



## What consumers expect from food control and what they get – A case study of the microbial quality of sushi bars in Denmark



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### ABSTRACT

Sushi is a traditional Japanese food, also popular in Europe, consisting of acidified rice and raw fish. This study investigated the correlation between monitoring of hygienic levels and compliance with establishment-managed controls by public food inspectors and observed microbial levels of two types of sushi products, Maki salmon and Nigiri salmon, sold by Danish outlets. Danish consumers' knowledge of the specific tests carried out by food inspectors was also examined. The total microbial contents of the products ranged from 4.1 to 7.5 log CFU/g and contents of *Escherichia coli* and *Staphylococcus* spp. ranged from <1 to 2.3 and <2 to 3.0 log CFU/g, respectively. There was in general no correlation between the publicly accessible rankings by the food inspectors and the microbiological contents of the products. Underlying reasons might be that the regulatory monitoring of compliance with control programs does not readily include two important parameters, personal hygiene and initial microbial quality of products. Microbiological examination of sushi products does not constitute a part of routine monitoring of hygienic levels, a fact that by use of a questionnaire study was found not to be widely known among consumers.

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### 1. Introduction

The traditional Japanese food, sushi, prepared from raw and cooked fish and soured rice has become very popular in many European countries, including Denmark. A recent German study showed that sushi prepared by sushi bars had relatively high aerobic plate count levels as well as counts of *Escherichia coli* and *Staphylococcus aureus*. This could be a result of processing conditions and/or cooling and hygiene conditions during storage and preparation (Atanassova, Reich, & Klein, 2008). The authors concluded that the consumers should be aware of the risk associated with such products, which should be eaten immediately or kept properly refrigerated and eaten no later than the “best before” date.

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The objectives of the present study were, firstly to compare the microbial standard of similar Danish sushi products with products from other countries and, secondly to examine the extent to which food authorities detect potential deviations from compliance with own control programs by sushi bars. Thirdly, knowledge among Danish consumers of the control programs carried out by food inspectors was also examined with a special focus on knowledge about microbial monitoring.

The Danish Veterinary and Food administration introduced the so-called Smiley system in 2001 (Kjeldgaard, Stormly, & Leisner, 2010; Nielsen, 2006; [www.findsmiley.dk/en-US/Forside.htm](http://www.findsmiley.dk/en-US/Forside.htm)) that resembles the restaurant hygiene grade cards in North America and the “scores on doors” schemes in the UK (Jin & Leslie, 2003; Worsfold & Worsfold, 2007). This system results in public records from unannounced visits by food inspectors. The inspector evaluations include visual observations; on the spot measurements of temperatures in incubators and in food products and inspection of data recorded under the shops own control programs. Usually microbiological examinations of foods are not a part of the evaluation. We have in this study used the web-based Smiley records to examine the extent to which the Smiley evaluations of the food

authorities agree with the microbiological counts of fresh sushi sold by a range of sushi bars in the Danish capital, Copenhagen.

Since results from inspections are made publicly accessible consumers can, at least in theory, evaluate sushi bars based on their Smiley rating. Indeed, practically all Danish consumers are acquainted with the Smiley system, and the level of general trust in it is high (Stürup & Nielsen, 2009). A majority of Danish consumers who have encountered a restaurant with a poor rating also rejected eating there (Stürup & Piper, 2007). However, it is unknown whether Danish consumers are aware that microbiological examinations are not a standard part of the Smiley evaluation. For this reason we also surveyed consumer's knowledge of the specific tests carried out by inspectors.

## 2. Materials and methods

A total of 20 shops were evaluated including both outlets with positive and negative smiley rankings. We ranked the shops according to smiley evaluations done within a half year before and a half year after our samplings (Table 1). The number of smiley evaluations varied widely from shop to shop, ranging from 1 to 4 smiley rankings during the year. The underlying reason for the different numbers of regulatory inspections appeared to be partly correlated with the smiley rankings obtained immediately before and during the year. Thus, if a poor smiley evaluation was obtained at a specific visit more visits would follow in a relatively short period of time. In some cases, however, shops also were inspected a number of times even if the outcome in all cases was a positive smiley evaluation. We therefore assume that for at least such shops the actual number of visits were to some extent random. The outlets were located within different geographical areas of Copenhagen including the central business district (one outlet), Østerbro (two), Vesterbro (five), Nørrebro (one), Frederiksberg (seven) and Valby (three). One package of Nigeri salmon and Maki

**Table 1**  
Listing of smiley rankings with microbial analyses of sushi products.

Smiley ranking	Product type	No. of samples <sup>d</sup>	Mean APC (log CFU/g) <sup>e</sup>	Mean <i>E. coli</i> (log CFU/g) <sup>f</sup>	Mean <i>Staphylococcus</i> spp. (log CFU/g) <sup>f</sup>
1 <sup>a</sup> ☺	Maki	14 (7)	5.5 (4.2–6.5)	N/A (0%)	N/A (0%)
	Nigeri	14 (7)	5.4 (4.3–6.2)	N/A (0%)	N/A (0%)
2 <sup>b</sup> ☺	Maki	10 (5)	5.7 (4.9–6.8)	2.3 (40%)	2.9 (20%)
	Nigeri	10 (5)	5.3 (4.1–7.5)	1.4 (20%)	2.6 (20%)
3 <sup>c</sup> ☺☺☺☺	Maki	16 (8)	5.7 (4.8–7.2)	2.0 (31.3%)	2.5 (6.3%)
	Nigeri	16 (8)	5.6 (4.8–6.6)	1.6 (37.5%)	3.0 (6.3%)

<sup>a</sup> These shops only received ☺ in 1 to four visits within the time period (less than half a year before and after microbiological samplings). In addition only ☺ was received if the time period included one to three additional smiley rankings (before and after the half year limit).

<sup>b</sup> These shops only received ☺ in 1 to four visits within the time period (less than half a year before and after microbiological samplings). However, ☺, ☺, ☺ or ☺ was received if the time period included one to three additional smiley rankings (before and after the half year limit).

<sup>c</sup> These shops received at least one of these rankings: ☺, ☺, ☺ or ☺ in 1 to four visits within the time period (less than half a year before and after microbiological samplings).

<sup>d</sup> Numbers in parentheses are numbers of outlets.

<sup>e</sup> Geometric average. Numbers in parentheses are the APC range.

<sup>f</sup> Geometric average of positive samples. Numbers in parentheses are the percentage of positive samples.

**Table 2**

Descriptive statistics, Smiley awareness, and score on knowledge scale in the three surveyed groups.

	High school students ( <i>n</i> = 80)	Veterinary students ( <i>n</i> = 116)	Food engineer students ( <i>n</i> = 44)
Gender			
Woman	67.5% (54)	86.1% (99)	70.5% (31)
Man	32.5% (26)	13.9% (16)	29.5% (13)
Age			
Mean (in years)	17.2	22.9	24.2
St.dv.	0.91	2.49	3.85
Awareness of Smiley system			
Yes	93.8% (75)	95.7% (110)	100% (43)
No	6.2% (5)	4.3% (5)	0% (0)
Knowledge scale <sup>a</sup>			
Mean	2.49	3.22	3.61
St.dv.	1.07	0.83	0.81

<sup>a</sup> Scale was constructed on basis of five questions probing on the evaluations included in the Danish Smiley examination (1. 'Self-policing control system': correct; 2. 'Microbial count': false; 3. 'Temperature': correct; 4. 'Sensory quality': false; 5. 'Firm accounting': correct). In the case of a correct response the score 1 was assigned (if incorrect 0) producing a measure with the range 0–5.

salmon were purchased and each shop was visited twice. Explanation on the Smiley symbols is as follows:

☺: the inspector had no remarks; ☺: certain rules must be obeyed; ☺: an injunction or prohibitory order has been given to the outlet; ☺: the outlet has received an administrative fine, been reported to the police or approval has been withdrawn.

We evaluated the microbiological qualities by homogenizing of aliquots of 10 g of fresh sushi products (including both rice and ingredients) in 0.1% peptone saline with a Seward Stomacher 400 Lab Blender (U.K.) for 30 s. The numbers of aerobic bacteria, *E. coli* and *Staphylococcus* spp. were determined after serial dilution in 0.1% peptone saline by pour plating 1 ml in, respectively, plate count agar (Oxoid) incubated aerobically at 25 °C for 3 d, 1 ml in Rapid *E. coli* agar (Biorad) incubated aerobically at 37 °C for 2 d and surface spreading 100 µl on Baird Parker agar (Oxoid) incubated aerobically at 37 °C for 2 d.

In Denmark Iron Agar and/or Long & Hammer agar is routinely used for determination of aerobic count and specific spoilage organisms in fish and fish products (NMKL 184). In this study we decided to use PCA for determination of the aerobic count as it has been used in several studies concerning microbial quality of sushi (e.g. Adams et al., 1994; Anon, 2000; Atanassova et al., 2008). *E. coli* and *Staphylococcus* spp. counts constituted measurements of hygiene in relation to faecal contamination and handling, respectively. Number of samples is indicated in Table 1. All bacteriological analyses were conducted within 2 h of purchase and samples were kept refrigerated under transport and subsequent storage. We have not included analysis of *Listeria monocytogenes* although there are limits for presence of this pathogen according to current legislation (Anon, 2006). This is due to the short shelf life of sushi in general prevent extended growth of this organism. In addition, *Vibrio* spp. such as *Vibrio vulnificus* and *Vibrio alginolyticus* could also be considered as potential pathogens in relation to sushi and indeed are important for Japanese sushi products (Anon, 2011). They are, however, seldom found in Australian or European sushi products (Anon, 2008; Atanassova et al., 2008) and we therefore also omitted analyses of contents of *Vibrio* spp. in this study.

We surveyed consumer usage of the Smiley ratings and knowledge about specific tests conducted by Smiley inspectors by means of a questionnaire that was distributed to three different student groups in the period April 2013 to May 2013. The first group consisted of students at a high school in Copenhagen (The Gefion Gymnasium, *n* = 80), the second group comprised veterinary undergraduate students (*n* = 115), and the third group food engineer

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