).** Hazard analysis and critical control point (HACCP) as a part of an overall quality assurance system in international food trade. *"Food Control"* 11.5 : 345-351.
- Wikipedia (2013).** Tomato. The free encyclopedia. WWW. Wikipedia – Tomato.

تطبيق نظام الهاسب أثناء إنتاج معجون الطماطم

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1 قسم الصناعات الغذائية - كلية الزراعة بمشهور - جامعة بنها - مصر

2 شركة هارفست للاغذية - الداخلية - مصر

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تعتبر سلامة الأغذية أحد أهم المقومات الأساسية للصحة العامة ويشكل ذلك تحديات كبيرة لجميع الشركات والمصانع والمؤسسات المهمة بالتصنيع الغذائي. هناك العديد من المخاطر التي تنتقل عن طريق المصادر التقليدية وغير التقليدية في السلسلة الغذائية، وتشكل المخاطر على الصحة عقبات أمام التجارة الدولية للأغذية. ومن هنا يجب تحليل هذه المخاطر وتقييمها وإدارتها بشكل صحيح لمواجهة المتطلبات المتزايدة والمتنامية في السلسلة الغذائية العالمية. يبدأ التنفيذ السليم لمبادئ الشئون الصحية في الأغذية في جميع أنحاء السلسلة الغذائية بالتزامن مع نظام تحليل المخاطر ونظام نقاط التحكم الحرجة (الهاسب) ، والذي يضمن سلامة الأغذية المنتجة. في هذه الدراسة تم إجراء الاختبارات الميكروبيولوجية والكشف عن وجود متبقيات المبيدات والمعادن الثقيلة أثناء إنتاج معجون الطماطم (38-36 %) علي خط الإنتاج بالشركة المتحدة لصناعة المراكزات، والتي تشمل بداية من (الطماطم الخام ، الغسيل ، الفرز ، الاستخلاص ، التنقية ، التركيز ، التعقيم ، التعبئة المعقمة) ثم يتم تخزينها في ظروف مناسبة، وتمت دراسته استخدام نظام الهاسب و تم إجراء تحليل للعينات الناتجة خلال بعض الخطوات الموضحة سابقاً لتحديد خصائص الجودة الميكروبيولوجية. فتم إجراء الاختبارات الميكروبيولوجية للعينات لتقدير العدد الكلي للبكتيريا وعدد مجموعة القولون وعدد الخمائر والفطريات. وكذلك تم الكشف عن بعض البكتيريا المرضية (الباسلس ، الاستافيلوكوكس ، السالمونيلا ، الكولسترديوم) ، وأظهرت نتائج الاختبارات الميكروبيولوجية أن معدل الميكروبات يتناقص تدريجياً حتى تم الحصول على منتج نهائي آمن صحياً و مطابقاً مع المواصفات القياسية المصرية. كذلك أظهرت النتائج أن محتوى بقايا المبيدات كانت أقل من الحدود القصوى المسموح بها لبقايا المبيدات في الأغذية وذلك في كلا من المواصفات القياسية المصرية والمواصفات الصادرة من الاتحاد الأوروبي. على الجانب الآخر لم يكتشف وجود معادن ثقيلة في المنتج النهائي.

الكلمات الدالة: تحليل المخاطر، نقاط التحكم الحرجة، معجون الطماطم، خصائص الجودة الميكروبيولوجية، المعادن الثقيلة، بقايا المبيدات.