

## **HACCP APPLICATION ON HEAVY METALS IN CUCUMBERS PROCESSING**

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### **ABSTRACT**

*HACCP system is systematic approach, which is used to prevent hazards appearing through food processing. Although the first step in HACCP system includes identification and analyses of all kinds of hazards, heavy metals present the kind of hazards that are very difficult to determine during identification process. In fact, they are present in small concentrations in all raw materials and food products; therefore, particular attention should be paid to their identification and determination. Regarding above mentioned, this work is aimed to present HACCP application on lead and cadmium in the technological process of cucumbers preserving, where special attention is paid to the content of lead and cadmium. In determined critical control points, CCPs, the content of these metals is determined by the electrochemical method. Based on the results obtained in this work and HACCP system, HACCP plan is given as the instruction for controlling hazards such as heavy metals.*

**Key words:** HACCP, heavy metals, cucumbers, processing

### **1. INTRODUCTION**

Food safety is defined as the assurance that the food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use [1]. Quality is defined by the International Organization for Standardization (ISO) as "the totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs." In other words, good quality exists when the product complies with the requirements specified by the client [2]. Safety and quality assurance should be ongoing processes incorporating activities beginning with selecting and preparing the soil and proceeding through to consumption of the product. It is very important to provide good quality and safety as well, but when hazards are present at trace level in food, then it is very difficult to provide safety product. Hazards, which are present in food and have negative impact on human health, are trace elements, particularly heavy metals such as lead and cadmium. According to different reserachs, the role of heavy metals in the whole food chain is a various, because some of them are very important for vital living functions, while others are toxic even in small concentrations [3]. The incerase of heavy metal concentration in vegetable products can be found very toxic to consumer's health, beacue thier toxicity depends on nature, amount and chemical form in vegetables [4]. Lead toxicity depends on its possibility to be bound to biologicly important molecules affecting thier functions. Consequences of increased lead intake are deffects of kidnies and nervous system, as well as blood preassure. JECFA, FAO and other international organisations [5] have established PTWI (Provisional Tolerable Weekly Intake) – value for lead, which is 25 µg/kg body weight. Cadmium is also one of microconstituents, which can be accumulated in organism causing disfunction of kidnies, bones, etc. Therefore, it is considered as cancergous and its intake should be reduced [6]. Na average concentration of cadmium in vegetables is from 0 to 0,1 mg/kg [7], and weekly-recommended intake is 7 µg/kg of body weigt [8]. According to above mentioned, it is importan to control and monitor heavy metal presence in the whole food chain. One of methodology, which can be applied to control metal presence, is HACCP approach. HACCP pinciples enable hazard identicfication and determination, as well as its monitoring and corrective actions in case of deviations of critical limits. The whole global HACCP concept can be observed as preventive measure in order to prevent food contamination in any step of its procesing, therefore this work is aimed to present the application of HACCP concept on cucumbers preservation.

## 2. MATERIAL AND METHODS

Identification and analyses of heavy metals, lead and cadmium, has done according to HACCP principles. After identifying the presence of heavy metals, critical control points were determined and critical limits were settled for both metals. In CCPs, the content of heavy metals is determined by electrochemical method, DPASV, differential pulse anodic stripping voltammetry. Based on the obtained results, monitoring and corrective actions were set for both metals in determined critical control points, e.g. CCPs in cucumbers preserving.

## 3. RESULTS

### 3.1 Identification and analyses of lead and cadmium

Table 1. Hazard identification and analyses

HAZARD IDENTIFICATION AND ANALYSES AND PREVENTIVE MEASURES					
Process step	Type and description of hazard	Cause	Probability (Big, average, low)	Seriousness (Big, average, low)	Preventive measure
Cucumbers (raw material)	The presence of higher content of lead and cadmium than it is allowed	The application of pest control and contamination	Average	Average	Cucumbers production in non-contaminated soil and pest control
Water and additives		Increased metal content in water and additives			Water use with controlling the presence of heavy metals
Calibration		Increased metal content in raw material and intake from environment			The great attention in handling with equipment, as well as worker's behavior
Washing		Increased metal content in raw material and intake from environment			
Inspection					
Packing – final product					Product discarding
Pasterisation and cooling of final product		No any influence, because product is packed			

### 3.2 Determination of critical control points and critical limits for lead and cadmium

Table 2. Critical control points determination, CCPs

CRITICAL CONTROL POINT DETERMINATION								
Process step	Hazard	Preventive measure	Q1	Q2	Q3	Q4	Remark	Critical control point (CCP)
Raw material preparation	Pb Cd	Cucumbers production in non-contaminated soil and pest control	No	No	Y	No	When cucumbers are grown in soil contaminated with heavy metals, they then can be taken into the cell structure where left bound.	CCP 1
Water and additives		Water and additive use with controlling the presence of heavy metals in it	No	No	Y	No	Water and additives can contain more heavy metals then it is allowed by the regulations	CCP 2
Cucumber Inspection		The great attention in handling with equipment, as well as worker's behavior	No	Y	--	--	During cucumbers inspection, they can be contaminated by heavy metals from air, environment and equipment.	CCP 3
Packed product		Discarding	Y	No	Y	No	During packing and additives adding, contamination by heavy metals might be also done, therefore monitoring in this step is necessary.	CCP 4

Comparison of heavy metals content in CCPs with maximum allowed concentration defined by B&H and EU regulation

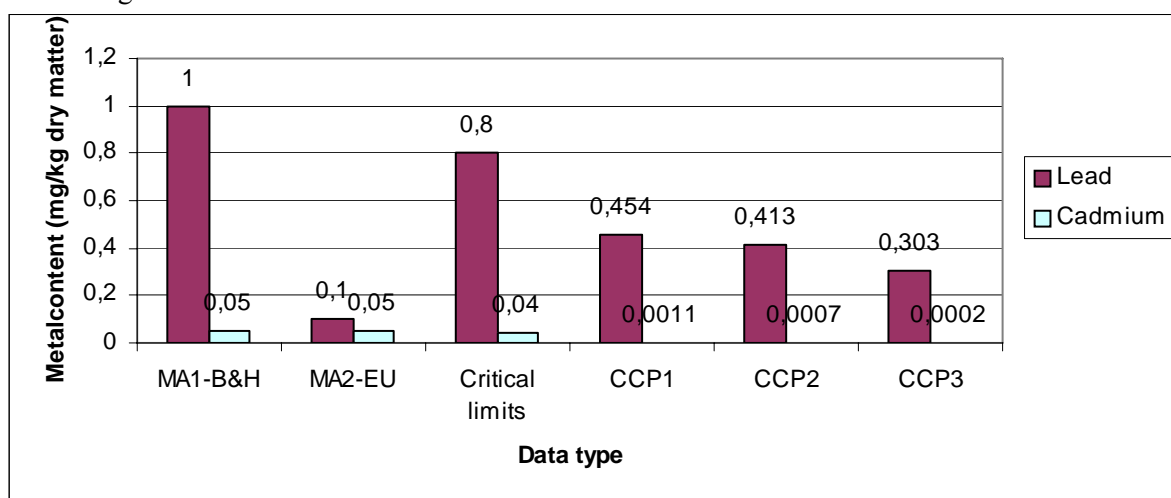


Diagram 1. Lead and cadmium content in CCPs with comparison to B&H and EU regulations [8],[9]

### 3.3 Monitoring and corrective measures for lead and cadmium

The equipment for heavy metal content is very demandable and expensive, because monitoring of heavy metals is very difficult and it is only possible as OFF – line, etc. sometime sampling and determining of heavy metals content. Corrective measures are only possible as discarding a raw material, because heavy metals are incorporated into the plant structure from which they are not possible to remove.

### 3.4 Verification and documentation

In this step, another team should confirm whether HACCP system functions or does not. Verification team is responsible for confirming the functioning the HACCP concept; in which another people are included who are not part of HACCP team. At the end of HACCP, the HACCP plan is created which is then used as guide for monitoring and implementing HACCP.

Table 3. HACCP plan for the technological conserving of cucumbers

Control point (raw material or step in process)	Risk	Control measure	CCP parameter	Critical limit	Target value	Monitoring	Corrective measure	Responsible person
Cucumbers – raw material	Lead and cadmium	Chemical analysis by the application of DPASV method	The content of heavy metals less for 20 % then maximal allowed value	Valid regulation about the content of metals in vegetables	CCP parameter	The determination of heavy metal content in CCPs	To discard	Technologists in processing
Water addition (mixture of additives)							To prepare new additive mixture with determination of heavy metal content	
Cucumbers after inspecting							To discard	
Final product								

#### 4. DISCUSSION

As above-mentioned, this work has aimed to present the HACCP methodology for hazards such as heavy metals. To present it, lead and cadmium are chosen, and the first table presents the identification and analyses of these metals as hazards in cucumbers processing. The focus in the identification and analyses was to include all steps during cucumbers processing and it was done with a short clarifications of causings of lead and cadmium presences in cucumbers. In this step, the probabilities and seriousness are also calculated. The decision tree was used for the determination of critical control points and critical limits. After applying of decision tree, four critical control points were chosen and they are present in table 2., including preventive measures and some remarks emphasizing the metals intake into the cucumbers for each CCP. Diagram 1 presents results of lead and cadmium content in critical control points comparing them with maximum allowed concentrations defined by B&H and EU regulations. The highest lead content was determined in the first CCP, 0,0011 mg/kg dry matter, and the lowest in the third CCP, 0,0002 mg/kg dry matter. The content of cadmium is much less than the presence of lead, and the lowest lead concentration was determined in the third CCP, 0,303 mg/kg dry matter, and the highest in the first CCP, 0,454 mg/kg dry matter. Comparing obtained results to maximum allowed values, defined by B&H and EU regulations the content of lead is higher in all CCPs according to EU regulation, but less than it is defined by B&H regulation. It is the consequences of the difference in B&H and EU regulations referring heavy metal content in vegetables. The last table presents the HACCP plan, which is used for monitoring and controlling the hazards such as heavy metals, particularly lead and cadmium. In the HACCP plan, lead and cadmium are present as risk, but control measures are defined as chemical analyses that can be preferred by polarographic method, such as DPASV. Target limits are concentrations of heavy metals that are lower for 20 % than the critical limits, and critical limits are contents that are also defined by regulations. The monitoring is only possible as OFF-line process, while corrective measure is also possible, but only as discarding the whole amount of raw materials.

#### 5. CONCLUSIONS

- Food regulations in B&H must be adjusted with EU and international standards;
- HACCP methodology applied in this work, can also be used for other contaminants;
- Risk analyses that are used in HACCP methodology in combination with other standards, such as ISO 9001, can be very good tooling for improving the image of factories at global market.

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