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Application of hazard analysis critical control points (HACCP) system to vacuum-packed sauced pork in Chinese food corporations

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ABSTRACT

Our study aims to establish an HACCP system which was implemented for the quality assurance of vacuum-packed sauced pork processing in Chinese food corporations. After identified hazards, the critical control points were defined using a decision tree. In addition, the vacuum-packed sauced pork products, manufactured by three corporations, were detected for chemical and microbial contaminants before and after the implementation of the HACCP system, respectively. According to the national food hygiene standards accepted by PR China, for nitrite, aerobic plate count and coliforms, the percentage of products obtained before vs. after the implementation of HACCP satisfying the standards was 86.2% vs. 100%, 71.3% vs. 96.4% and 71.3% vs. 95.5%, respectively. In conclusion, the contaminants of vacuum-packed sauced pork can be reduced or eliminated if an HACCP system is applied effectively.

1. Introduction

Sauced pork is one of favorite ready-to-eat food in the People's Republic of China because of its convenience, rich nutrition and good taste. Specially, vacuum-packed sauced pork which has longer shift life is common in almost every super market. Thus, this popular food presents an ideal substrate supporting the growth of several spoilage and pathogenic bacteria. Intrinsic factors of meat such as pH and water activity are not inhibitory to growth of such microorganisms owning to their neutral and high initial values, respectively (Mataragas & Drosinos, 2007). Pathogenic bacteria and virus inhabited in meat production constitute a large proportion of all food-borne illness (EFSA, 2007). Besides, the chemical residue would be high if food additives were not properly implemented. For example, nitrite is usually used as food additive in meat products, which can develop pink color, inhibit the growth of food bacteria, contribute to the favor and the texture, etc. (Cassens, 1997). However, nitrite is an important precursor of N-nitroso compounds, the latter can be carcinogenic and mutagenic (Cassens, 1995; Jay, Loessner, & Golden, 2005). Although the sauced pork has become more popular in recent years, the microbial and chemical qualities of this product need to be taken into consideration by the food corporations and consumers.

Classical quality control methods only emphasized on hygienic quality of end products rather than processing are inadequate to control these hazards which were diverse. To provide safe food and prevent food-borne illness outbreaks, hazard analysis critical control point (HACCP) programs are recommended. The HACCP system was originally developed as microbiological safety system that was used in the production of the food destined to be used in space in the early days of the USA manned space program. In the early time, the HACCP system only applied in the army to ensure the food safety (Mortimore & Wallace, 1998). But in the 1980s, commercial food producers began establishing their own HACCP program (Adams, 1994). The National Advisory Committee (NAC, 1998) defined HACCP as "a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazard from raw material production, procurement and handling, to manufacturing, distribution, and consumption of the finished production." The HACCP system could identify and assess the potential risks associated with the storage, manufacture, delivery of food and the appropriate effective control measures aiming to eliminating or reducing these hazards at specific points of the production line. Therefore, the HACCP is a

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systematic approach to control the potential hazards in a food operation applied in the food industry and other production units.

Although there is a growing demand for sauced pork, no information is available regarding the processes, hazards, preventive measures of this product in PR China. The aims of this study were to establish the HACCP system of vacuum-packed sauced pork in the Chinese food corporations. Since this was the first study of vacuum-packed sauced pork in this country, these results provide basic information about the production of this food.

2. Materials and methods

HACCP is a profitable investment in our society. Setting up an effective HACCP system provides evidence a company is conscious of safety consumer. Therefore, it must be based on a series of scientific principles. The principles of HACCP are defined as below (Codex Alimentarius Commission (CAC), 1997):

P1: List the steps in the process where significant hazards occur and describe preventive measures.
P2: Identify the critical control points (CCPs).
P3: Determine the critical limits for preventive measures associated with each CCP.
P4: Establish CCPs monitoring requirements.
P5: Establish corrective actions to be taken when monitoring indicates a deviation from an established critical limit.
P6: Establish effective record-keeping procedures.
P7: Establish procedures for verification that the HACCP system is working correctly.

2.1. Establishment of HACCP plans

HACCP is applied from the raw material reception stage to final storage before final production distribution. These processing were made up in accordance with the Codex Alimentarius Commission (Codex Alimentarius Commission (CAC), 1997). In these studies, Good Manufacturing Practice (GMP) and Sanitation Standard Operating Procedure (SSOP) considerations are included in the HACCP studies. Therefore, a written questionnaire was developed for this study at first. Thirty five sauced pork corporations located in Wuhan, Hubei province of PR China were obtained in this investigation. Table 1 included 21 questions related to Good Manufacturing Practice (GMP) procedures, including prerequisite programs such as sanitation, hygiene procedures and managements, and procedures for packaging and storage. Yes/no responses were given for each question. After the investigation, three food corporations (replaced by A, B, C) were obtained to establish the HACCP plans.

Step 1: An assembly of the HACCP team.

Before setting up an effect HACCP plan, it was first to ensure that all relevant knowledge and expertise was available. The HACCP system mainly focuses on microbiological, chemical, physical and biological hazards, but expertise relating to the processes and process control plays an essential role in the sessions of the HACCP teams. Therefore, senior dietitians, managers and staffs who prepared and administered the sauced pork' manufacturing were needed to setting up the HACCP system. These specialized persons and staffs make up the HACCP team.

Step 2: Product description of vacuum-packed sauced pork (Table 2).
Step 3: Construction of flow chart of processing.

The HACCP processes should be systematic and successive, so flow chart was prepared including all relevant steps including acquisition of the raw materials, storage, mixing, boiling, package and so on (Fig. 1). Then, the accuracy of the flow chart should be verified by the HACCP team. If unanimity was attained by the HACCP team, the flow chart shouldn't be changed in later research.

Steps 4–5: Hazard analysis, determination of critical control points (CCP).

Understanding the potential pollution of the vacuum-packed sauced pork and manufacturing was essential for preparing an HACCP plan. Some pollution could be eliminated sufficiently in the operation, but others were not. Therefore, knowledge of possi-

Table 1
Hygienic conditions investigation of sauced pork corporations ($N = 35$).

GMP[a] procedure of sauced pork corporations		Yes *n* (%)	No *n* (%)
Sanitation requirements of factory environment	Flat and dry	33 (94.7)	2 (5.3)
	Plentiful water resources	35 (100.0)	0 (0.0)
	No toilet, garbage plant, chemical plant and so on nearby	35 (100.0)	0 (0.0)
	No bug dust, harmful gas, radioactive contamination nearby	35 (100.0)	0 (0.0)
Sanitation requirements of workshop	Separate raw meat and cooked meat processing area	32 (91.4)	3 (8.6)
	Air purification equipments	33 (94.7)	2 (5.3)
	Independent dressing-room	33 (94.7)	2 (5.3)
Requirements of production supervisors and technicians	Health certification	32 (91.4)	3 (8.6)
	Hygiene training	26 (73.7)	9 (26.3)
	Apinoid uniform, glove, hat and mask	31 (89.5)	4 (10.5)
Requirements of equipments	Qualified production equipments	34 (97.1)	1 (2.9)
	Hygienic container	31 (89.5)	4 (10.5)
	Sterilizing facilities	33 (94.7)	2 (5.3)
Hygienic requirements of raw materials and auxiliary materials	Qualified raw meat examined by veterinarian	35 (100.0)	0 (0.0)
	Detailed use records of auxiliary materials	22 (63.2)	13 (36.8)
	Segregated depository of raw materials and auxiliary materials	32 (91.4)	3 (8.6)
Hygienic requirements of production	Detailed hygienic management system and operation norm	30 (85.7)	5 (14.3)
	Detailed production record	28 (80.0)	7 (20.0)
Hygienic requirements of packaging and storage	Effective air sterilization equipment in packaging workshop	33 (94.7)	2 (5.3)
	Standard refrigeration room	35 (100.0)	0 (0.0)
	Detailed records of temperature, time and pressure	24 (68.4)	11 (31.6)

[a] GMP, good manufacturing practice.

Table 2
Product description of vacuum-packed sauced pork.

Product name	Vacuum-packed sauced pork
Raw materials	Animal and poultry meat
Auxiliary materials	Salt, monosodium glutamate, cooking wine, chili, perfuming agents, food additives and so on
Processing methods	Boiled
Product characteristic	Sensory index: The product has a natural color, smell and taste, no foreign body attached, no bad smell Hygienic index: High water activity, neutral pH value and room temperature. Aerobic plate count $\leqslant 8 \times 10^4$ cuf/g, coliforms $\leqslant 150$
Usage	MPN/100 g, pathogens can not be detected, nitrite $\leqslant 30$ mg/kg
Package	Ready-to-eat
Guarantee period	Vacuum-packed
Production sites	Six months with vacuum-packed Food factories and restaurants

ble microbiological, chemical, physical and biological hazards connected to the processes under evaluation was essential for the HACCP team. After identifying the hazards and the control measures which did or did not exist, we defined a step or procedure at which control can be applied and a food safety hazard can be prevented, eliminated, or reduced to acceptable levels. This step or procedure was critical control point (CCP). The selection of CCPs was aided by the use of a CCP decision tree (Fig. 2 and Table 3). This decision tree was designed to allow the HACCP team to ask specific and logical questions to help determine what was truly a critical control point vs. a control point or something that could be handled under the GMPs (Good Manufacturing Practices) or SOPs (Standard Operating Practices). Although this Decision Tree was not perfect, it was certainly useful to focus the attention of the team on what should be used in a HACCP plan to control hazards.

Steps 6–8: Establishment of critical limits, monitoring methods and corrective actions to each CCP.

To each CCP, specification, critical limits, monitoring methods, frequency and corrective actions were maximum validity to reduce the hazards (Table 4).

Steps 9–10: Establishment of effective record-keeping procedures and verification procedures.

Various kinds of documentation models were supplied to the sauced pork corporations for monitoring selected CCPs and ensuring appropriate corrective actions.

2.2. Sample collection

A total of 94 and 110 vacuum-packed sauced pork samples were obtained for chemical and microbiological contaminants examination before and after the implementation of the HACCP system in these three corporations which applied the HACCP system during a 12-month period, respectively. Various types and batches of sauced pork were randomly collected. Besides, 85 air-packed sauced pork samples were detected from markets as control group. Each sample was taken by scrubbing a 100-cm^2 area from three

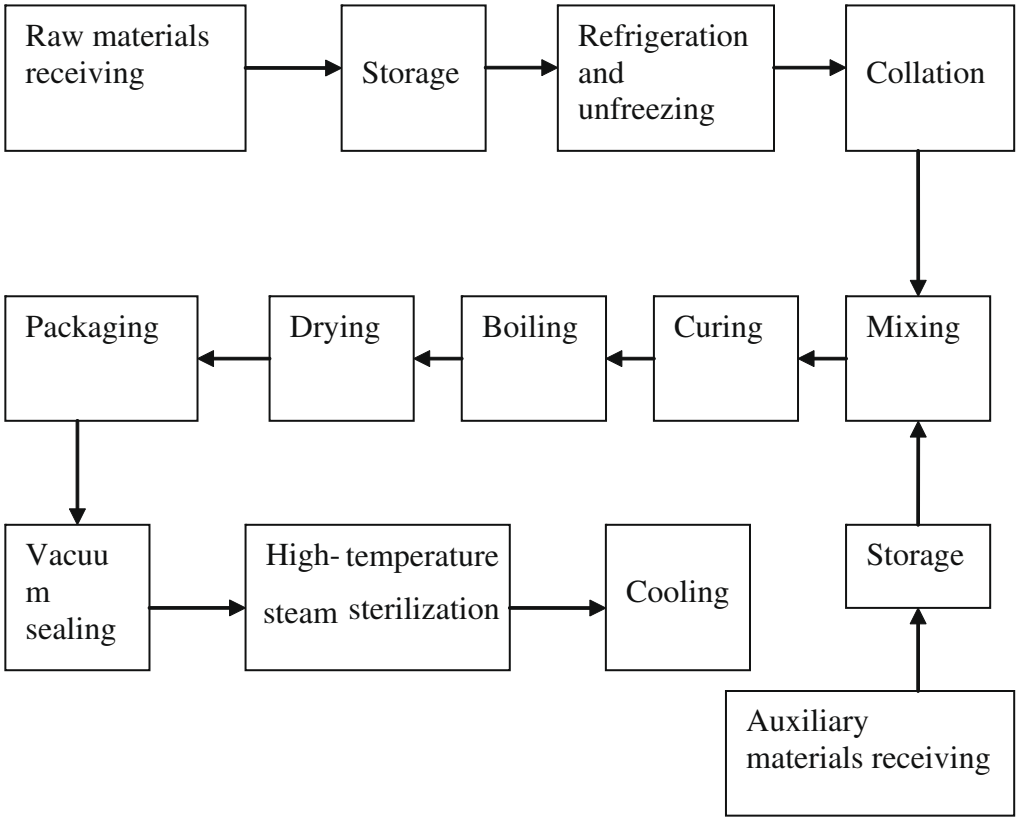

Fig. 1. A common simplified flow diagram can be constructed for vacuum-packed sauced pork.

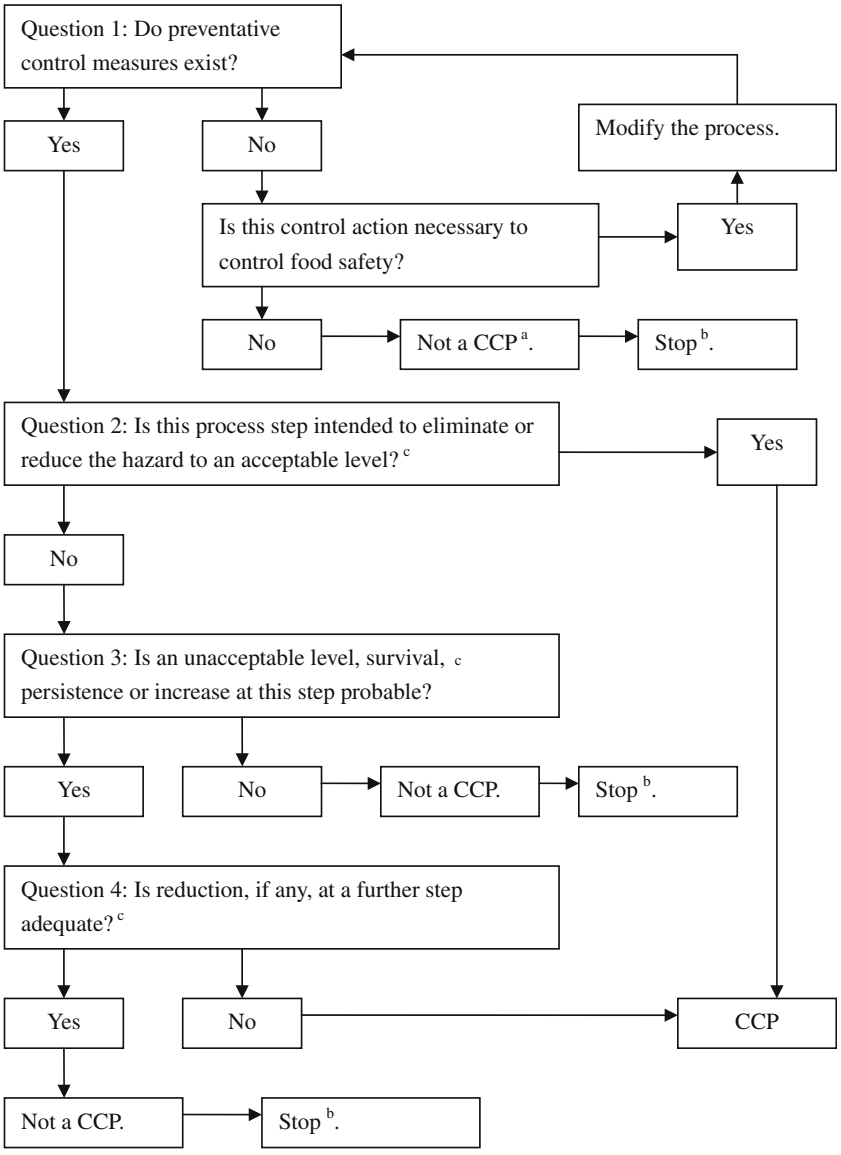

Fig. 2. Four questions should be included in the CCP decision tree of the HACCP system. [a]CCP = Critical Control Point. [b]Proceed to the next identified hazard in the described process. [c]Acceptable and unacceptable levels need to be determined within the overall objectives in identifying the CCPs of the HACCP plan.

Table 3
Decision of critical control points (CCPs).

The processing steps	The questions of CCP decision tree[a]				Whether CCP, or not	Main hazards
	Question 1	Question 2	Question 3	Question 4		
Raw materials and auxiliary materials receiving	Yes	Yes			CCP	Biological, chemical and physical pollutions
Storage	Yes	No	Yes	Yes	Not	
Refrigeration and unfreezing	Yes	No	Yes	Yes	Not	
Collation	Yes	No	Yes	Yes	Not	
Mixing	Yes	Yes			CCP	Abused food additive
Curing	Yes	No	Yes	Yes	Not	
Boiling	Yes	Yes			CCP	Pathogenic microbes
Drying	Yes	No	Yes	Yes	Not	
Packaging	Yes	No	Yes	Yes	Not	
Vacuum sealing	Yes	Yes			CCP	Pathogenic microbes
High-temperature steam sterilization	Yes	Yes			CCP	Pathogenic microbes
Cooling	Yes	Yes			CCP	Pathogenic microbes

[a] The four questions can be found in Fig. 2.

different locations, equidistant from each other at each end and in the middle. All samples were placed in sterile bags and transported to the laboratory at low temperature (<7 °C) and stored at 4 °C, until testing. All samples were analyzed within 24 h after sampling.

2.2.1. Analysis of aerobic plate count, coliforms and nitrite in sauced pork

The APC and coliforms were enumerated by using Plate Count Agar (ACP) and Brilliant Green Lactose Bile (BGLB), respectively (FDA, 1998, chap. 4; FDA, 2001, chap. 3). The content of nitrite in sauced pork was determined by zinc-N-(1-Naphthyl) ethylene diamine dihydrochloride spectrophotometric method (Sunil, 1990).

2.3. Statistical analysis

Results were reported as percentage of samples testing exceeding the nitrite, aerobic colony count and coliforms standards for sauced pork accepted by People's Republic of China. A Chi-square test was performed to compare the rate of isolation. All statistical analyses were conducted using SPSS 13.0 for windows software.

3. Results

GMP standards were categorized into seven parts (requirements of factory environment, workshop, production supervisors and technicians, raw materials and auxiliary materials, packaging and storage), responses to these questions were summarized in Table 1. The majority of food corporations had a high sanitation condition of factory environment, workshop and equipments. 91.4% food corporations reimbursed employees for their examination charges and staffs had health certifications. It was significantly common in food corporations (91.4%) that clear physical separation was provided between raw meat and cooked production areas. All the corporations (100%) purchased qualified raw meat examined by veterinarian, and 91.4% corporations set segregated depository of raw materials and auxiliary materials. Comparatively, the hygiene training and production records were not common. Over a quarter (26.3%) of corporations had not held hygiene training for their managers and staffs. 63.2%, 80.0%, 68.4% had detailed records about use of auxiliary materials, production and storage, respectively.

The overall processes of sauced pork contained 12 steps which were discussed in detail by the HACCP team in Fig. 1. Although each step could be polluted by potential hazards, some of them were eliminated sufficiently in the operation. Therefore, it was necessary to discuss and identify all potential hazards and to evaluate possible critical control point. Based on CCP decision tree (Fig. 2) and the information obtained from HACCP team, the CCPs of the processing were identified. A summary of the CCPs was presented in Table 3. Additionally, the relevant hazards for CCPs, specifications, critical limits, monitoring methods and frequency, and corrective actions of both processes were presented in Table 4.

The results and distribution of nitrite and microbial analyses of sauced pork samples were summarized in Tables 5 and 6. Regarding the distribution, 100% of the samples were found to have nitrite. According to the food hygiene standards accepted by the People's Republic of China (Food Sanitation Standard, 1996), for nitrite ($\leqslant$30 mg/kg), aerobic plate count ($\leqslant 8 \times 10^4$ cuf/g) and coliforms ($\leqslant$150 MPN/100 g), the percentage of vacuum-packed sauced pork products obtained before the implementation of HACCP satisfying the standards was 82.6%, 71.3% and 71.3%, respectively. Comparatively, after the HACCP, the percentage of vacuum-packed sauced pork products was 100%, 96.4% and 95.5%, respectively. For the distribution, the percentage of vacuum-packed sauced pork samples obtained from food corporations which had applied the HACCP system of satisfactory or acceptable chemical quality was higher (for the distribution, see Table 5) when compared with vacuum-packed sauced pork samples obtained from the food corporations before the HACCP, and air-packed sauced pork samples obtained from the markets. For microbiological contaminants, 71.3% and 96.4% of samples were found to have aerobic plate count $\leqslant 8 \times 10^4$ cuf/g, before and after the implementation of the HACCP system, respectively. 71.3% and 95.5% of samples were found to have coliforms $\leqslant$150 MPN/100 g

Table 4
Identification and monitoring of important process (ranked as critical control points) phase in the vacuum-packed sauced pork process.

The processing steps	Hazards	Specifications/critical limits	Monitoring methods and frequency	Corrective actions
Raw materials receiving	Microbiological: potential pathogenic microbes and parasites Chemical: residues of veterinary drugs, agricultural chemicals, hormone and heavy metals Physical: metals, sands	Suppliers provide the conformity certificate of raw pork	Microbiological laboratory, chemical and physical laboratory, every batch	Refuse the unqualified raw materials
Auxiliary materials receiving	Chemical: abused food additive Physical: metals and sand Biological: mouldy auxiliary materials	Suppliers provide the conformity certificate	Microbiological laboratory, chemical and physical laboratory, every batch	Refuse the unqualified auxiliary materials
Mixing	Chemical: abused food additive	Weighing accurately	Console, physical laboratory, every batch	Destroyed
Boiling	Microbiological: potential pathogenic microbes	Keep in boiling temperature at 100 °C. Keep in centre temperature higher than 70 °C	Console, microbiological laboratory, every batch	Re-boiled
Packaging	Microbiological: potential pathogenic microbes Chemical: residues of abluent, cracked plastic	Reports, documents and instructions related to internal hygiene audits and cleaning	Visually, every 0.5 h	Discarded the products
High-temperature steam sterilization	Microbiological: potential pathogenic microbes	Keep in temperature at 100 °C in 20 min	Console, every batch	Discarded the products
Cooling	Microbiological: potential pathogenic microbes	Maximum time of 30 min between sterilization and distribution	Console, every batch	Discarded the products

Table 5
Distribution of nitrite in sauced pork products obtained from different food corporations[a].

Sampling point		No. of samples	Percentage of samples in the following range (%)				
			⩽30[c]	31 ~ 60	61 ~ 90	91 ~ 120	⩾120
A	Before HACCP[b]	32	84.4	9.4	0.0	6.3	0.0
	After HACCP	36	100.0[d,e]	0.0	0.0	0.0	0.0
B	Before HACCP	28	90.5	7.1	3.8	0.0	0.0
	After HACCP	34	100.0[d,e]	0.0	0.0	0.0	0.0
C	Before HACCP	34	85.3	8.8	2.9	0.0	2.9
	After HACCP	40	100.0[d,e]	0.0	0.0	0.0	0.0
	Markets	85	65.9	15.3	4.7	5.9	8.2

[a] 289 samples were tested.
[b] HACCP, hazard analysis critical control point.
[c] mg/kg.
[d] Significant difference from the group which before HACCP at $p < 0.05$ (by x^2 test).
[e] Significant difference from the control group from markets at $p < 0.05$ (by x^2 test).

Table 6
Percentage of aerobic plate count and coliforms not meeting the microbiological standard established by the People's Republic of China in sauced pork made by different place.

Sample type	Sampling points		No. of samples	Percentage of samples not meeting the microbiological standard[a]	
				APC[c]	Coliforms
Vacuum-packed sauced pork air-packed sauced pork	A	Before HACCP[b]	32	25.0	31.3
		After HACCP	36	2.8[e,f]	5.6[e,f]
	B	Before HACCP	28	32.4	25.0
		After HACCP	34	2.9[e,f]	2.9[e,f]
	C	Before HACCP	34	29.4	29.4
		After HACCP	40	5.0[e,f]	5.0[e,f]
Air-packed sauced pork	Markets		85	32.9	31.8

[a] The microbiological standard for sauced pork as following: aerobic plate count, less than 8×10^4 cfu/g; Coliforms, less than 150 MPN/100 g.
[b] HACCP, hazard analysis critical control point.
[c] APC, aerobic plate count.
[e] Significant difference from the group which before HACCP at $p < 0.05$ (by x^2 *test*).
[f] Significant difference from the control group from markets at $p < 0.05$ (by x^2 *test*).

before and after the implementation of the HACCP system, respectively (for the distribution, see Table 6). These were a significant reduction in the aerobic plate count and coliforms after implementation of the system. As the control group, 32.9% and 31.8% of air-packed sauced pork samples obtained from markets were found containing excess aerobic plate count and coliforms, respectively. This finding was significant ($p < 0.05$) when comparing the isolating samples (Tables 5 and 6).

4. Discussion

Good Manufacturing Practices (GMPs) are the foundation of any effective food safety program. GMPs advantage addresses the hazards associated with personnel and the processing environment. So GMPs are considered as the premise of implication of HACCP system. However, most Chinese businesses often emphasize their enterprise scale, workforces and high quality equipments but frequency training, production records and so on which usually called "soft conditions". Specially, to HACCP system, it not only requires financial strength but also tight management. In this study, 73.7% of food corporations' directors reported that they had frequency hygienic training, the percentage of detailed records about using of auxiliary material, production and storage were not high. As a scientific management system, HACCP has strict requirements for these. Take training for example, a report by Oliveira, Mayes (1994) showed that hygiene training of personnel in food corporations in the application of the HACCP was an essential element for effective implementation of HACCP. The aims of the training were to require the staff not only understand what they were doing but why they were doing it, which improved the commitment of personnel to implementation of the HACCP system. Production records were also required strictly in the HACCP system, which rarely appeared in many other food safety procedures. Sukyung and his colleagues (Youn & Sneed, 2003) found that more than 90% of directors reported to have standard operation procedures, but more than half of these directors did not have written procedures for any of these processes, which was a requirement for the HACCP programs.

Sauced pork, as a kind of ready-to-eat food, provided a source of readily available and nutritious meals for the consumer, however, the safety of these foods should be the first priority, since they have characteristic technology and did not receive any heat treatment before consumption. Therefore, sauced pork, like other cooked meat production, was regarded as high-risk food (Ministry of Agriculture & Food (MAFF), 2005). Smerdon, Adak, O'Brien, Gillespie, and Reacher (2001) reported that large outbreaks of infectious intestinal diseases had occurred in the UK and abroad as a result of consumption of cooked meats. Though there were rare centralized investigation about sauced pork in China, distributed food poisoning cases could not be neglected. According to the Food Sanitation Standard of the Republic of China, nitrite, aerobic plate count, coliforms should not exceed 30 mg/kg, 8×10^4 cfu/g, 150 MPN/100 g, respectively. In this study, excessive nitrite, total aerobes and coliforms were detected in the sauced pork samples, which revealed that contaminants in this food presented a potential health hazard to consumers. The aim of an

HACCP system was to reduce these potential hazards in food. After running the CCP decision tree of the HACCP system, five CCPs are chosen by the HACCP team. They were raw materials and auxiliary materials receiving, mixing, boiling, packaging, sterilization and cooling. At each CCP, corrective actions were immediately taken during the sauced pork production. After the implementation of HACCP system, the chemical and bacteriological quality of the sauced pork samples was significantly increased ($p < 0.05$) by the corrective actions, as compared to samples which were obtained from corporations that before HACCP and markets. Implementation of the HACCP system helped to improving the chemical and microbiological quality of sauced pork. However, it should be pointed out that the success of the system does not depend exclusively on chemical and microbiological contaminants results which obtained from the processing. The significance of the results is helpful to show whether or not the HACCP system was working effectively.

Applied the HACCP system, vacuum-packed sauced pork was higher safety than air-packed sauced pork. In this study, the proportion of vacuum-packed sauced pork samples obtained from food corporations which had applied the HACCP system of satisfactory or acceptable chemical and microbiological quality was higher when compared with air-packed samples. However, before applying the HACCP, the proportion of satisfactory microbiological quality vacuum-packed sauced pork samples was not significant when compared with air-packed samples. This finding should be explained that more additives which were added to foods to inhibit spoilage had appeared more frequently in air-packed sauced pork.

Chemical and microbiological contaminants were two main hazards in sauced pork, a variety factors could lead to these pollutions. For chemical contaminants, irregular usage of food additives used as auxiliary material could lead to chemical pollution. In this study, 26.8% of food corporations had not provided a detailed use record of auxiliary material, and some corporation (8.3%) had not separated raw materials and auxiliary materials, which could cause potential hazard of irregular usage. However, the incidence of nitrite in the sauced pork reduced to zero when a HACCP system was applied. A report by Pérez-Rodriguez (Pérez-Rodriguez, Bosch-Bosch, & Garciá-Mata, 1996) shown that nitrite residue would maintain a high level at the first 18 days during refrigeration in frankfurters, but it should reduce gradually. Therefore, effect control measures applied in early processes help to reduce and eliminate the nitrite contaminants in sauced pork. Comparatively, microbiological contaminants were hardly eliminated in food. Many factors could affect the ability of microorganisms to colonize foods. Firstly, time and temperature were two key issues, research in food production system indicated that time and temperature errors occurred where were of unaccepted microbiological quality (Blakelee & Penner, 1999; Kim & Shanklin, 1999). Elson and his colleagues (Elson, Burqess, Little, & Mitchell, 2004) also reported that poor microbiological quality was associated with storage above 8 °C. Secondly, some food additives could also impact of microbial growth. A study by Soultos (Soultos, Tzikas, Abrahim, Georgantelis, & Ambrosiadis, 2008) showed that chitosan addition resulted in significant inhibition of microbial growth, while nitrites did not seem to protect sausages from microbial spoilage. Otherwise, contaminated raw material, cross-contamination during preparation or high storage temperature could take the occurrence of coliforms, especially in high number (Fang, Wei, Liao, Hung, & Wang, 2003). These factors were complex, and increased the difficulty of resolving the food safety issues.

The implementation of HACCP system in food processing provides a pragmatic framework for good hygienic practice. Current European Union proposals to consolidate food hygienic directives currently envisage the application of food safety management procedures based upon HACCP principles, including documentation and verification, to all sectors of the food chain (Food Standard Agency (FSA), 2001). HACCP system emphasized that the relevant hazards were identified, the potential risks were estimated and specific control measures were applied in the CCPs rather than in the ending products. This study had shown that chemical and microbiological contaminants in vacuum-packed sauced pork could be reduced or eliminated if a systematic approach such as HACCP was implemented effectively and maintained. It was better to ensure the food safety of end products. However, it was more important to maintain the HACCP system rather than to establish, the managers of food corporations should ensure the application of HACCP system in their current production.

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