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HAZARD ANALYSIS AND CRITICAL CONTROL POINTS OF TRADITIONAL VS INDUSTRIAL CREMESCHNITTE PRODUCTION

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Changes in the consumption habits of the population forces food industry to produce traditional products in modern ways, sometimes not taking into account the modified safety issues. The aim of this study has been to compare hazards and critical control points for traditional and industrial cremeschnitte production. The result shows that the traditional cremeschnitte production includes two additional critical control points, cooking and moulding of egg cream basis, which is essential for safety. In addition, the results of microbial analysis pointed out that the traditional cremeschnitte is safer than the industrial one produced from dried cream powder when comparing *Escherichia coli,* total aerobic count, and mould contamination ($P<0.05$). Moreover, our controlled contamination test with *E. coli* of raw material shows that the traditional cremeschnitte production process reduces microbiological hazard even in the worst-case scenario. All this indicates that traditional food safety practices are not granted and should not be neglected in new production technologies.

Keywords: cremeschnitte production, microbial safety, critical control points, thermal treatment

In recent years, more and more consumers are concerned about food safety, especially when taking into account the globalisation of food market. The availability of safe, quality, and locally produced food is important for our health, environment, and economy (Smith et al. 2004; Greenhill et al., 2010). In the past, food safety practices were developed based on experience and practical findings while manufacturing the food products. Traditional food was used locally for an extensive period of time, and ingredients or recipes were passed from one generation to another (Panagou et al., 2013; Tajkarimi et al., 2013). The modernized and rapid development of the world has changed food consumption habits that might require food producers' adaptation to new trends (Qadri & Kayali, 1998). Especially, demand for precooked, processed, and convenient food can result in food safety failures (Tajkarimi et al., 2013).

Several researches have studied food safety issues of traditional foods. For instance, Ji and co-workers (2007) studied food safety of MiGao, a traditional Chinese steamed cake, and found that total plate counts in the products on the third day of storage were under 10^3 CFU g^{-1} and that shelf-life of the product was estimated to be only two or three days. In another study, Samson and co-workers (1987) analysed microbiological quality of Tempeh, a traditional Indonesian soybean food, and found that 98% of the samples exceeded 10^5 CFU g^{-1} for *Enterobacteriaceae,* but also found presence of *Staphylococcus aureus, Bacillus cereus,* and *E. coli*. Kim and co-workers (2013) studied microbial quality of food, including cakes, and found that the highest bacterial counts were associated with dried cakes, suggesting

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that appropriate regulations of these food types should be considered. Similarly, Uhitil and co-workers (2004), who analysed microbiological safety of cakes in Croatia, found that 6.4% of cakes were contaminated with *Listeria* spp. A report on food poisoning in 2005 in Austria revealed that possible sources of food related illnesses could also be cakes, especially in case of family celebrations (Much et al., 2007). Epidemiological investigation of food poisoning of 26 persons in United States has revealed *Salmonella* in cake batter mix, indicating that the industrial premix was contaminated with *Salmonella* (Zhang et al., 2007).

A cremeschnitte is a vanilla and custard cream cake popular in several Central European countries. There are many regional variations, but they all include puff pastry base and custard cream. Traditionally, vanilla cream is made of egg yolk, flour, and sugar and it is cooked to given appropriate density. The aim of this study was to provide hazard analysis and identification of critical control points for industrial and traditional cremeschnitte. The second step has been to compare microbiological food safety and to provide controlled test of contamination with *E. coli.*

1. Materials and methods

1.1. Hazard analysis and identification of critical control points

Hazard analysis has been provided based on observation of the cremeschnitte process and data collected from a manufacturer. All production steps have been taken in consideration according to the internal HACCP decision tree. The critical control points (CCPs) and control points (CPs) have been determined. The number of CCPs in a process depends on the complexity of the process. The traditional preparation of cremeschnitte includes heat treatment opposite to the industrial technology.

1.2. Microbial analysis of cremeschnitte

Microbial analysis of industrial (n=50) and traditional (n=50) cremeschnitte was carried out immediately after the production. The samples were homogenized in sterile bags using Stomacher laboratory system. The samples were diluted with sterile water and their microbial contaminations were tested by the following standard methods. Detection of the presence of *Salmonella* was carried out according to the ISO (2002) standard. The presence of *E. coli* was tested according to ISO (2005). *Enterobacteriaceae* were tested according to ISO (2004) standard. *S. aureus* was analysed according to ISO (1999) standard, total aerobic counts (TAC) according to ISO (2013) standard, mould and yeasts were analysed according to ISO (2008) standard. The results of microbiological analysis for each type of cremeschnitte are presented as average for microorganism tested. The average log CFU g^{-1} for single microorganism in traditional and industrial cremeschnitte samples were compared by paired Student's *t*-test. The results were compared at the 5% probability level.

1.3. Controlled contamination test with E. coli

In the controlled contamination test *E. coli* were added to raw materials. For industrial cremeschnitte, the cream was prepared from dried cream powder and contaminated with *E. coli* in concentration of 10^3 CFU per gram of the cream. For traditional cremeschnitte, the eggs that were used for the cream preparation were contaminated with the same concentration of *E. coli* simulating worst-case scenario of poor hygiene. Both creams were treated as proposed in production process simulating the worst-case scenario. For each type of cremeschnitte three parallels and three replications were done. The evaluation method of *E. coli* was the same as described in 1.2.

2. Results and discussion

The transition from traditional to specialised and large scale industrial food producing has brought up the needs for new hazard analysis.

2.1. Hazard analysis and identification of critical control points

The results of the hazard analysis show that the production of traditional cremeschnitte is more delicate and sensitive for production errors, which can cause deterioration of the final product and also presents a hazard for consumer. The production steps and related CPs and CCPs are shown in Table 1. The CPs and CCPs are marked with plus symbol (+). Production steps, which are not defined as CP or CCP, are not marked with plus symbol (+). As shown in Table 1, there are two CCPs (baking of puff pastry and metal detector) that are presented in both types of cremeschnitte production, while traditional cremeschnitte preparation includes another two CCPs, cooking and moulding of egg cream basis, which are essential for safety as well as sensory characteristic and stability of end product. The corrective actions are described in Table 2.

Table 2 shows corrective actions as described in relation to the production process. For industrial cremeschnitte, measures are related to prolonging the baking time and metal detection. Meanwhile, in the traditional cremeschnitte technology, plus action related to the cream cooking procedure and temperature management are expected, too.

2.2. Microbial analysis of cremeschnitte

The results of traditional and industrial cremeschnitte analysis show no presence of *Salmonella* spp. and *S. aureus* in the samples. In addition, no *E. coli* was found in the traditional cremeschnitte. For all tested bacteria, more log CFU g^{-1} was found in case of the industrial cremeschnitte in comparison to the traditional one (Fig. 1). The highest levels of bacteria for both cremeschnitte cases were found for TAC, meanwhile, the lowest for mould. These findings indicate that the traditional cremeschnitte is less contaminated with the selected bacteria in comparison to the industrial ones.

Producing the cremeschnitte by traditional recipe is microbiologically safer than using dried cream powder, although in traditional technology fresh eggs are used. One of the reasons could be the cooking of egg cream at 130 °C for 15 min, where the potential bacterial contamination is managed, in comparison to the industrial cream powder that is only mixed with water without thermal treatment. International Commission on Microbial Specifications has proposed that such food should undergo heating for 2 min at 70 °C or high pressure treatment at 500 MPa for 7.5 min (Stewart et al., 2003). Due to heat treatment of traditional cremeschnitte, lower presence of *E. coli, Enterobacteriaceae,* and mould was found in comparison to the industrial one. Microbiological quality of raw materials is irrespective of the technological procedure, the most important parameter that can affect the safety of the final product. The microbiological criteria concerning the dried powders like vanilla or vanilla-egg creams are not as strict as they are for fresh eggs. The average criteria for dried

Table 1. Traditional and industrial cremeschnitte production process with critical and critical control points

Industrial cremeschnitte				Traditional cremeschnitte			
Production operation	CP	CCP	Control/monitoring	Production operation	CP	CCP	Control/monitoring
Puff pastry preparation	+		Specification, ingredients	Puff pastry preparation	+		Specification, ingredients
Thawing	+		≤+8 ºC	Thawing	+		≤+8 ºC
Shaping/Cutting of pastry			Dimensions and weight control	Shaping/Cutting of pastry			Dimensions and weight control
Baking of puff pastry		+	t=22’ T=215 ºC #1	Baking of puff pastry		+	t=22’ T=215 ºC #1
Cooling of puff pastry	+		≤+20 ºC	Cooling of puff pastry	+		≤+20 ºC
Modelling of baked puff pastry			Dimensions and weight control	Modelling of baked puff pastry			Dimensions and weight control
Cream preparation from dried cream powder	+		Water to dried cream powder ratio control	Egg cream cooking		+	Cooking with cream for 15’ at set T=130 ºC, temperature of cooked cream ≥ 97 ºC. Hot cream (≥ 97 ºC) adding to whipped egg white. #2
Cream molding with pastry			Weight of cream control	Hot cream molding with pastry	+		T≥+65 ºC #3
Cream stabilizing	+		T≤+5 ºC online monitoring	Cream cooling	+		T≤+5 ºC online monitoring
Milk/vegetable cream whipping			Cream ratio	Milk/vegetable cream whipping			Cream ratio
Milk cream molding			Weight control	Milk cream molding			Weight control
Covering of cream with baked puff pastry				Covering of cream with baked puff pastry			
Cutting cake in portions	+		Weight control	Cutting cake in portions	+		Weight control
Decoration with ice sugar				Decoration with ice sugar			
Packaging in boxes	+		Tracking/tracing data control	Packaging in boxes	+		Tracking/tracing data control
Metal detection		+	Metal detector #4	Metal detection		+	Metal detector #4
Packaging in transport cartons			Packaging in transport cartons	Packaging in transport cartons			
Release to storage	+		Product release to market	Release to storage	+		Product release to market
Cool storage and distribution	+		≤+5 ºC	Cool storage and distribution	+		≤+5 ºC

+ defines CP/CCP; # followed by number represent corrective action in case of nonconformity procedure explained in Table 2.

Table 2. The corrective actions in traditional and industrial cremeschnitte production process

Symbol	Production step	Description of error	Corrective action
#1	Baking of puff pastry	The temperature is too low	Prolong the baking time/or manually increase the set temperature on oven display.
		The appearance of baked dough is too pale	Prolong the baking time and check the set temperature.
		The baked dough is too soft for further manipulations-cutting/shaping	Set the oven in "half load" program and bake it again.
#2	Egg cream cooking (only traditional)	The set temperature T=130 ºC drops while cream is cooking	Immediately increase the set temperature to T=135 ºC. If the temperature does not increase in 2 min, discard the cream and inform maintenance department.
		The set temperature T=130 ºC is >140 ºC and does not drop	Do not start cooking. Inform maintenance department. After set T=130 ºC is correct continue cooking.
		While adding hot cream, the temperature of egg base is lower than ≥97 ºC	Immediately reheat the cream until it reaches the temperature of at least 97 ºC.
#3	Hot cream molding with pastry (only traditional)	Temperature of cream is lower T≥+65 ºC	Discard the cream! Do not reheat! Make another batch.
#4	Metal detector	The metal detector does not react on etalon and raises the alarm. The metal detector is not working.	Check the metal detector settings "product name" on panel and if still not working than remove all products in storage an do NOT RELEASE the product on market. Inform maintenance department. Metal detection have to be provided by another metal detector or by the same one after maintenance confirms the proper functioning and the etalon test is confirmed.
		The alarm occurs	Recheck it again and if alarm occurs again hold the product for further manual analysis and search for metal parts. Discard the product!

vanilla-egg cream ranged for total aerobic count from 5×10^3 to 1×10^6 CFU g^{-1}, for moulds from 25 to 1×10^4 CFU g^{-1}, yeast from 25 to 1×10^3 CFU g^{-1}, total coliform bacteria and *E. coli* absent in 1 g, and Salmonella spp. absent in 25 g. Meanwhile, criteria for fresh eggs: total aerobic count max 1×10^4 CFU g^{-1}, total yeast and mould together max 1×10^2 CFU g^{-1}, and for total coliform bacteria and *E. coli* absent in 1 g, and *Salmonella* spp. absent in 25 g. The criteria for dried powders are based on its production, which is usually spray drying, and the fact that the dried powder has water activity (a_w) <0.30, meanwhile for fresh eggs it is a_w>0.95. The water activity of a wide range of water- and sweet-based creams is also relatively high a_w>0.97, for fat-based creams, such as chocolate, it is a_w>0.90, or for some cookies, it is below a_w<0.30. These factors have important influence on microbiological growth and therefore food safety.

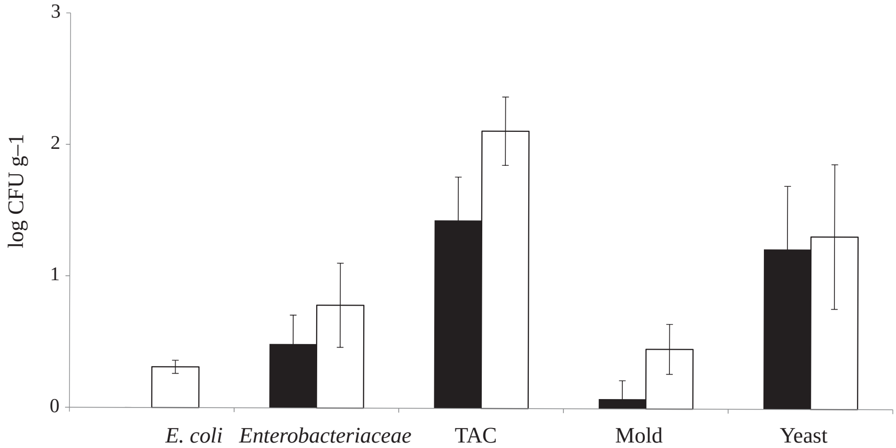

Fig. 1.: Comparison of average log CFU g^{-1} of selected microorganisms in traditional and industrial cremeschnitte
■: Traditional; □: industrial

Table 3 shows a significantly lower log CFU g^{-1} of *E. coli* for the traditional compared to the industrial cremeschnitte (P<0.0001). Similar differences can be obtained for TAC and mould, meanwhile no statistical significant difference was found for *Enterobacteriaceae* and yeast (P>0.05).

Table 3. Statistical analysis of bacterial presence in the traditional and the industrial cremeschnitte

Bacteria	Traditional average log CFU g^{-1}	Industrial average log CFU g^{-1}	Difference in average	*t*-value	P	Significance
E. coli	0.0000	0.3100	0.3100	4.5647	0.0000	**
Enterobacteriaceae	0.4861	0.7824	0.2963	1.6000	0.1163	NS
TAC	1.4300	2.1102	0.6802	3.0878	0.0044	*
Mould	0.0741	0.4547	0.3806	2.6936	0.0124	*
Yeast	1.2176	1.3129	0.0953	0.4165	0.6792	NS

*: P<0.05; **: P<0.001; NS: not statistically significant

Similarly to our study, WINKELHAUSEN and co-workers (2007) analysed traditional homemade cookies for presence of *S. aureus*, sulphite reducing clostridia, and coliform bacteria. The authors reported negative results for all bacteria because of the high baking temperature. In the study of KOTZEKIDOU (2013), food safety of the industrial produced pastries in Greece were analysed, and the highest *Enterobacteriaceae* counts were found for desserts with cream, which correspond to our study.

2.3. Controlled contamination test with E. coli

The results of our controlled contamination test for traditional and industrial cremeschnitte (averages with standard deviations) show more than 3 log CFU g^{-1} reduction of *E. coli* numbers during the production process of the traditional cremeschnitte. Contrary to that for industrial cremeschnitte, a significant increase in log CFU g^{-1} can be observed (Table 4).

Table 4. Results of controlled *E. coli* contamination test comparing log CFU g^{-1} before and after the production process

	Before production process log CFU g^{-1}	After production process log CFU g^{-1}	Difference log CFU g^{-1}
Traditional	4±0.2	0.9±0.01	↓ 3.1
Industrial	4±0.3	8±0.2	↑ 4

↓: decrease; ↑: increase

3. Conclusions

Our traditional attitude to food is changing along with the safety issues of food production. Modern, industrialized, and mass made food products are not granted safe as our research has shown. Traditional cremeschnitte is from microbiological point of view safer due to the egg cream thermal treatment in comparison to dried cream powder. Moreover, our controlled test of *E. coli* contamination shows that in worst-case scenario the traditional cremeschnitte will be safer that industrial one. All this indicates that traditional experiences in food safety practices are not self-evident and should not be neglected in modern technology.

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