새싹채소의 HACCP 관리계획 개발

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Ⅰ. 서 론

2000년 생명존중, 이웃사랑이라는 풀무원의 창업 정최근 소비량이 증가하고 있는 다양한 품종의 새싹채소류는 비타민, 무기질 등의 영양가가 높고, 독특한 기능성 물질들이 함유되어 있어 현대인에게 문제가 되는 성인병 및 각종 질병 예방에 도움이 된다(1). 십자화과 식물에 속하는 새싹채소류(알팔파, 브로콜리, 양배추, 무, 숙주 등)는 비타민, 무기질, 식이섬유, 플라보노이드 등의 다양한 영양성분들을 함유하고 있다. 특히 브로콜리의 경우에는 비타민 K, 비타민 B2, 비타민 B6, 엽산, β-카로틴, 루테인, 플라보노이드의 종류에 해당하는 플라보놀(쿼세틴), 이소티오시아네이트(설포라펜), 인돌 등의 다양한 식물성 유용성분(phytochemicals)들이 함유되어 있어 항산화, 해독, 면역기능 증강, 호르몬 조절작용, 노화지연, 암예방, 고혈압, 골다공증 등의 여러 질환을 예방하는데 중요한 작용을 하는 것으로 보고되었다(2). 일본에서는 무에서 당뇨병을 완화시키는 효과가 있는 것으로 알려져 있다(3).

그러나 새싹채소는 병원성 미생물의 오염과 성장이 용이한 식품으로서 미국, 일본 등 주요 선진국에서 대형 식중독 사고의 원인식품으로 판명되었다(4-6). 새싹채소의 병원성 미생물 오염은 주로 오염된 원료종자로부터 기인한다고 보고되어진다(7). 대표적으로 미국, 일본 시장에서의 새싹채소 생산량)은 매년 크게 신장하고 있으며, 이는 대부분 샐러드 등으로 날로 섭취됨으로써 식중독 사고를 일으킨 바 있으며(미국 1996-2004년, 1,636 cases/27건; 일본 1996-1997년, 16,126 cases/15건 등), 그 원인이 새싹종자인 것으로 밝혀졌다(4-6)

1973년 미국의 한 가정에서 콩(soy), 크레스(cress), 겨자(mustard) 종자에서 Bacillus cereus가 발견되었는데 새싹을 키우는 도구에 의한 것으로 가장 먼저 보고되었다(Portnoy 등 1976). 미생물학자들은 종자가 발아하는 동안 Bacillus cereus는 >107/g로 증식한다는 사실을 밝혀냈다(8).

미국 캘리포니아에서는 오염의 근원이 종자로 추정되는 알팔파에서 Salmonella spp., E. coli O157:H7이 검출되었고, 이미 주요 선진국에서는 새싹채소가 대형 식중독 사고의 원인식품으로 판명되었으며, 다양한 식중독 균이 검출되었다(9). 이와 같이 새싹채소류로 인한 식중독이 자주 발생함에 따라 미국 FDA는 새싹채소를 생식하는 것은 위험하다고 경고하였다(10).

미국에서는 새싹채소에 의한 식중독이 지속적으

로 발생함에 따라 모든 종자를 발아시키기 전에 20,000 ppm calcium hypochlorite 용액으로 살균할 것을 권고하였다(11-13). 새싹채소용 종자표면 제균을 위해 제안되고 있는 살균제로는 sodium 혹은 calcium hypochlorite, hydrogen peroxide, chlorine dioxide, ethanol, oxonated water, acidified sodium chlorite, organic acid/hypochlorite와 gaseous acetic acid가 있다(14-16).

우리나라 식품의약품안전청에서는 새싹채소를 신선편의식품으로 분류하고 안전성 확보를 위한 규격(대장균 및 살모넬라 음성, 바실러스 세레우스 103 / g 이하 등)을 마련하여 2008년 3월부터 시행하고 있다(식약청 고시 제2008-15호).

미국은 새싹채소류의 원료측면에서 GAP 제도와 가공측면에서의 GMP 제도의 적용, 이외의 위생 및 안전성 확보를 위한 노력으로 HACCP 가이드라인 등이 개발 활용되고 있다. 국내에서는 아직까지 새싹채소로 인한 식중독 사고가 발표된 것은 없으나 새싹채소의 위생적 생산을 위한 우량제조 및 품질관리기준(Good Manufacturing Practices, GMP)이나 위해요소중점관리기준(Hazard Analysis Critical Control Point, HACCP) 관리계획을 개발할 필요가 있을 것이다. 따라서 본 연구에서는 새싹채소의 HACCP 관리계획을 개발하여 새싹채소의 안전한 생산을 위한 자료로 제시하고자 한다.

1. 새싹채소의 생산공정 흐름도

새싹채소의 생산단계는 Fig. 1과 같이 원료 입고 및 보관, 종자침종, 발아, 재배, 세척, 탈수, 예냉, 포장의 과정으로 이루어져 있다.

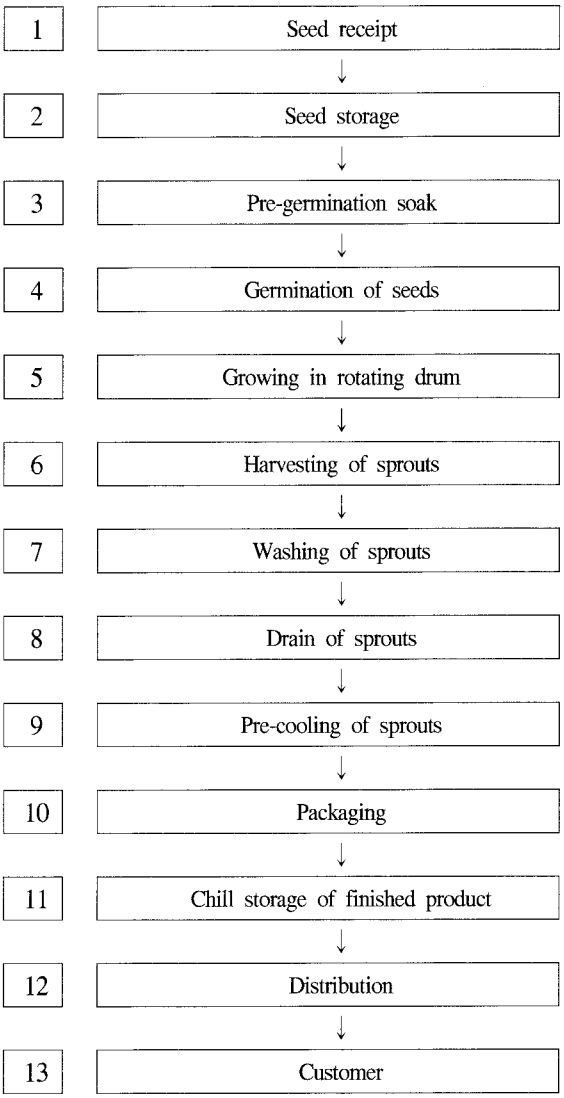

Figure 1. Process step flow for sprout production.

2. 새싹채소의 생산단계별 위해 목록표

새싹채소 생산단계별 위해목록표는 Table 1과 같다.

Table 1. Hazard analysis of sprout production

No.	Process	Hazard(s)		Origins	Hazard analysis		Hazard	Control measures
					severity	likelihood		
1	Raw materials: Dried seeds	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination by birds, rodents or insects -High microbial loading -Presence of pathogens on seeds -Contamination by pesticides	High	High	Hazard	-Bird, rotent and insect control program -Selection of suppliers of good quality seed -Microbial tests on dried seeds -Discard seed
		C	Agrichemicals	-Pesticides used during seed crop	Medium	Low	No Hazard	-Inspection
		P	Foreign matter such as soil, metal fragments, broken glass, hair et al.	-Contamination by foreign matter	Low	High	No Hazard	-Inspection, sieving and washing
2	Seed storage	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Bacterial growth due to damp storage conditions -Contamination by dirt	High	Low	No hazard	-Dry storage/Humidity control and moisture control in seeds -Clean storage environment
3	Pre-germination soak	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Growth of surface microbial contamination -Contamination from dirty soaking containers -Contamination from water supply	High	High	Hazard	-Surface decontamination of seeds -Cleaning and disinfecting of recycled soaking containers -Disinfection of water supply
4	Germination	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination from dirty germination containers -Contamination from water supply	High	High	Hazard	-Cleaning and disinfecting of recycled germination containers -Disinfection of water supply
5	Growth	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Excessive microbial proliferation -Contamination from dirty growth containers -Contamination from water supply	High	High	Hazard	-Use of disinfected irrigation water -Cleaning and disinfecting of recycled growth containers -Disinfection of water supply

No.	Process	Hazard(s)		Origins	Hazard analysis		Hazard	Control measures
					severity	likelihood		
6	Harvest	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination during harvesting -High microbial levels on the harvested sprouts	Medium	Medium	No hazard	-Cleaning and disinfecting of spades, etc. used for harvesting -Application of control measures before harvesting
7	Wash	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination from wash water -Proliferation of microorganisms in wash tank water -Contamination of wash tank surfaces -Dirty collection bin contamination	Medium	Medium	No hazard	-Chlorination of wash water -Chilling and chlorination of wash water -Cleaning and disinfecting wash tank system daily at the end of production -Clean and disinfect collection bins
		C	Residual chlorine	-Chemical residue from rinse water	Low	Low	No hazard	-Rinse sprouts thoroughly with potable water following harvest -Sufficient rinsing
8	Drain	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination of drain surfaces	Medium	Nglg	No hazard	-Cleaning and disinfecting of drainers
9	Pre-cooling	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Cross-contamination from raw material, germination and growing areas	Medium	Medium	No hazard	-Well designed factory line layout and drainage system. Controlled movement of staff and equipment -Maintain, clean and sanitize all equipment and clean and sanitize all surfaces that may contact the sprouts
10	Packaging	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Contamination due to unsanitary handling practices	Medium	Medium	No hazard	-Personnel hygiene control, regular hand washing, regular change of gloves, regular cleaning and sanitation of equipment - Package time is less than 10 minutes
		C	Chemicals	-Outflow from packaging materials	Low	Nglg	No hazard	-Used approved food grade packaging materials
		P	Packing materials	-Contamination by foreign matter during packing	Low	Nglg	No hazard	-Use Good Manufacturing Practices (GMPs) -Protect al lights from accidental breakage

No.	Process	Hazard(s)		Origins	Hazard analysis		Hazard	Control measures
					severity	likelihood		
11	Chill storage	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Microbial growth	Medium	Medium	No hazard	-Storage under chill 4℃±2℃. Limited shelf-life
12	Distibution	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Microbial growth -Use of out of date product	Medium	Medium	No hazard	-Chill distribution chain 4℃±2℃ -Date label and stock rotation control
13	Consumer	B	High microbial level, pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	-Storage abuse of product leading to microbial growth	Medium	Medium	No hazard	-Clear instructions to the consumer on storage, shelf-life and product preparation -Ensure a pest control program is in place -Use sneeze guards where product is sold in bulk

*Severity was evaluated by three stage: low, medium, high
Likelihood was evaluated by five stage: negligible, low, medium, high, critical

3. 새싹채소의 생산단계별 중요관리점 결정

새싹채소에 대한 중요관리점의 결정표는 Table 2와 같다.

4. 새싹채소의 HACCP 관리계획

새싹채소의 안전한 생산을 위하여 작성한 HACCP 관리계획표는 Table 3과 같다. CCP 1인 발아 전 침

Table 2. Determination of critical control points on sprouts

No	Process	Hazard(s)		Q1a	Q1b	Q2	Q3	Q4	CCP No.
1	Raw seeds	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	Yes		No	Yes	Yes	
3	Pre-germination soak	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	Yes		Yes			CCP-1B
4	Germination	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	Yes		No	Yes	Yes	
5	Growth	B	Pathogenic bacteria such as *E. coli* O157:H7, *Salmonella, L. monocytogenes, B. cereus*	Yes		Yes			CCP-2B

* Q1a : Do preventive measures exist for the identified hazard(s)? If no-go to Q1b. If yes-go to Q2.
Q1b : Is control at this step necessary for safety? If no-not a CCP. If yes-modify step, process or product and return to Q1a.
Q2 : Does this step eliminate or reduce the likely occurrence of hazard(s) to an acceptable level? If no-go to Q3. If yes-CCP
Q3 : Could contamination with identified hazard(s) occur in excess of acceptable levels or could these increase to unacceptable levels? If no-not a CCP. If yes-go to Q4.
Q4 : Will a subsequent step eliminate hazard(s) or reduce the likely occurrence to an acceptable level? If no-CCP. If yes-not a CCP.

종에서의 종자소독단계는 미국 FDA에서 권장하고 있는 20,000 ppm Ca(OCl)2에 의한 방법과 이 실험에서 제시한 70℃의 열수에 1분간 처리하는 방법 두 가지를 제시하였다.

억제시키기 위한 재배수 관리(HClO 100 ppm, pH 3 이하의 전해산화수)를 통한 2차적 위생관리 등 단계적 위생관리의 적용이 권장된다.

Table 3. HACCP plan

CCP	Significant hazards	Critical limits	Monitoring procedure and frequency				Corrective action	CCP Verifica-tion	HACCP records
			What	How	Frequency	Who			
CCP-1B / Pre-germination soak	Pathogen growth	Soak for 15min at 20,000 ppm Ca(OCl)2	Treatment concentration & time	Test paper & timer	Each batch	Field crews	Return to soaker until 15min at 20,000 ppm Ca(OCl)2	-Calibration timer -Check visual colorimetric test paper	-Treatment log -Timer calibration log
		-Soak above 1min at 70℃ in hot water	Treatment temperature & time	Thermometer & timer	Each batch	Field crews	Return to soaker until 5min at 65℃ hot water	Calibrate thermometer and timer each week	-Treatment log -Thermometer calibration log
CCP-2B / Growth	Pathogen growth	-irrigation with acidic electrolyzed water with below pH 3, chlorine 100 ppm	Property of EOW	pH meter & test paper	Each batch	Field crews	Irrigation after adjusting property of EOW	-Calibrate pH meter -Check visual colorimetric test paper	-Property of EOW log

Ⅱ. 요 약

신선편이 식품의 수요가 증가되고 있는 시점에서 웰빙식품으로 다소비되고 있는 새싹채소의 안전성 확보가 시급히 추진될 필요가 있다. 따라서 본 연구에서는 새싹채소의 위생적 생산을 위한 HACCP 관리계획을 개발하고 생산현장에서 적합성 검증을 실시하였다.

위생적으로 안전한 새싹채소 재배를 위해서는 새싹종자 소독(Ca(OCl)2 20,000 ppm 농도에서 15분간 처리 또는 70℃ 이상에서 1분 이상 열수처리)을 통한 1차적 관리와 재배기간 동안의 미생물 증식을

Ⅲ. 참 고 문 헌

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