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Research Article

Application of Hazard Analysis and Critical Control Point (HACCP) System in Hygiene Management of Nutritious Food Provided for College Sports Students

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Abstract: Nutritious food poisoning events have increasingly happened in sports students recently. To prevent nutritious food poisoning in college sports students, three nutritious food companies with the daily lunch supply quantity of 12,000, 7,000, 3,000 and one school canteen with the daily lunch supply quantity of 900 are taken as research objects. Through hazard analysis, Critical Control Points (CCP) are confirmed: food purchasing, food cooking and heating, washing and disinfection of cooked food containers, physical condition of employees and hand washing and interval time of food from out of pan to consumption. In addition, relevant intervening measures for CCP are put forward: purchase food by normal way; heat food thoroughly; perform thermal disinfection before every use of cooked food containers; forbid to employ a person who obstructs food hygiene condition; wash and disinfect; restrain interval time of food from out of pan to consumption to less than 3 h. The method is proved to be simple and easy to perform, 4 research objects can strictly carry out intervention measures basically and the supplied nutritious foods meet health requirements.

Keywords: College sports students, food poisoning, Hazard Analysis and Critical Control Point (HACCP), nutrition

INTRODUCTION

Foreign experience indicates that the launch of student's nutritious food is an effective measure to improve student's nutritional status. Nutritious food of college sports students in China starts late and develops slow in few cities. In recent years, the state and government at all levels attach great importance to students' nutritional problem and Beijing municipal government has listed nutritious food project in one of the practical works that have to be done each year for citizens (State Economic and Trade Commission, 2001). Investigation on Students' Nutrition State, Knowledge, Attitude and Eating Behavior, (Liangliang *et al*., 2012) mentioned that college students as a special group are badly in need of reasonable dietary nutrition and good dietary habit under tense study and mental work. College students, high-quality talents cultured by the country are generally the only child from a family due to national population policy, which makes their daily self-care ability poor and psychological quality low, thus affecting talents quality directly. According to the article of Application of HACCP Management System on Food Safety in the University Refectory (Na *et al*., 2013), HACCP acquires critical factors to control links by analyzing various factors influencing product safety in raw material production processes, then forms monitoring procedures and standards and is perfected in the study. Hazard prevention is eliminated or reduced to an acceptable level for consumers with corrective measures with good effects, so as to ensure food processor can provide safer food for consumers. Furthermore, The Preliminary Application of HACCP in the College Canteens (Fang and Yang, 2012) pointed out that critical control point is the core of HACCP management system and food safety and sanitation problems may exist in various links of raw material selection, preliminary processing, cutting and allocation, raw material cooking and dish up in canteen. This thesis analyzes hazard factors that are likely to occur in processing processes in three student's nutritious food companies and one school canteen applying HACCP system and specific analysis results and prevention measures are shown as follows.

RESEARCH OBJECTS AND METHODS

Research objects: Two main forms of supplying nutritious food for college sports students in Beijing were nutritious food company and school canteen. Three nutritious food companies which provide large (12,000), medium (7,000) and small (3,000) scale daily lunch for college sport students were selected and one school canteen with the daily lunch supply quantity of 900 in Beijing were taken as research objects.

Methods:

Observation of processing course: The whole processing courses of college sports student's nutritious

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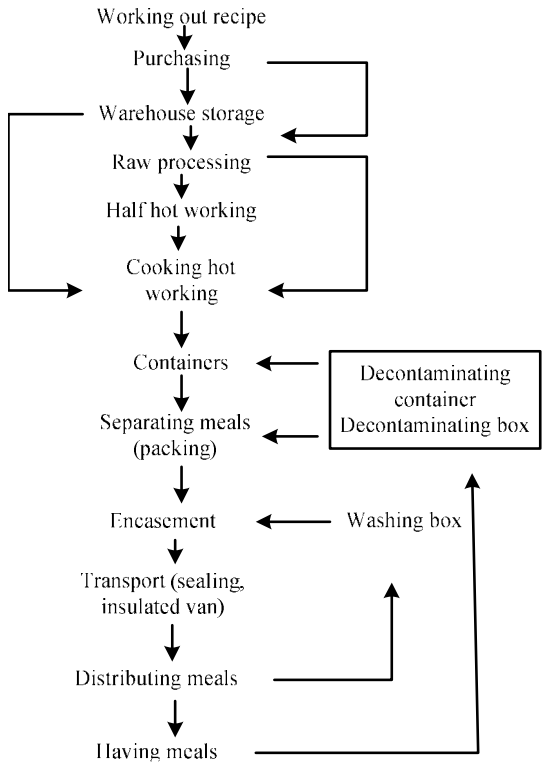

Fig. 1: Processing flow diagram of student's nutritious food

food of four units were observed at the scene in January and June 2013 respectively, 3 days for each time.

Measurement of food temperature: SCOTAR micro-electronic thermometer developed by the food hygiene supervision and inspection of ministry of health was used for measuring the temperature of each food from out of pan to consumption. The temperature of food after being put into container was measured immediately and the dinning temperature of school with longest storage and transport time was measured. The measurement results showed that the temperatures of food out of pan in January and June were 81-97 and 86-96°C, respectively and the consumption temperatures in January and June were 39-56 and 46-62°C respectively.

Formation of process flow diagram of student's nutritious food: The 1-week recipe of nutritious food for college sports students was formed based on nutritional requirements and used repeatedly and the recipe differed every day. There were about 35 kinds of food including meat, vegetables, main course and soup and four units did not offer cold dish. Student's nutritious food had dozens of food materials containing meat, birds and beasts, fishes, bean products, eggs, vegetables, rice, noodles, oil, seasonings, etc. and basic cooking methods were stir-frying, stewing, steaming, boiling and deep frying. In view of complicated and varied processing process of Chinese food, there was certain difficulty in forming detailed process flow diagram of nutritious food for college students. By on-site observation for four units, research group together with head chef in each unit worked out basic processing flow diagram for various nutritious foods. Please refer to Fig. 1.

Hazard analysis: Aiming to prevent food poisoning, hazard factors that are likely to cause food poisoning in nutritious food are stressed in this study. Factors cause harm to human body in nutritious food for sport students are divided into 3 types: pathogenic bacterium hazard, biological hazard and chemical hazard (Shengyu *et al*., 2013). Details are shown in Table 1.

Reasons why food poisoning commonly happens are: Bacterial food poisoning, animals and plants food poisoning and chemical food poisoning, please refer to Table 2.

Nutritious food poisonings that have happened in students are all bacterial food poisonings, which are caused by disqualified container washing and disinfection, too long storage time and halfway heating. Hazard analyses of each step are shown in Table 3.

Corresponding methods: CCP and intervening measures are confirmed on the basis of hazard analysis and critical limit, monitoring system, corrective actions, validation procedures and file record system are formed (Table 4).

Table 1: Hazard factors in nutritious food

Types	Hazard factors
Pathogenic bacterium hazard	*Bacillus cereus*, pathogenic *Escherichia coli*, *Staphylococcus aureus*, *Proteusbacillus vulgaris*, *Vibrio parahemolyticus*, *Salmonella*, *Shigella*
Biological hazard	Pathogenic parasites
Chemical hazard	Toxin in bean, clenbuterol hydrochloride in pork liver, mistakenly added nitrite and organic phosphorus pesticide in vegetables

Table 2: Common food poisoning reasons

Categories	Reasons
Bacterial food poisoning	Long storage time for cooked food, without cold storage, tool contamination, bacteria-carried processing people, unsafe food source and improper cooking and heating
Animals and plants food poisoning	Improper cooking and heating and wrongly taking
Chemical food poisoning	Wrongly take toxic food, abuse feed additives when raising pigs and abuse pesticides when planting vegetables

Table 3: Worksheet of hazard analysis of student's nutritious food

Steps	Potential hazards	Significance	Determining basis	Control measures	CCP (with/without)
Food purchasing	Biological property: pathogenic bacteria, parasite	With	Meat, birds and beasts, fishes, eggs, milk, bean products and vegetables may be polluted by pathogenic bacteria and pathogenic parasites	There is no measures on pathogenic bacteria; part of parasites in raw meat have been controlled by quarantine; sentinel procurement by normal way is performed and pollution-free agricultural products are purchased under permitted conditions; there is no measures on kidney bean	Without
	Chemical property: clenbuterol hydrochloride, organic phosphorus, bean toxin, etc.	With	Clenbuterol residues in liver by adding it in fodder excessively; pesticide abuse by vegetable grower; natural toxin in kidney bean		With
	Physical property: metal, glass, etc.	Without	Occasional metal, glass in grain		Without
Warehouse storage	Biological property: pathogenic bacteria	With	Pathogenic bacterium breeds in animal foodstuff	Controlling storage conditions (temperature, time)	Without
	Chemical property: without				
	Physical property: without				
Production and processing	Biological property: pathogenic bacteria	With	Pathogenic bacterium breeds in animal foodstuff	Shortening processing time	Without
	Chemical property: without				
	Physical property: without				
Half hot working	Biological property: pathogenic bacteria	With	Pathogenic bacteria residues, container pollution, pollution from chef, pathogenic bacterium breeding	Washing and disinfect containers, supervising chef's health, shortening storage time or controlling temperature	Without
	Chemical property: without				
	Physical property: without				
Cooking and heating	Biological property: pathogenic bacteria	With	Pathogenic bacteria residues; natural existence in kidney bean; misapplication	Heating thoroughly (controlling heating temperature and time); heating thoroughly; educating chef; do not buy or use or store sodium nitrite	With
	Chemical property: bean toxin, sodium nitrite	With			With
	Physical property: without				
Containers	Biological property: pathogenic bacteria	With	Pathogenic bacteria pollution caused by incomplete container wash and disinfection	Building enough cooked food container, performing heating wash and disinfection before every use	With
	Chemical property: without				
	Physical property: without				
Separating meals	Biological property: pathogenic bacteria	With	Packing people with pathogenic bacteria; pathogenic bacteria pollution caused by incomplete container wash and disinfection	Supervising packing people's health; washing hands, performing disinfection and wearing mask and disposable gloves before working it; washing and performing heating disinfection meal box before each meal	With
	Chemical property: without				
	Physical property: without				
Encasement	Biological property: pathogenic bacteria	Without	Unclean boxes	Keeping clean internal and external packing box	Without
	Chemical property: without				
	Physical property: without				
Storage and transportation	Biological property: pathogenic bacteria	With	Pathogenic bacterium breeding	Controlling storage and transportation time	With
	Chemical property: without				
	Physical property: without				

Table 3: (Continue)

Steps	Potential hazards	Significance	Determining basis	Control measures	CCP (with/without)
Distributing meals	Biological property: pathogenic bacteria Chemical property: without Physical property: without	Without	Pathogenic bacteria pollution caused by frowziness distributing places, but there is no growth and reproduction chance	Keeping clean distributing place	Without
Having meals	Biological property: pathogenic bacteria Chemical property: without Physical property: without	Without	Pathogenic bacteria pollution caused by student's dirty hands before having meals, but there is no growth and reproduction chance	Educating students wash hands before having meals	Without

Table 4: HACCP schedule of student's nutritious food

			Monitoring				
CCP	Significant hazard	Critical limit	Objects	Content	Method	Frequency	Personnel
Food purchasing	Clenbuterol hydrochloride in pork liver (meat), organic phosphorus pesticide in vegetables	Sentinel procurement, checking, asking for supplier's food safety certificate	Pork liver (meat), vegetables, etc.	Fixing point, safety certificate	Checking, asking for certificate for reference	Each batch	Purchaser
Cooking and heating food	Pathogenic bacteria, bean toxin, sodium nitrite	Internal lowest temperature of food (≥70°C), do not eat leftovers. Colors of beans change from green to brown without beany flavor. Do not buy, store or use sodium nitrite	Hot dishes, hot dishes containing hyacinth bean. Kitchen, storeroom	Temperature sensory properties, sodium nitrite	Sensory test measured by temperature	Each kind every meal of each pan per month	Chef administrator
Cooked food container disinfection	Pathogenic bacteria	Boiling (100°C) and disinfecting for over 5 min before every use or performing moist-heat sterilization (100°C) for over 10 min	Sterilizing pan, disinfection cabinet	Temperature	Temperature measurement, sensory test	Each meal	Disinfectioner
Separator, chef	Pathogenic bacteria	Employing people without diarrhea, hand injury, vomit, swollen sore throat, cough, fever and other skin disease; washing and disinfecting hands before separating meals; wearing disposable gloves; washing and disinfecting hands again before leaving separating position and wearing disposable gloves	Separator, chef	Conditions of sickness, hygiene of hands	Reporting actively, inquiring passively and checking repeatedly	Each meal	Administrator
Time interval	Pathogenic bacteria	Time interval of food from out of pan to consumption (≤3 h)	Finished product of nutritious food	Time	Timing	Each case	Separator

CCP	Corrective action	Record	Verification
Food purchasing	Changing other materials	Purchasing record	Checking record, inspecting suppliers once every half year, testing organic phosphorus pesticide in vegetables by the month
Cooking and heating food	Reheating like above destroy	Cooking record like above checking record	Checking record, performing bacterial examination by sampling every month
Cooked food container disinfection	Prohibition of use, re-disinfecting	Recording sterilization temperature and time	Checking record, performing sampling inspection every month
Separator, chef	Dismissing sick people immediately, washing and disinfecting hands again	Record of employee's sanitary inspection	Checking record, performing sampling inspection every month
Time interval	Fasting, replacing it with other food	Record	Checking record

RESULTS

Confirmation of food purchasing, cooking and heating food and cooked food container: Five CCP of student's nutritious food are decided, including washing and disinfection, health supervision of people separating meals and chef and washing hands and interval time of food from out of pan to consumption and the intervening measures of CCP are as follows.

Food purchasing: Food is bought from large-scale company with good reputation, business license and hygienic license. Meat and bean products should be purchased directly from large-scale manufactures and units with good economic conditions ought to buy pollution-free vegetables approved by the relevant department. Field visit are supposed to be performed in suppliers and certificates and materials related to food safety should be asked for, checked and put on records, such as hygienic license, quarantine certificate, relevant authentication certificate, etc. Unknown food or food without hygienic license had better not be bought and sodium nitrite and some toxic substances similar to food are forbidden to purchase and store. In addition, sensory test of each batch of food should be normal.

Food cooking and heating: Internal lowest temperature of food is considered to reach over 70°C, especially heating temperature of heated semi-finished product and large animal foodstuff. Sensory test of hyacinth bean is supposed to achieve that the color of all hyacinth bean changes from blue green to dark brown. Packaging mark of salt had better be checked carefully and leftovers should not be considered as student's nutritious food.

Cooked food container washing and disinfection: Containers and meal boxes used for holding hot dishes are needed to be washed and disinfected with heating power before each use with the scalding at 100°C for over 5 min and moist-heat sterilization at 100°C for over 10 min. Chemical disinfection method is forbidden to use. Container stacking is strictly prohibited and it is washed and disinfected once after every use and disposable meal box is supposed to be used.

Health supervision of people separating meals and chef and washing hands: Sickness condition of packing people and chef are supposed to be checked and inquired before every working and people with diarrhea, hand injury, vomit, swelling of throat, cough, fever and other skin disease are forbidden to work. Before separating meals, workers had better wash hands thoroughly, perform disinfection and wear mask and disposable gloves and wash hands, disinfect and change disposable gloves again after leaving position.

Time: The time of nutritious food from out of pan to consumption should be 3 h at most and times of out of pan and consumption deadline are supposed to be marked on external packing of nutritious food.

Verification: Performances of CCP's hygiene of research objects are inspected randomly once a week, for three weeks, after hygiene support system is established based on HACCP principle. We discover that four units all can carry out hygiene operation requirements strictly with simple record except purchasing certified pollution-free vegetables. Three samples collected from the nutritious food taking out the pan at the earliest are sent immediately for testing total plate count, coliform, pathogenic bacterium and the inspection results indicate that bacterium are not controlled effectively (Table 5).

DISCUSSION

Processing process of nutritious food provided for college sports students is different from other food industry, with tight processing time, very rush processing process, low mechanization and automation degree and basically manual operation, therefore, a complete HACCP system is hard to be established in nutritious food processing unit (Peng and Li, 2008). However, HACCP, as a food sanitary control method, can play an important role in nutritious food sanitary control. The premise of applying HACCP in supplying nutritious food for college students lies in that the unit basically accords with food sanitary requirement and conforms to catering industry's food hygiene management approach and relevant hygiene regulation of student's nutritious food; otherwise, a lot of critical points have to be controlled, which will reduce the effect.

By hazard analysis, contamination, growth and reproduction of pathogenic bacterium is the primary goal of hygiene management and can be controlled in the processing process. Total plate count and coliform are not considered to be focused on Ping and Xingwu (2010). CCP of clenbuterol hydrochloride and organic phosphorus pesticide in cultivation and plantation process can only be controlled in purchasing to the greatest extent. Because of the specificity of student's nutritious food processing, it has certain difficulty to take field-measured quantitative index as critical limit

Table 5: Random inspection results of nutritious food when students are having meals

Unit number	Samples of random inspection	Total plate count CFU/g	Coliform MPN/100 g	Pathogenic bacterium
1	9	<10~7000	<30	Negative
2	9	<10~690	<30	Negative
3	9	20~450	<30	Negative
4	9	30~1800	<30	Negative

and some indexes can only be the qualitative index for field sensory test or inquiring survey. Selected limiting value and monitoring method should possess operability. For example, fixed quantity of food can be used in experiment to confirm the time for the temperature reaching 70°C as the chef is so busy to measure the temperature of every dish; experienced chef can confirm the heating temperature through sensory.

The key points of HACCP management are hygienic consciousness of leaders and chefs in nutritious food processing unit and awareness of HACCP. It is very necessary for employees and chefs to train food hygienic knowledge and HACCP basic knowledge and CCP should be trained again after hygienic support system is established based on HACCP, which can improve training effect and play half the work with double results role.

To date, sports student's nutritious food supplied by college canteen ensures the hygienic quality and nutrition more easily. College canteen supplies nutritious food, which omits the transport link, shortens storage time of nutritious food and improves the security; at the same time, the tasty food is more likely to be accepted by students, which avoids that students throw away or do not eat nutritious food due to its bad flavor so that the purpose of improving student's nutrition cannot be achieved (Huiyan and Dianmin, 2005).

CONCLUSION

To sum up, the nutritious food CCP of college students and its hygiene operation requirement in this survey are confirmed with simple and practicable content, which are convenient for promotion. But company with different nutritious food should perform hazard analysis, confirm CCP and intervening measures based on their reality rather than use a certain pattern. Recently, Beijing has set up hygiene support system in nutritious food enterprise and student's nutritious food canteen in the whole city according to HACCP and the enterprises or canteens that do not pass acceptance inspections will be canceled supply qualification.

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