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# A MODEL HACCP PLAN FOR SMALL-SCALE MANUFACTURING OF TARHANA (A TRADITIONAL TURKISH FERMENTED FOOD)

N. KARAGOZLU[1], C. KARAGOZLU[2] and B. ERGONUL[3]
[1]*Celal Bayar University, Engineering Faculty, Food Engineering Department, Muradiye Campus, Muradiye, Manisa, Turkey*
[2]*Ege University, Faculty of Agriculture, Dairy Technology Department, Bornova, Izmir, Turkey*
[3]*Celal Bayar University, Engineering Faculty, Food Engineering Department, Muradiye Campus, Muradiye, Manisa, Turkey*

## Abstract

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Most of the tarhana consumed in Turkey is homemade and therefore sun-dried. However, there is a great commercial potential for the production of tarhana on an industrial scale using modern drying techniques. Since tarhana produced by traditional methods is consumed widely and take an important role in diets of many people, safety of this product is so important in terms of consumer health. At this point of view, adopting a food safety system to tarhana production is so important.

In this study hazard analysis system was adopted to manufacturing line of tarhana, critical control points on the line were determined and a sample generic HACCP plan was recommended. Preventive and corrective actions for the critical steps were also discussed in the manuscript.

*Key words:* tarhana, HACCP system, food safety

## Introduction

Tarhana is one of the widely consumed traditional fermented foods in Middle East countries and is of great importance in the diet of Turkish people. Tarhana is prepared by mixing yoghurt, wheat flour, yeast and a variety of cooked vegetables and spices (tomato, onion, salt, mint, paprika, tarhana herb, dill and basil) followed by fermentation for 1–7 days. Fermentation is usually carried out by yoghurt bacteria; *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. After fermentation the mixture is sun dried and ground to a particle size of nearly 1 mm (Ibanoglu et al., 1995). Instant tarhana is used to make tarhana soup by adding into water and boiling. Tarhana has an acidic and sour taste with a strong yeasty flavor and is also a good source of proteins and vitamins and therefore is used widely for feeding children and elderly people in the form of a thick soup (Turker and Elgun, 1995; Hammad and Fields, 1979) There are some other products similar to tarhana such as kishk (Tamime et al., 2000; Youssef, 1990), kushuk (Alnouri and

*nural.karagozlu@bayar.edu.tr*
*cem.karagozlu@ege.edu.tr*
*bulent.ergonul@bayar.edu.tr*

Duitschaever, 1974), trahana (Economidou and Steinkraus, 1983) and tahonya/talkuna (Siyamoglu, 1961). Methods for preparation of tarhana may vary from one place to another, but cereals and yoghurt are always the two major components. Since it has high nutritional properties, there is a growing commercial interest to produce tarhana soup in instant form (Ibanoglu and Ibanoglu, 1998).

Most of the tarhana consumed in Turkey is homemade and therefore sun-dried. However, there is a great commercial potential for the production of tarhana on an industrial scale using modern drying techniques (Maskan and Ibanoglu, 2002). Tarhana is not high hygroscopic and it can be stored for 2 to 3 years without any sign of deterioration.

Formerly it was believed that acidity and low water content prevent the growth and multiplication of foodborne pathogenic microorganisms. But it was shown by the researches that several pathogenic bacteria can survive for over than 2 hours in foods having a pH value of 2-2.5 (Ghenghesh et al., 2005). Since tarhana has a pH value of approximately 4.0 (Ekinci, 2005) and has a lot of ingredients in it, it can act like a medium for microorganisms. Not only microbiological risks, but also physical and chemical contaminations can occur during tarhana manufacturing because of the processing technique of the product. Especially physical contaminations are seen during sun-drying of traditional tarhana in small-scale production units.

The most affective and well-known system for pathogen reduction and prevention of chemical and physical contaminations and risks during manufacturing is HACCP system.

HACCP is known as a combined system of microbiology, quality control and risk assessment (Schmidt et al., 2007). Through implementation of HACCP system, hazards in any step of the manufacturing chain can be identified and risks can be classified. Other benefits of establishing HACCP system in a plant are reduced need for final inspection and analysis of a product, higher costumer satisfaction and trust in product safety, and improved food safety.

The use of a highly structured Hazard Analysis Critical Control Point (HACCP) system in food-safety control is not new. The first food-industry HACCP application (in the 1960s) was by the Pillsbury Co. who had been contracted by National Aeronautics and Space Administration (NASA)—in conjunction with U.S. Army Natick Laboratories—to design and produce foods for space flights. The cooperative HACCP program which evolved had the goal of nearly 100% assurance that space foods produced would be free of microbial or viral pathogens. This systematic, preventative approach combines the principles of food microbiology, quality control, and risk assessment (Schmidt et al., 2007).

HACCP is an effective system because of being designed to provide the information flow for preventive and corrective actions and can easily be established on the production lines of all kinds of foods (Unnevehr and Jensen, 1998).

The primary advantage of HACCP is that it is a preventative—rather than a reactive— approach to hazard identification and control in the food handling environment.

Additional benefits to be realized include: more efficient and directed use of resources, reduced need for expensive end product testing, improved product quality, and higher customer satisfaction.

HACCP can be adapted to plants that produce different kinds of foods, but industrial applications show differences because the flow diagrams of the products differ. Thus, all production lines have different critical control points (CCP) and HACCP plans (Topal, 2001).

A ***Critical Control Point (CCP)*** can be defined as any operation (practice, procedure, process, location, or step) at which there is a high- to medium-risk that lack of control will result in human risk; and at which control can be applied.

The first step to establish the HACCP system should be to form the flow diagram of the production line. In this way, critical control points can be determined on the flow diagram sample and hazard analysis can be performed (Topal, 2001; Mortimore and Wallace, 1994).

Hazards seen in food manufacturing is divided into 3 sub categories as follows,

***Microbiological hazards*** are the potential for pathogenic organisms to survive, grow, contaminate the product/raw materials and eventually cause food-borne illness.

***Chemical hazards*** could result from a number of sources: agricultural chemicals, insecticides, fungicides, etc.; cleaning/sanitizing agents and chemicals, certain toxins, and misuse of food chemicals (preservatives, additives, etc.).

***Physical hazards*** include: inadvertent field matter (stones, metal, insect fragments, etc.); inadvertent processing residues (glass, metal fragments, etc.); intentional materials (employee sabotage) and miscellaneous particulates and fragments (Schmidt et al., 2008).

In this study it was aimed to determine the possible hazards and critical points in terms of food safety on the production line of tarhana. Understanding the hazards involved and best practices for control are important in developing an improved food safety control program for the tarhana industry.

## Materials and Methods

Manufacturing of tarhana was realized by traditional methods in Tarhana Plant of Menemen Research and Practice Farm of Agricultural Faculty, Ege University. First of all, identification of the product and the target consumer profile were discussed and traditional method of tarhana production was determined. Tarhana production consists in two stepped manufacturing: tarhana dough fermentation and sun-drying of the fermented tarhana dough. A sample flow diagram for tarhana production is given as Figure 1. Each step of tarhana manufacturing and possible risks and preventive actions were explained in details below. By conducting hazard analysis and using "decision tree" (Figure 2) critical steps of the process and critical limits of these points were determined.

Determination of the manufacturing flow diagram and critical control points were realized by HACCP team. HACCP team was consisting of 4 members of the staffs of Celal Bayar University Engineering Faculty Food Engineering Department and Ege University Faculty of Agriculture Department of Dairy Technology. Flow diagram was determined according to the manufacturing line in Menemen Research and Practice Farm and verified on the production line by the HACCP team.

### Identification of the Product and Target Consumer Profile

Name of the product is "instant tarhana". Tarhana is consumed by consumers from all ages. Since tarhana is rich in minerals and vitamins, it is advised to be consumed by children as tarhana soup. Also, sick people consume this soup especially in winter as hot drink or as a starter before meal.

### Manufacturing Process of Instant Tarhana

Method used for tarhana production was given as Figure 1. The composition of tarhana dough, based on total weight (wet basis), is generally as follows: wheat flour 900 g/kg; yoghurt, 300 g/kg; onion, 30 g/kg/; tomato paste, 120 g/kg; salt 40 g/kg; yeast, 100 g/kg; paprika paste 20 g/kg; tarhana herb, basil and dill, 15 g/kg each. Tomato paste, paprika paste, onion, tarhana herb, basil and dill are smashed, blended and sieved. This mixture is then boiled at min 90°C for 30 minutes and left for cooling down to 25°C. After boiling vegetables can be kneaded easily and also by boiling a pasteurization process is applied at meantime. Then whole flour, salt, yoghurt and yeast are added into the mixture. They are kneaded in steel saucepan with a spoon to form tarhana dough. The dough is fermented at 30°C for 24 hours in an incubation room. Dough is left to fermentation for 1 day at room temperature. The following day, dough is cut into pieces. Dough pieces are left to be fermented for 2 more days. Next day, dough pieces are passed through crushing machine to obtain smaller pieces and then sieved. Powdered tarhana is left for drying process for 2 days at 35°C. After 2 days, second grinding is applied. Then, grinded tarhana is packaged (Karagozlu and Ergonul, 2007).

Raw Material and Packaging Material Income and Storage **CCP**

↓

Onion

Tarhana herb, basil and dill ← Washing vegetables **CCP**

Tomato paste

Paprica paste

↓

Boiling (90°C/30 min.) **CCP**

↓

Cooling down to 25°C

↓

Wheat flour, salt and yoghurt ← Baker yeast (*S.cerevisiae)* **CCP**

Mixing

↓

Kneading to obtain tarhana dough

↓

Spreading dough on trays

↓

Fermentation and Drying Process

↓

1st incubation (30 °C / 24 h) (1st day) (b)

↓

2nd incubation at room conditions (18 – 24 °C/ 24 h) (2nd day)

↓

Dividing dough into big pieces

↓

3rd incubation at room conditions (18 – 24 °C/ 24 h) (3rd day)

↓

Breaking dry dough into smaller pieces

↓

Waiting at room temperature (24 h) (4th day)

↓

↓

Grinding

↓

Sieving (<1 mm) **CCP**

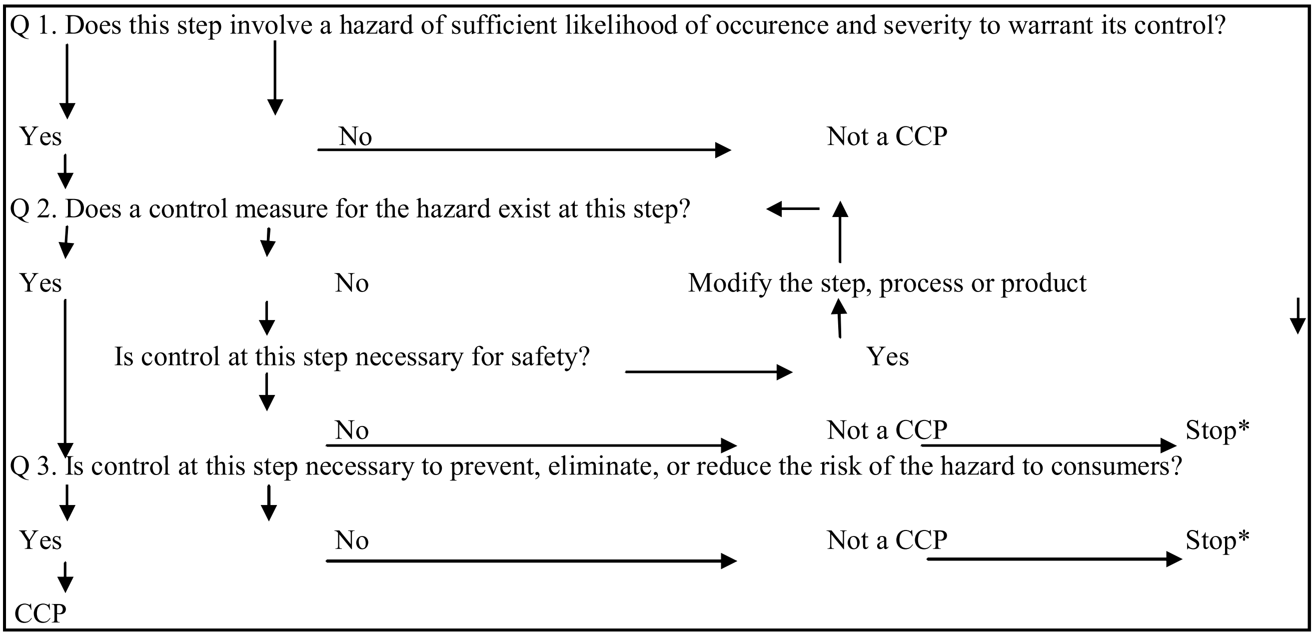
↓

Metal Detector **CCP**

↓

Packaging

**Fig. 1. Sample flow diagram for manufacturing process of instant tarhana**




* Proceed to next step in the process

**Fig. 2. Decision Tree (NACMCF, 1997; Karagozlu and Ergonul, 2007)**

### Hazard Analyses on the Manufacturing Line of Tarhana

Each step of tarhana manufacturing was taken into consideration individually in terms of food safety. Possible biological, physical or chemical hazards and risks on manufacturing steps were identified and given as Table 1. Also corrective and preventive actions were determined according to the hazard identified in each step.

As seen in Table 1, important chemical, physical and biological (both macro and microbiological) hazards can be seen during receiving and storage of raw materials and packaging materials. Hazardous substances like woodchips and stone particles should not be found in raw material like wheat flour. Because of the manufacturing process of wheat flour, it is obvious that several hazardous foreign materials can be seen in product.

Since wheat flour is dry foodstuff, the most important microbiological risk is presence of moulds. Presence of moulds causes also mycotoxins in wheat flour (Ergonul and Kundakci, 2003). Mycotoxins can be considered as the most important chemical risk in wheat flour, and also in tarhana.

Microbiological loads of raw materials used or tarhana manufacturing should be under the upper limits given in Microbiological Criteria for Foods in Turkish Food Codex. Also, vegetables used for manufacturing should not contain high amounts of dirt and physical contaminants.

Washing vegetables is an important step in manufacturing in terms of removal of the dirt, and physical and chemical contaminants. At the end of an improper washing facility, instead of the removal of contaminants, vegetables can be contaminated if the microbiological and chemical quality water used is poor. In washing, chlorine is generally used as an antimicrobial agent, thus the level of the chlorine in water is so important to assure an affective and safe washing.

In tarhana manufacturing, pasteurization is realized in order to inhibit the pathogen microorganisms originated from raw materials. So, temperature and time of this thermal process should be established to be adequate for the removal of these microorganisms.

Using baker yeast (*Saccharomyces cerevisiae*) is another concern in the manufacturing of tarhana.

**Table 1**
**Hazard analysis and critical control points on the manufacturing line of instant tarhana**

| Step | Possible Hazard(s) |
|---|---|
| 1. Raw Material and Packaging Material Income and Storage | Possible chemical, physical and biological (macrobiological and microbiological) risks originated from raw material and packaging material<br>Hazardous substances like woodchips or insects from wheatflour<br>Chemical hazards from un-refined salt<br>High microbiological load of tarhana herb, basil and dill, etc.<br>Possible presence of pathogens on incoming raw material<br>Pesticides<br>Moulds and mycotoxins from wheatflour<br>Packaging materials shipped by using un-covered and un-clean vehicles<br>Contamination during storage<br>Inadequate storage temperature and relative humidity. |
| 2. Washing vegetables | Inadequate washing<br>Low/high chlorine amount in water (chemical hazard)<br>Low water quality in terms of chemical and microbiological structure<br>Presence of pathogens in water |
| 3. Boiling (pasteurization) | Inadequate heating process.<br>Presence of pathogens and high microbiological load after pasteurization |
| 4. Addition of baker yeast | Baker yeast should be a pure culture of the microorganisms (*Saccharomyces cerevisiae* ) and should be free of pathogens<br>Undesired microorganisms from baker yeast culture |
| 5. Sieving | Presence of physical hazardous substances and foreign materials like woodchips, stone particles and insects in final product |
| 6. Metal Detector | Presence of metal particles in final product after manufacturing |

Pure culture of this yeast should be used; otherwise, microbiological contamination from mixed culture may cause food-safety risks.

Dried tarhana is sieved and then detected by using metal detector. These two steps should be taken into consideration as critical control points.

The aim of the sieving is the removal of the undesired physical particles and foreign materials in tarhana. Also, metal particles in tarhana that can not be removed by sieving should be checked by using metal detector.

Packaging is also an important step in terms of physical, chemical or microbiological contaminations from packaging material. Since, "packaging material" is taken into consideration in the first step of the manufacturing, in "Raw Material and Packaging Material Income and Storage" step, "Packaging" step may not be determined as critical control point.

## Generic HACCP Plan of Tarhana Manufacturing

Generic HACCP Table of tarhana manufacturing is given as Table 2. In HACCP plan, critical control point, hazards determined in this step, critical limits, monitoring process (what, how, frequency, who), corrective actions, verification and records kept are suggested.

As seen in Table 2, critical control points, critical limits for each CCP, monitoring process including how the CCP is monitored by who, when and the control

**Table 2**
**A model HACCP plan for small-scale tarhana manufacturing unit**

| Critical Control Point (CCP) | Hazard(s) | Critical Limits | Monitoring | | | | Corrective Action | Verification | Record Keeping |
|---|---|---|---|---|---|---|---|---|---|
| | | | What | How | Frequency | Who | | | |
| Raw material and packaging material income and storage | Physical (dirt, stone particles woodchips in vegetables) | Supplier guarantee specifications established by quality assurance department of plant | Ensure supplier guarantee exists for each incoming shipment | Supplier guarantee certificate is visually confirmed | Each incoming shipment for all materials | Receiving manager/ staff | Reject materials if not accompanied by supplier guarantee. | Review monitoring corrective action and verification records within one week of preparation | Supplier guarantee |
| | Chemical (toxins, mycotoxins from wheatflour, pesticides from raw materials) | | | | | | | Audit the supplier periodically for adherence to guarantee | Supplier audit report |
| | Microbiological (high microbiological load of raw materials, presence of pathogenic bacteria) | Raw materials should not contain pesticides and mycotoxins | Storage areas | To avoid the cross contamination, these food stuffs should be kept at different temperatures, and in different places | | | | | |
| | Inadequate storage conditions and contaminations during storage | Microbiological attributes of all raw materials should be in …. with the microbiological criteria of foods given in Turkish Food Codex | Relative humidity of the storing places might change from 80% to 95% according to the raw material (Jay, 1992). | FIFO system should be established | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Washing vegetables | Physical (non-removal of dirts because of an inadequate washing programme) | Generally, 50-125 ppm active chlorine is adequate for elimi-nating the microbial risks of vegetables. For very dirty raw materials 1-5 ppm active chlorine should be added to the final rinsing water (Aran et al., 1987) | Ensure that the microbiological and chemical quality of water is adequate to be named as potable water | Periodic water analyses should be performed in accredited laboratories | For each washing and rinsing facility | QC/QA staff member | Re-wash the vegetables in case of an inadequate washing | Review water analysis results | Water analyses results |
| | Chemical (contamination from low quality water, presence of chlorine after an inadequate rinsing) | | | | | | If the residue chlorine is high, re-rinsing should be performed | | |
| | Microbiological (contamination of microorganisms, especially pathogens from low microbiological quality water) | Potable and high microbiological and chemical quality water should be used<br><br>Residue chlorine amount of vegetables should be under the upper limits given in specifications | Ensure that proper amounts of chlorine is used for antimicrobiologic activity | Chlorine should be purchased with a certificate ensuring the purity of the chemical<br><br>Check the amount od chlorine used for washing process | Water analyses should be performed periodically according to the legislation established by health ministry departments | | Results and the certificates of the water analyses should be checked<br><br>If chemical and microbiological attributes of water are not being matched with the standards, water should be treated before using in the manufacturing line | | Chlorine certificates and specifications<br><br>Washing effectiveness test results |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Boiling (paste-urization) | Microbiological (presence of pathogenic bacteria after heat treatment because of an inadequate heating process) | Vegetables used in the formulation of tarhana dough should be boiled well at min 90°C for at least 30 minutes | Temperature and boiling period should be controlled during process | Temperature and time should be checked<br><br>Thermocouples should be used for temperature control | Each boiling process | QC/QA staff member | Microbiological analysis should be performed | If adequate temperature is not provided, re-boil the vegetables, repeat the heating process<br><br>Check the microbiological count reports of raw and boiled vegetables | Time – temperature records<br><br>Microbiological analyses results |
| Adding baker yeast (*S. cerevi-siae)* | Chemical, physical and microbiological contamination from starter culture having a low purity in microbiological and chemical attributes | Supplier guarantee specifications established by quality assurance department of plant<br><br>Culture should only contain pure strains of *Saccharomyces cerevisiae* | Ensure supplier guarantee exists for each incoming shipment | Supplier guarantee certificate is visually confirmed | Each incoming shipment | Receiving manager/ staff | Reject materials if not accompanied by supplier guarantee | Audit the supplier periodically for adherence to guarantee | Supplier guarantee<br><br>Supplier audit report |
| Sieving | Physical (non-removal of physical contaminants from tarhana because of an inadequate sieving performance) | Sieved tarhana should not contain physical contaminants | Sieves should be checked periodically<br><br>After sieving physical contaminants in tarhana should be checked visually | Calibration samples containing known physical contaminants having different shapes and dimensions should be sieved through these sieves | Periodically (monthly, bimonthly etc.) | QC/QA staff member | Tarhana should be re-sieved if physical contaminants are seen visually<br><br>In need of support and periodical maintanence, service should be called | Check the calibration and test results of the sieves used | Periodical calibration reports<br><br>Physical contaminant test reports |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Metal detector | Physical (presence of metal particles in final product) | Final product should be free of metal contaminants | Presence of metal particles should be checked | Control is done by metal detectors | Each final product | QC/QA staff member | Rejection of the product having metal contamination | Check the calibration and test results of metal detectors used | Test results<br>Periodically calibration results and certificates of metal detectors |

frequency, also verification process and records kept were identified.

First critical control point on the manufacturing line of tarhana was determined as "Raw Material and Packaging Material Income and Storage". According to Table 1, hazards in this step are physical contaminants like stone and woodchips originated from raw material, chemical beings like mycotoxins synthesized by moulds present in raw materials like wheat flour, chemical contaminants from low purity salt, pesticides, and microbiological hazards like high microbiological load of raw materials and presence of pathogenic bacteria.

Critical limits for these hazards should be identified in supplier guarantee specifications established by quality control or quality assurance department of the plant. For instance, levels of the chemical contaminants like pesticides and mycotoxins should be under the maximum levels given in European Food Codex.

Also, during welcoming of the raw materials, microbiological attributes of them should be taken into consideration. Also, a manual indicating the Microbiological Attributes of Raw Materials should be prepared by the department and incoming of the raw materials should be done according to this manual.

To monitor the raw material income, receiving manager/staff should ensure that supplier guarantee exists for each incoming shipment and supplier certificate should be visually confirmed by the personnel. This should be done for each incoming shipment for all raw materials.

As a corrective action for this critical control point, raw materials should be rejected if not accompanied by supplier guarantee. And, this corrective action should be reviewed by verification and verification records should be checked within one week of preparation. Also, supplier should be audited periodically for adherence to guarantee. Supplier guarantee forms and audit reports should be documented in terms of record keeping for this step.

Because of insufficient and improper storage conditions, rapid microbial growth can be seen. Cross contamination of the pathogen microorganisms from storage places to production area is another important hazard (Bryan, 1992). *"Raw Material Storing Instructions"* should be determined by QC/QA department for proper storing. Storing should be performed according to First in First out (FIFO) system.

QC/QA staff members are responsible for proper storing conditions. Temperatures and relative humidity of the storage places should be monitored by thermocouples and hygrometers continuously. Temperatures and relative humidity of the storage places, and changes in these parameters should be recorded; when necessary, these parameters should be reset. Sanitary and hygienic conditions of the stores are very significant to avoid the contamination. In addition, hygienic barriers might be used and stores should be cleaned and sanitized periodically, and records mentioned in *"Raw Material Storing Instructions"*, should be kept for archive and audits.

Hazards in "Washing Vegetables" the second step of tarhana manufacturing can be classified into 3 titles as microbiological, chemical and physical hazards. Physical hazards are named as non-removed dirt because of an inadequate washing program; on the other hand, chemical hazards are identified as chemical contaminations from low-quality water and presence of chlorine after an inadequate rinsing. Also, microbiological risks like contamination of microorganisms, especially pathogen bacteria from low microbiological quality water are also identified.

Generally 50-125 ppm active chlorine is adequate for eliminating the microbiological risks of vegetables. For very dirty raw materials, 1-5 ppm active chlorine should be added to the final rinsing water (Aran et al., 1987). During washing and rinsing, high chemical and microbiological quality potable water should be used. Residue chlorine amount of vegetables should be under the upper limits given in specifications.

It should be ensured that the microbiological and chemical quality of water is adequate to be named as potable water and proper amounts of chlorine is used for adequate antimicrobiological activity. Periodic water analyses should be performed in accredited laboratories and chlorine used in the process should be purchased with a compliance certificate showing the purity of the chemical. Amount of chlorine used for washing and rinsing process should be checked for each washing and rinsing process. Water analyses should be performed according to the legislation established by health ministry. QC/QA staff should be responsible for all these monitoring activities.

In case of an inadequate washing and rinsing, rewashing of the vegetables should be ensured. If the residue chlorine is high, re-rinsing also should be repeated.

In verification process, results of the analyses (reports) and certificates of the water analyses should be monitored and checked. If chemical and microbiological attributes of water are not being matched with the standards, water should be treated before using in the manufacturing line.

Blanching the vegetables used in the formulation is an important step in the process since, blanching also means pasteurization because of the heat treatment applied. If blanching temperature is inadequate, pathogenic bacteria can not be inhibited. So, vegetables used in the formulation of tarhana dough should be blanched well at 80°C for at least 30 minutes. During blanching process, temperature and blanching period (time) should be controlled. Thermocouples should be used for temperature control for each boiling process. QC or QA staff member should be responsible for the facilities done in this step. If adequate temperature is not ensured, re-boiling of the vegetables should be done by repeating the heating process.

For documentation, time-temperature records and microbiological analyses results should be kept and archived.

*Saccharomyces cerevisiae* (baker yeast) is used for the fermentation of tarhana dough. *S.cerevisiae* should be pure culture of the microorganism on the other hand, chemical, physical and microbiological contaminations from starter culture having a low purity in microbiological and chemical attributes. Supplier guarantee specifications indicated by QA or QC department of the plant should be demanded from the supplier with the each incoming shipment of the starter culture. Culture should only contain pure strains of *Saccharomyces cerevisiae* and supplier guarantee certificate should be visually checked and confirmed by the receiving staff. Culture should be rejected if not accompanied by supplier guarantee. Also, supplier should be periodically audited by the quality assurance department staff for adherence to guarantee.

Supplier guarantee records and supplier audit reports should be kept and archived for documentation step.

Sieving of tarhana is done in order to remove the undesired physical beings in the final product. Sieved tarhana should not contain physical contaminants which are hazardous to consumer. In order to achieve an adequate sieving process, sieves used should be checked periodically and after sieving, tarhana should be checked visually in terms of physical contaminants.

Calibration samples which are containing physical contaminants having different shapes and dimensions should be sieved through these sieves periodically by QA or QC staff (monthly, bimonthly, etc.) in order to check the performance of the sieves.

Tarhana should be re-sieved if physical contaminants are still found in the product after final sieving. In need of any support and periodical maintenance, service should be called. Periodical calibration reports, physical contaminant test reports and service records should be kept and archived for further documentation.

Presence of metal particles in the final product is so important I terms of consumer health and "metal detector" step should be taken into consideration as a critical control point. Each final product should be free of metal contaminants and presence of metal particles should be checked by using metal detectors by the QA or QC department. Product having metal contamination should be rejected by the operator. QC/QA department staff should constitute a detailed *"Metal Detector Manual"*. In this manual, dimensions of metal particles that metal detector should determine must be given (Mortimore, 1994). QC/QA staff member, responsible for this operation, should periodically check the detector by test and should calibrate it frequently. Test results and periodically calibration results and certificates of metal detectors should be archived for documentation facilities.

QC/QA department should ensure to avoid the potential hazards in all steps of the process by stating preventive and corrective actions. Effectiveness of the HACCP system can be stated by verifying. All the activities taken place in HACCP system should be kept as records and forms, and archived for periodic internal and external audits. Audits are performed by Production Management Department and government officials dealing with food safety (Annon., 1998).

## Conclusion

HACCP should be considered as a system based on Good Manufacturing Practices (GMP) and Standard Sanitation Operation Procedures (SSOP). GMP applications include building, environment arrangements and personnel hygiene and behaviors. Sanitary and hygienic conditions of the plant can be improved by SSOP applications.

For tarhana manufacturing, it is important to establish an affective food safety management system to improve the microbiological quality of the product and to ensure the protection of the consumer health. Since tarhana is widely consumed by people from a wide range of age, in case of any physical, chemical or microbiological hazard, it is obvious that many people may suffer because of food-borne diseases.

Since tarhana is widely manufactured in small-case plants, government and related ministries should take several measures to ensure the establishment of food safety systems in such places. Tarhana is also produced at homes by consumers. Consumers should also give great importance to food safety measures during manufacturing of tarhana mentioned below.

## References

**Anon.,** 1998. Food Quality and Safety Systems. Food and Agricultural Organization of the United Nations, Rome, Italy. 232 pp.

**Aran, N., I. Alperden and S. Topal,** 1987. Mold control problem in tomato paste production and hazard analysis system at critical control points. *Food Industry*, Turkey. **2**: 43-47.

**Bryan, F. L., C. A. Bartleson, O. D. Cook, P.**

**Fisher, J. J. Guzewich, B. J. Humm, R. C. Swanson and E. C. D. Todd,** 1991. Procedures to implement the Hazard Analysis Critical Control Point System. Int. Assoc. Milk, Food & Environ. Sanitarians. Des Moines, IA.

**Carter, R. D.,** 1989. Florida Orange Juice (Commonly called Fresh-Squeezed Florida Orange Juice) Production—Packaging—Distribution. Fl. Dept. Citrus/ Univ. Florida, IFAS-CREC, Lake Alfred, FL.

**Economidou, P. L. and K. H. Steinkraus,** 1983. Acid-fermented milk and milk/cereal foods. In: Steinkraus K.H. (ed) Handbook of indigenous fermented foods. *Marcel Dekker*, New York.

**Ekinci, R.,** 1995. The effect of fermentation and drying on the water-soluble vitamin content of tarhana, a traditional Turkish cereal food. *Food Chemistry*, **90**: 127-132.

**Ergonul, B. and P. Gunc,** 2004. Application of HACCP system in Turkey. *Int. J. of Food Safety,* **3:** 20-24.

**Ergonul, B. and A. Kundakci,** 2003. Et ve urunlerinde mikotoksin sorunu ve mikotoksikozis 1. Ulusal Mikotoksin Sempozyumu, 18-19 Eylul, Istanbul. Proceedings, pp. 35-40.

**Ghenghesh, K. S., K. Belhaj, W. B. El-Amin, S. E. El-Nefathi and A. Zalmum,** 2005. Microbiological quality of fruit juices sold in Tripoli-Libya. *Food Control*, **16:** 855-858.

**Hamad, A. M. and M. L. Fields,** 1982. Preliminary reductions of a new soy-based kishk. *Journal of Food Science*, **47:** 1140–1142.

**Ibanoglu, S. and E. Ibanoulu,** 1998. Rheological characterization of some traditional Turkish soups. *Journal of Food Engineering*, **35**: 251-256.

**Ibanoglu, S., P. Ainsworthi, G. Wilson and G. D. Hayes,** 1995. The effect of fermentation conditions on the nutrients and acceptability of tarhana. *Food Chemistry*, **53:** 143-147.

**Jay, J. M.,** 1992. Modern Food Microbiology. *Chapman and Hall*, New York. 701 pp.

**Karagozlu, N. and B. Ergonul,** 2007. Turnip juice manufacturing and HACCP concept. *Italian Food and Beverage Technology,* **50**: 11-16.

**Maskan, M. and S. Ibanoglu,** 2002. Hot air drying of cooked and uncooked tarhana dough, a wheat flour-yoghurt mixture. *European Food Research and Technology*, **215:** 413-418.

**Mortimore, S. and C. Wallace,** 1994. HACCP a practical approach. *Chapman & Hall*, New York. 296 pp.

**Pierson, M. D. and D. A. Corlett, Jr.** 1992. HACCP Principles and Applications. AVI/Van Norstrand Reinhold, New York.

**Schmidt, R. H., C. A. Sims, M. E. Parish, S. Pao and M. A. Ismail,** 2000. A Model HACCP Plan for Small-Scale, Fresh-Squeezed (Not Pasteurized) Citrus Juice Operations. University of Florida, Cooperative Extension Service, Institute of Food and Agricultural Sciences, No: CIR 1179.

**Siyamoglu, B.**, 1961. Investigations on the Preparation and Composition of Turkish Tarhana, Vol. 44. Izmir, Turkey: *Ege University Press* (Tr).

**Tamime, A., D. Muir, M. Khaskheli and M. N. I. Barclay**, 2000. *Lebensm. Wiss. Technol*., **33**: 444-451.

**Topal, S**., 2001. Risk Management System in Food Industry: HACCP and Applications. Tac Ofset Matbaacэlэk. Istanbul, Turkey, 172 pp.

**Turker, S. and A. Elgun,** 1995. Saglam, pisirilmis ve cimlendirilmiє kuru baklagiller eklenerek, mayasiz ve mayali (*Saccharomyces cerevisiae*) sartlarda uretilen tarhanalarэn renk ve kimyasal ozellikleri. *Selcuk Univ. Zir. Fak. Dergisi*, **6** (8): 21-31.

**Unnevehr, L. J. and H. H. Jensen,** 1998. HACCP as a regulatory innovation to improve food safety in the meat industry. *American Journal Agricultural Economics*, **78:** 764-769.

**Youssef, M. M**., 1990. Instantization and evaluation of some traditional Egyptian foods. *Food Chemistry*, **38:** 247–254.

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