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Application of Haccp System on Guava Nectar Production Line

Shalaby, M. T.; M. M. Rabie; N. A. El Boraie and M. H. Toyour
Food Industry Department, Faculty of Agriculture, Mansoura University, Egypt

ABSTRACT

HACCP is a key part of modern food safety management applications such that design, implementation, control and management of HACCP systems are crucial to the production of safe food products. Whilst it is widely accepted that food companies should apply HACCP, understanding of the factors affect successful HACCP application is limited and this knowledge is important to the delivery of systems that will control all relevant food safety hazards. An important portion of fruit production is processed into nectar .‘‘Nectar, refers to non-alcoholic beverages produced by dilution of fruit pulp or juices. Nectar is commercialized from a single fruit or more. ‘‘Nectar must contain at least 25 – 50 % fruit juice, depending on the type of fruit. This study presenting the application of HACCP and focuses on the flow diagrams based on the production line of manufacture guava nectar in Egyptian Canning Company (BEST) located in Delta region of Egypt. It also studying the effect of Pasteurization and storage on physiochemical characters, moisture, ash, protein, total color density, vitamin C and amino acids in guava nectar. It also presents an analyses of the hazards and the critical control points (CCP) and monitoring them beside verification to assure that the HACCP system is working effectively.

Keywords: Haccp, Guava nectar, Microbiological quality, Color density

INTRODUCTION

The demand for safe and high quality food is increasing. Many food safety systems such as total quality management, ISo 9000, HACCP have been developed and improving the food industry

Historically, acid foods such as fruit juices has been considered safe, anyway, the latest foodborne disease outbreaks ascribe to un pasteurised juices contamination by pathogens such as *Salmonella spp.* and *Escherichia coli O157:H7* has indicate that un pasteurised juice may be a transport for food borne illness (Australian Department of Health and Ageing, 1999)

The HACCP system is a very good way to ensure the food safety from the farm to the final consumption. This system was developed by the US Space Agency for the astronauts to obtain a safe food product because in this period the only concern was the control of the final product (Bardic 2001, Bennet and Steed 1999, Mortimore and Wallace 1997).

HACCP is a system aimed to redue all hazards associated with food production, as well as development of preventive measures to ensure that the production process is monitored from beginning to end and not only following the final product (A simple guide... 1993).

Most microorganisms can cause very large damage to fruit juices and lead to very many changes in the final product such as color, flavor and smells. Corruption in yeast is the most common type of corruption in fruit juices (Tournas, *et al.* 2006). reduce pH of juice can be a protection against juices from many bacteria as they can stop their activity *Bacillus coagelans* These bacteria are responsible for the corruption of acidic beverages, as they have the ability to grow in different pH levels 4 (Chang and Kang 2004).

Fruit juices remove detoxification in the human body; also, fruit juices play an important role in the modern diet of many societies as they are infertile in their content of minerals and vitamins and thus provide the body with its needs and are given a delicious taste. The juices are either naturally concentrated or mixed with other prepared types (Franke *et al.* 2005).

Fruit juice is made up of water, sugar, and preservatives, colors and fruit pulp. Citric acid is one of the most famous organic acids in fruits. It plays an important role in protecting the juice from microbes and thus acts as a preservative. For water, it is a major source of contamination in food factories where it is a source of bacteria like Coliforms, faecal coliforms, faecal Streptococci, etc. The surrounding environment can make fruit unsuitable for human consumption and may keep a part of the spread of microbes such as *Salmonella sp*, *Shigella sp*, *Vibrio sp*, *Escherichia coli* and others and cause diseases as well as fruits spoilage (Doyle, *etal.*, 2001). The aim of this study is to apply the HACCP as a food system, during production of guava nectar, it’s packaging on tetra pak packaging for high safety, high quality and healthy product .it also studying the effect of pasteurization and storage on physiochemical parameters, moisture, ash, protein, total color density, vitamin C and amino acids in guava nectar.

MATERIALS AND METHODS

Materials

Fruits (Guava)

Guava (*Psidium guajava*) was purchased from the local market and transported to the factory of Egyptian canning company (BEST).

Sugar

Sugar used was of commercial grade of Dakahlia Company at Al-Dakahlya, Egypt.

Water

Ground water taken from the ground is used and the water is filtered by a treatment plant before entering the production stages.

Citric acid and Pectin

Were obtained from Egyptian canning company (Best), Menyat Sammanoud, Aga, Dakhahlia, Egypt.

Culture media

Total plate bacterial counts medium, coliform bacteria medium, Yeast and molds medium and *Bacillus cereus* medium were purchased from Cairo Chemical Company, Cairo, Egypt.

Tetra Pak packaging

Reel of tetra pak paper, it is printed in kingdom Saudi Arabia

Methods

1-Preparation of guava nectar

Guava juice was prepared in juice preparation laboratory by adding guava pulp then reconstituted by water to make starter concentration then add sugar solution to make the finished concentration.

2- Application of HACCP system

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

Assemble the HACCP team (step 1)

Fill out product description and intended use forms (Step 2 and 3):

Construct a process flow diagram and conformable with real steps on plant (Step 4 and 5)

Principle 1: conduct a hazard analysis (step6):

Principle 2: Determine Critical Control Points (CCPs) (step 7):

For each process step where a significant hazard has been identified using CCP decision tree Fig. (1) and your own common sense to determined CCPs.

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

Principle 4: Establish CCP monitoring requirements (step 9).

Principle 5: Establish corrective actions (step 10):Fill out HACCP plan worksheet to fulfillment previously steps.

Principle 6: Establish verification procedures (step 11).

Principle 7: Establish documentation and Record Keeping (step 12).

3- Clean In Place (CIP)

As for CIP, it is one of the programs adopted by factory management to assure the effectiveness of cleaning procedures and it is considered to be a routine daily work.

4-Microbiological assay

The total aerobic bacterial count were determined using nutrient agar medium according to Difico Manual (1985). Potato dextrose agar medium was used for yeast and mold counting Nottingham, *et al. (1971*). MacConkey agar medium was used for counting coliform bacteria according to (Eaton*, et al* 2005).

The *Bacillus cereus* was examined using *Bacillus cereus* bacteria medium according to (Corry, *et al* 2003).

5- Measurement of hydrogen peroxide concentration

As for hydrogen peroxide, it is one of the programs adopted by factory management to assure effectiveness of concentration of hydrogen peroxide and it is considered to be a routine daily work. A relationship between density and temperature, hydrometer was used to measure the density as well as the thermometer to measure the temperature; it was measured by the recommendations of Tetra Pak.

6-Residue of hydrogen peroxide

Was enumerated as recommended by (Merckoquant 2005).

7- Sealing test of tetra pak packaging

The packaging sealing shall be tested after packing by some tests such as (transversal sealing and longitudinal sealing) that carried out in the factory periodically throughout the production process.

Processing / Preparation of guava nectar

Guava received and removal of damaged and immature fruits were removed. Is then rinsed by hot water at 80-85C˚ for 30sec to remove dirt, small leaves of the fruits pocket and reduce microbial load. Then the process of crushing and extracting juice. After this, the seeds of the fruit were removed. The pulp is collected in tank and sends to juice blending tank. Then water was to make primary focus, which required increasing it followed the final texture. Then sugar solution was (melt pectin as well as a simple amount of citric acid to adjust the taste) until reach the final focus (15 B˚). After that, the juice was tasted and adjust the pH (3.8 – 3.9). The next stage is pasteurization of juice at 105 C˚ for 15 sec in Pasteurizer then juice is transfer to the Holding stage in pasteurizer then transfer to cooling stage in Pasteurizer and then to the packaging process in aseptic packaging Tetra Pak. Then the seals are confirmed by some tests on (transversal sealing and longitudinal sealing Recommendation from Tetra Pak Company)

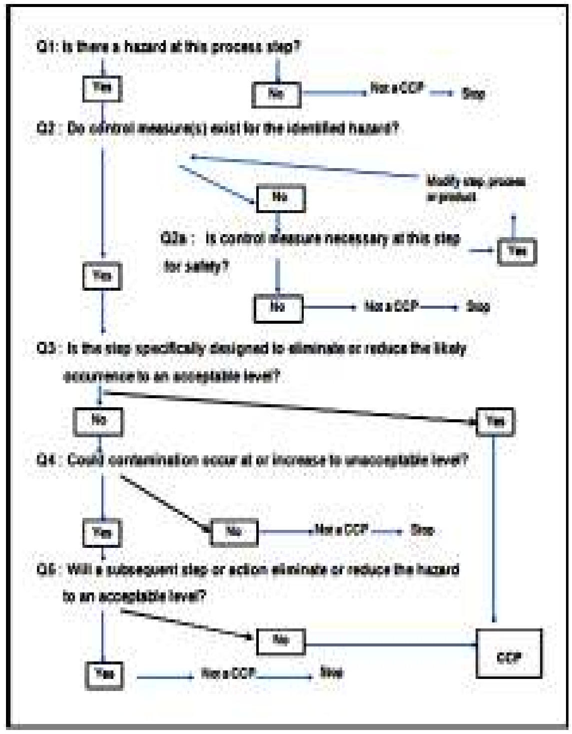

Fig. 1. The CCP decision tree (Corlett, 1998; Efstratiadis and Arvanitoyannis, 2000; Horchner *et al*., 2006)

RESULTS AND DISCUSSION

Application of HACCP system during manufacturing of guava nectar

Assemble the HACCP team (step 1)

Assignment of safety and quality team, these tow team were already assigned as official employees at Egyptian canning company (BEST).

Establish verification procedures (Step 11)

The HACCP systems are the basic for safety rule. This system has been developed to ensure food safety from microbiological hazards. The HACCP system is a self-contained preventive program aimed at food safety. The requirements for its success are adherence to GMP principles (Rushing and Ward, 1999).

From Fig. (2-3), which presented flow diagram for manufacturing of guava juice with estimating the CCPs, determined 4 critical control points, including: pasteurization step, concentration of hydrogen peroxide, Residue of hydrogen peroxide and sealing of tetra pak packaging.

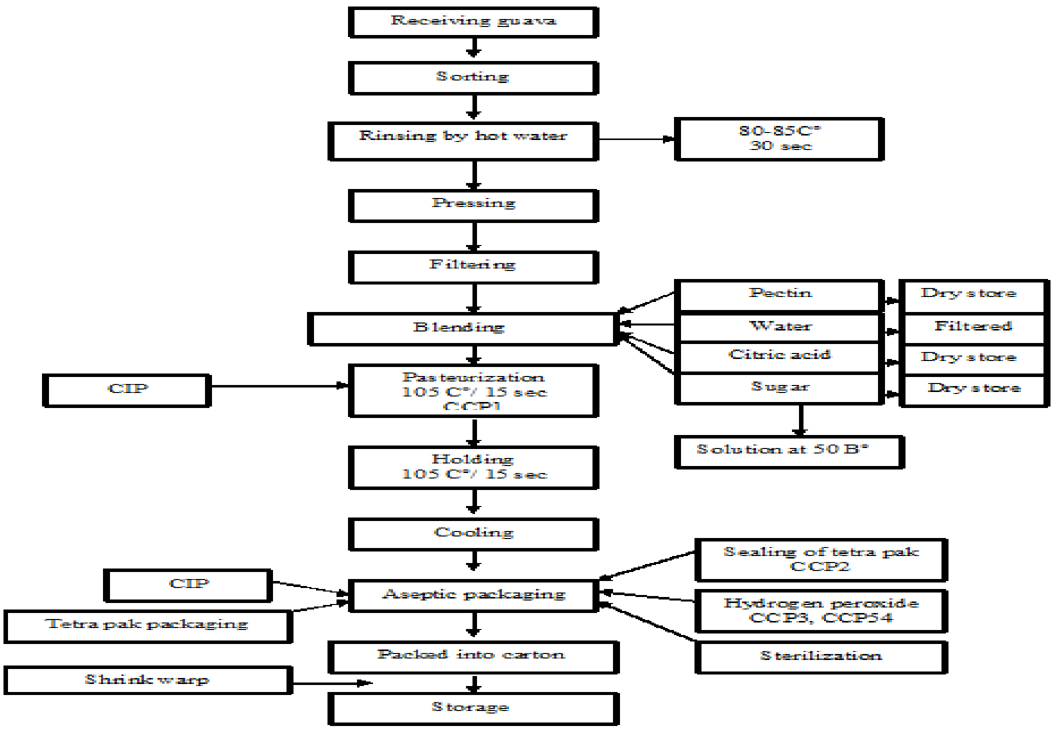

Fig. 2. Flow diagram of guava nectar preparation

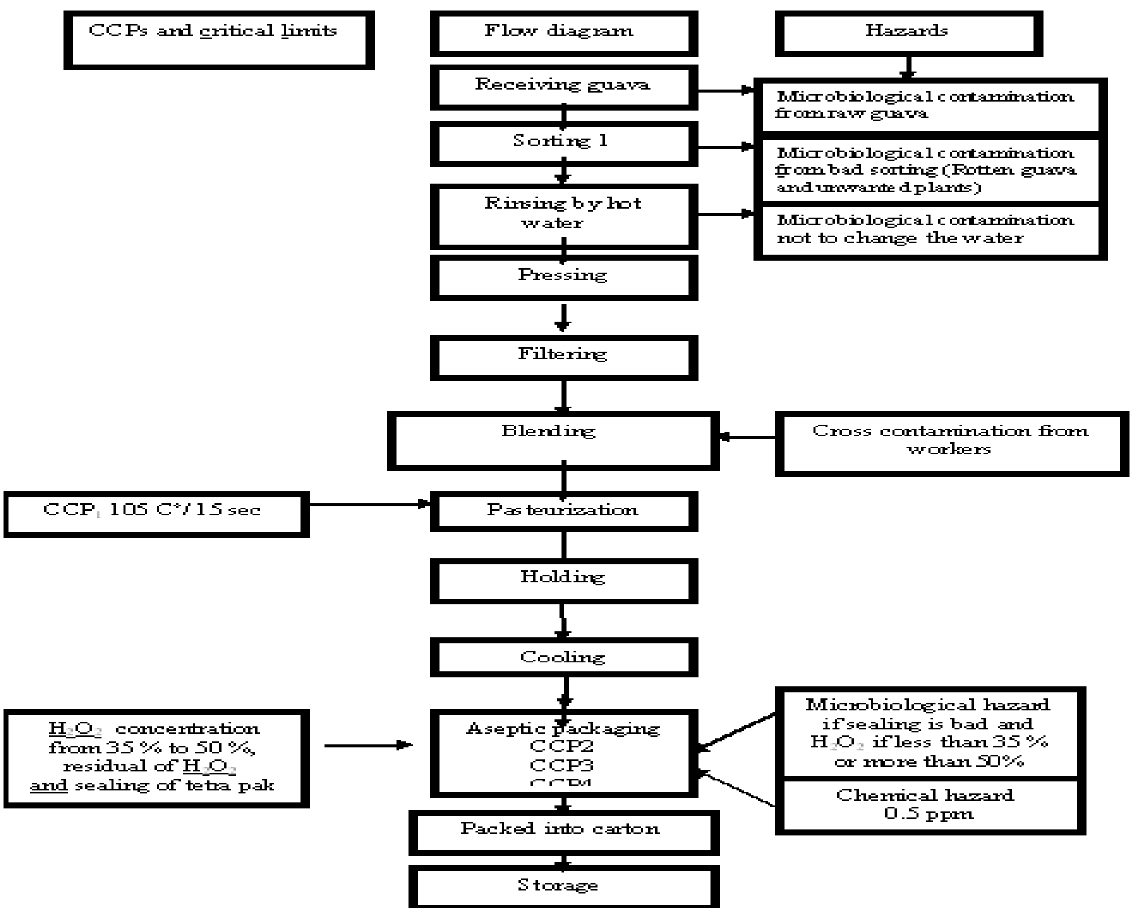

Fig. 3. HACCP Flow diagram of guava nectar preparation

PRODUCT DESCRIPTION PAPER

Product: Guava juice **Plant: Line of manufacture guava nectar**
TYPE: drink **Date: October, 2013**
Prepared by: HACCP team

DESCRIBE PRODUCT PAPER	
Product: Guava	**Plant:** Line of manufacture guava nectar (Tetra pak)
Type: drink	**Date :** October ,2013
Prepared by : HACCP staff	
The following questions should be answered when the product describe :	
1- Description A canned guava product in a sterile container (Tetra pak), containing pulp 25% , the pH is 3.8-3.9 , its mixing with another additives such as water, sugar solution 50 % Brix, citric acid and pectin and preservative free	
2- What is the common name? Guava nectar	
3- What the expirty period? What is the method of storing? 12 months at room temperature	
4- Intended use :Keep refrigerator after opining , Keep away from high temperature	
5- Where it sealing points?At supermarkets	
6- Target consumer :All persons of different ages	
7- How the product consumed?Cold drink	

CRITICAL LIMITS & MONITORING & CORRECTIVE ACTIONS WORKSHEET						
Product: Guava nectar			**Plant:** Line of manufacture guava nectar (Tetra pak)			
TYPE: drink			**Date:** : October 2013			
Prepared by: HACCP team						
A CCP	**Critical limits**	**Monitoring**				**Corrective actions**
		Object	**Method**	**Frequency**	**Responsible**	
1- Pasteurization	Temperature (102-105C°) /15 sec	Temperature	Automatic	Hourly	Operator and Q.A inspector	Reheat treatment
2- Concentration of H_2O_2	35-50%	Concentration	Manual by Hydrometer and thermometer	Daily	Operator and Q.A inspector	Replace with another
3- Residue of H_2O_2	.5 p.p.m	Residue of H_2O_2	By strips A certain color is given at a given concentration	Daily	Q.A inspector	Stop machine if it up to .5 p.p.m
4- Sealing of tetra pak packaging	The Strip separates (Delaminates) when it's pulled off. The seal remains intact but a delaminates between the two inner coatings takes place.	Sealing	Manual Longitudinal sealing(LS) , Strip Applicator(SA) and Transversal sealing(TS) Red dye (T.S , Strip)	Hourly	Q.A inspector	Stop machine if sealing is bad

In addition, used some microbiological analyses such as total bacterial, yeast and mold counts, coliform group and *Bacillus cereus*. Chemical analysis such as chemical composition (moisture, protein, ash) and chemical quality attributes vitamin C and amino acids contents . physical characteristics such as pH value, acidity, Brix and total color density were determined. To monitor system and finding any deviation to control, to insure it. All these attributes must be in Egyptian Standards 1602-1/2005[a], finally produced high safety and quality products for consumers.

Microbiological quality of CIP for pasteurizer and filling machine:

Table (1) showing that total bacterial count in pasteurizer after CIP is not detected during 8 days of study period. On the first day, it was found that bacterial count was 1×10^1 /cm in filling machine. Whenever the obtained data declared the presence of bacterial contamination, cleaning was repeated to assure the safety of the machine before filling of juice.

In food industry, cleaning-in-place (CIP) is a common practice, which a series of rinsing steps was performed using in-situ method, without dismantling the process equipment (Tamime, 2008).CIP is an important process in maintaining the hygiene aspect in food processing plant. Single stage alkaline based cleaning detergent was used in many cleaning studies. as reported by , Law *et al*. (2009) and Liu *et al*. (2006b)

Table 1. Bacterial analysis of Pasteurizer and filling machine after (CIP)

Day	Total bacterial count, cfu /cm	
	Pasteurizer	Filling machine
1	0×10^1	1×10^1
2	0×10^1	0×10^1
3	0×10	0×10^1
4	0×10^1	0×10^1
5	0×10^1	0×10^1
6	0×10^1	0×10^1
7	0×10^1	0×10^1
8	0×10^1	0×10^1

Microbiological analysis of water:

The Data in Table (2) showing that, all samples were contaminated by a total bacterial count, mold and yeast, whilst coliform and *Bacillus cereus* were not detected. This means that water treatment is done with high efficiency.

Table 2. Microbiological analysis of water (Cfu / 1 ml)

Day	Microbial count , cfu / ml			
	Total bacteria	Yeat and molds	Coliform	*Bacillus cereus*
1	89	30	N.D	N.D
2	40	50	N.D	N.D
3	42	65	N.D	N.D
4	18	50	N.D	N.D
5	20	38	N.D	N.D
6	17	37	N.D	N.D
7	15	28	N.D	N.D
8	44	30	N.D	N.D

N.D = Not detected

Microbiological analysis of guava juice before pasteurization:

Results in Table (3) showing that there were great variations among total bacterial count, mold and yeast count, coliform count and *Bacillus cereus*. These variations are expected once , these data refer to non sterilized juice.

In spite of the potential benefits offered by fruit juices, concerns over their safety and quality have been raised; as freshly prepared juices have no process or steps to minimize the microorganisms if they are contaminated (Mahale *et al*., 2008).

Microbiological analysis of guava juice after pasteurization and after storage for 6 months:

The data from Table (4), showing guava juice after pasteurization. In the first day 1 cfu/ 1ml of total bacterial count and mold & yeast were observed. This contamination cause because Longitudinal sealing temperature is low and thus the entry of microorganisms. On the fourth, sixth and seventh days 1 cfu /1 ml was observed . Results in table .4 showed also that both coliform and *Bacillus cereus* were not detected that is in agreement with Egyptian Standards 1602-1/2005.

The data obtained showed also that guava juice after storing 6 months not containing any microbes. Mendoza *et al.* (1982) stated that *Rhodotorula, Pichia, Candida and Saccharomyces* were frequently isolated from pasteurized fruit juices. Hatcher *et al.* (2000) and Parish and Higgins (1989) had also reported that yeasts were the major spoilers of fruit juice,*Candida spp* and *Saccharomyces spp*.

Table 3. Microbiological analysis of guava juice before Pasteurization (cfu / 1 ml)

Day	Sample	Microbial count , cfu / ml			
		T .B	Molds and yeast	Coliform	*Bacillus cereus*
1	Start of production	5	9	1	7
	Middle of production	43	115	43	20
	End of production	15	30	2	17
2	Start of production	12	100	25	44
	Middle of production	50	50	15	20
	End of production	20	15	16	10
3	Start of production	65	49	30	56
	Middle of production	105	20	10	19
	End of production	44	52	16	7
4	Start of production	60	17	12	9
	Middle of production	89	63	15	56
	End of production	4	2	2	4
5	Start of production	33	30	20	30
	Middle of production	56	65	45	59
	End of production	33	20	12	10
6	Start of production	77	35	20	22
	Middle of production	120	65	14	25
	End of production	26	12	10	14
7	Start of production	59	112	8	58
	Middle of production	56	44	35	29
	End of production	62	55	30	20
8	Start of production	89	59	38	46
	Middle of production	56	41	32	9
	End of production	110	38	40	15

T.B. =Total bacterial count.

Table 4. Microbiological analysis of Guava juice after Pasteurization (cfu / 1 ml) (CCP1)

Day	Sample	Microbial count , cfu / ml			
		T.B	Molds and yeast	Coliform	*Bacillus cereus*
1	Start of production	1	1	N.D	N.D
	Middle of production	1	1	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
2	Start of production	N.D	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
3	Start of production	N.D	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
4	Start of production	N.D	N.D	N.D	N.D
	Middle of production	1	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
5	Start of production	N.D	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
6	Start of production	1	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D
7	Start of production	N.D	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	1	N.D	N.D	N.D
8	Start of production	N.D	N.D	N.D	N.D
	Middle of production	N.D	N.D	N.D	N.D
	End of production	N.D	N.D	N.D	N.D

N.D = Not detected T.B. =Total bacterial count.

Microbial analysis of packaging material:-

Table 5 shows that hydrogen peroxide an effective with microorganisms and this result is in agreement with those of Wang and Toledo, (1986) they showed that hydrogen peroxide kills a wide variety of organisms.

Table 5. Microbial analysis of packaging material

Day	Total bacterial count, cfu ×10^1/cm	
	Before dipping on peroxide	After dipping on peroxide
1	8.0	0
2	6.2	0
3	7.6	0
4	8.6	0
5	5.6	0
6	8.0	0
7	4.2	0
8	5.8	0

Measurement of hydrogen peroxide concentration (CCP2)

The results of hydrogen peroxide concentrations are summarized in Table 6 showing that H2O2 concentrations increased day after day, and on the eighth day, the concentration was 35% due to change after a week of work. This increase in concentration was due to the increase in the density of peroxide and is believed to increase the intensity of paper sterilization and its degradations, which leads to increased density of peroxide and thus increasing concentrations day by day.

Table 6. Concentration of peroxide (CCP2)

Day	Density	Temperature, C°	Hydrogen peroxide concentration,%
1	1.095	70	35
2	1.102	70	37
3	1.110	70	39
4	1.117	70	41
5	1.124	70	43
6	1.131	70	45
7	1.140	70	47
8	1.095	70	35

Measurement of hydrogen peroxide residue in the finished product :-(CCP3)

In Table 7 result showing that hydrogen peroxide residue is 1 p.p.m in the first day and this may be increased peroxide residue in the final product is air knife or calender roller, indeed, the problem is in the calendar roller. When measure peroxide residue after treatment, hydrogen peroxide (0.5 p.p.m) was observed.

FDA regulation limits residual H2O2 to 0.5 p.p.m in finished food packages (Code of Federal Regulations, 2000).

Table 7. Hydrogen peroxide residue in the finished product: :-(CCP3)

Day	Hydrogen peroxide residue, p.p.m
1	1
2	.5
3	.5
4	.5
5	.5
6	.5
7	.5
8	.5

Sealing of tetra pak packaging (CCP4)

In Table 8 results show that observed L.S (Longitudinal sealing) was damaged due to sealing process and observed that heat is 245 C° but the normal heat is 260 C°and when injecting strip by red dye it observed problem in the sealing so stopped the machine and solve the problem and in the middle of production in the same day observed the same problem, and where's the decrease of heating temp. during sealing had caused this damage.

Documentation and record keeping (step 12)

Efficient and accurate record keeping is essential to the application of a HACCP system. HACCP procedures should be documented. Documentation and record keeping should be appropriate to the nature and size of the operation and sufficient to assist to verify that the HACCP controls are in place and being maintained.

Table 8. Sealing of tetra pak packaging (CCP4)

Day	Sample	Test strip (LS,SA) By hand	Test strip (LS,SA) By dye (injection)	Test T.S By hand	Test T.S By dye
1	Start of production	Bad	Bad	Good	Good
	Middle of production	Bad	Bad	Good	Good
	End of production	Good	Good	Good	Good
2	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
3	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
4	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
5	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
6	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
7	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good
8	Start of production	Good	Good	Good	Good
	Middle of production	Good	Good	Good	Good
	End of production	Good	Good	Good	Good

L.S: Longitudinal sealing T.S: Transversal sealing
S.A: Strip applicator

CONCLUSION

This study detected that the control points of safety were Pasteurization, cooling and Packaging, while the control points of quality from receiving of raw material to the finished product. The guava nectar can have high safety and quality if all CCPs in the processing are under control.

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تطبيق نظام الهاسب على خط انتاج نكتار الجوافة

محمد طه شلبى ، ممدوح محمد ربيع ، نعيم عبد اللطيف البرعى و محمود حشمت محمود طيور
قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة – مصر

يعتبر نظام تحليل المخاطر والتحكم في النقاط الحرجة عنصرا رئيسيا فى الممارسة الحديثة لادارة سلامة الأغذية ،بحيث أن تصميم أنظمة تحليل المخاطر ونقاط الرقابة الحرجة وتنفيذها ومرافبتها وادارتها أمر حاسم لانتاج منتجات غذائية مأمونة فى حين أنه من المقبول على نطاق واسع أن تقوم شركات الأغذية بتطبيق نظام تحليل المخاطر والتحكم فى نقاط التحكم الحرجة. وينتج نكتار الفاكهة من تخفيف مركز الفاكهة بالماء وهو يتكون من نوع واحد من الثمار أو أكثر من نوع . وتقدم هذه الدراسة ارشادات لتطبيق نظام تحليل المخاطر خلال انتاج نكتار الجوافة فى شركة المعلبات المصرية (بست) والموجودة فى نطاق الدلتا فى مصر كما تقدم هذه الدراسة أيضا تأثير البسترة والتخزين على الصفات الفيزيوكيميائية والرطوبة والرماد والبروتين واللون وفيتامين سى بالاضافة الى الأحماض الأمينية فى نكتار الجوافة ويقدم هذا النظام تحليلا للمخاطر ونقاط التحكم الحرجة ومراقبتها للتأكد من أن النظام يعمل بكفاءة عالية .

الكلمات الدالة : الهاسب ، نكتار الحوافة ، الجودة الميكروبيولوجية و كثافة اللون