Application of the hazard analysis of critical control points (HACCP) concept in the control of the micro-biological quality of meals and cleanliness in restaurants

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ABSTRACT

Results obtained from a bacteriological examination of 148 samples of meals and 2005 samples of swabs/prints from work surfaces, of cutlery, and of the hands of employees in the "Studentski centar" restaurant, were the subject of analysis. Considering negative findings, where there was no presence of *Salmonella* spp. or other conditionally pathogenic bacteria *(S. aureus, E. coli* and sulphide-reducing Clostridia) in the examined materials, it may be concluded that the microbiological risk of nutrition in the restaurant falls within the parameters of control at critical points during the preparation of ready-cooked meals. The latter includes thermal treatment (at 75 ºC), personal hygiene of working staff, and the microbiological purity of work surfaces during the preparation and handling of ready-cooked meals. Permanent monitoring of the above, and other, conditions is necessary. An improvement in these conditions, according to the HACCP-concept, is desirable.

Key words: meals, bacteriological quality, restaurants, HACCP-concept

Introduction

The system of preparation and provision of food in 'closed'-type restaurants can generally be described as catering. However this system also poses significant epidemiological problems since occurrences of food poisoning in such establishments occur, first and foremost, on a massive scale.

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In considering this matter we also bear in mind information provided by GAREIS (1995), according to whom the premier position in the epidemiology of food poisoning caused by *S. enteritidis* in Germany is occupied by ready-cooked restaurant meals, which account for 49% of the total of all recorded cases of this type of food poisoning.

Information available in literature indicates the hygiene problems which can arise in restaurants and other public catering establishments.

The results of an investigation carried out by NJARI and KOZAČINSKI (1993) indicate that the microbiological state of work surfaces and eating utensils in 'closed'-type restaurants was assessed as good in 88% of tested samples, as satisfactory in 9.5% of samples, and as unsatisfactory in 2.5% of samples (n=667). These results are significantly better than those arrived at in research undertaken by PFEIFER et al. (1983), VORGIĆ (1983), KOSTIĆ et al. (1988), and MIOKOVIĆ et al. (1991), according to whom the hygienic standard of ready-cooked meals in restaurants and hotels was found to be unsatisfactory. This finding relates mainly to a very high level of overall bacterial contamination, and to positive results of provisionally pathogenic bacteria, specifically *E. coli*, pyogenic staphylococcus and sulphide-reducing clostridia on work surfaces, eating utensils and the hands of catering staff.

The problem area dealt with in literature within the framework of the stipulated system of veterinary and sanitary control relates to measures which need to be taken in order to prevent both initial and subsequent contamination of foodstuffs. In their response to this, MOSSEL and STRUIJK (1992) point out that control includes the selection of contaminated ingredients, prevention of contamination and colonization and destruction of micro-organisms in foodstuffs in general.

Viewed from the above aspect the most effective concept in the control of sources of contamination is the Hazard Analysis Critical Control Points (HACCP) concept. HACCP has proved to be very effective, concrete and critical in the control of microbiological contamination (as, for example, with *Salmonella* spp.) when compared with traditional procedures for control and inspection (SIMONSEN et al., 1987).

In his description of the application of the HACCP-concept in the central food preparation area, CHRISTENSEN (1989) points out that the main

risks incurred in the preparation of ready-cooked meals involve their contamination from raw ingredients, and from the hands of catering staff, from direct or indirect contact with contaminated work surfaces, as well as from the growth of bacteria caused by rises in temperature during the course of their preparation and storage. The author makes particular mention of the fact that the food preparation process should include effective contamination control, which involves the rapid cooling and storage of cooked meals (0 °C). Also effective in this respect are procedures for the hot storage of food (60 °C), the cooking (75 °C) and the reheating of food (72-75 °C/15 min). On the other hand, the restricted control of food contamination by pathogenic bacteria involves the cleaning and disinfecting of work surfaces, education and a high level of personal hygiene, as well as the health control of personnel. The foregoing also relates to application of the HACCP-concept in the preparation of food in households (GRIFFITH and WORSFOLD, 1994), as well as to the very concrete evidence for the advantages of the HACCP-concept in the preparation and microbiological improvement of food quality within airline companies (BEUMER et al., 1994).

With the above in kind we set ourselves the task, within the framework of this paper of gathering data that would enable us to provide more reliable answers to the question of how application of the HACCP-concept could improve the hygienic and technological level of ready-cooked meals in the restaurants of the 'Studentski centar' in Zagreb. The main emphasis was placed on the microbiological condition of ready-cooked meals, as well as on the level of microbiological cleanliness of work surfaces, eating utensils and the hands of catering staff.

Materials and methods
Within the framework of this paper 148 samples of ready-cooked meals containing meat (34 of which were chicken meat) in the nine restaurants at the 'Studentski centar' in Zagreb, including the central food preparation area and kitchens in faculties and student homes, were analyzed. Results arrived at have been interpreted in accordance with bylaws governing biological standards for foodstuffs which stipulate that microbiologically-sound ready-cooked food in restaurants must not contain aerobic bacteria

in an amount exceeding 10,000 cfu/g, bacteria of the *Salmonella* spp. in
an amount exceeding 25/g, and *S. aureus, E. coli* and sulphide-reducing
bacteria in an amount exceeding 10/g.

Analyzed ready-cooked meals were prepared with beef, pork or
chicken, the analysis being performed immediately after their preparation;
i.e., immediately prior to serving and without having been warm stored or
reheated. The samples were mostly traditional dishes of local cuisine, such
as roast pork and chicken, oil-fried chicken and pork in batter, minced-
meat burgers, chicken paprika stew and stewed baby beef, served with
various side dishes such as rice, pasta, potatoes and other vegetables.
Samples (c. 400 g) were taken from all the mentioned restaurants and
establishments by authorized personnel, were placed in polyvinyl chloride
bags and stored in a portable cool box packed with ice (up to 6 °C) for a
period of two to three hours.

Also analyzed were the results of bacteriological testing of 2005 swabs
and rinses from work surfaces, eating utensils and the hands of catering
staff. Results of analyses, with regard to the total number of mesophylic
bacteria, were interpreted in accordance with the stipulations of bylaws
governing standards for microbiological cleanliness and the methods by
which they are determined: porcelain, glass, metal (CrNi), plastic and
smooth cement surfaces, as well as plastic chopping and cutting boards
(10-30 cfu/m1/cm^2), eating utensils (500 cfu/m1), hands of employees in
direct and indirect contact with food (100-2000 cfu/m1).

Additionally, findings of enterobacteria and group D streptococcus
had to be negative on 10 cm^2 of a swab or in 1 ml of a rinse.

The tests were carried out during the course of 1994 and 1995, at the
request of the 'Studentski centar' in Zagreb supervisory service, at
authorized laboratories in Zagreb. The following media of the original
composition (Biolife, Milan, Italy) were used in accordance with formal
procedures (Anonymous, 1994; Anonymous, 1994.) for isolation and
determination of the relevant bacteria (aerobic mesophylic bacteria in
0.0001 g; *Salmonella* spp. in 25 g; *Staphylococcus aureus* in 0.1 g; *E. coli*
in 0.1 g; sulphide-reducing clostridia; *Enterobacteriacae* (10 cm^2, 1 ml);
Enterococcus (10 cm^2, 1 ml).

Bacteriological analyses of ready-cooked meals, of swabs and rinses from work surfaces, of eating utensils and of the hands of employees were carried out after the introduction of the HACCP-concept of microbiological quality control of ready-cooked meals in Studentski centar restaurants (SIMONSEN et al., 1987; CHRISTENSEN, 1989; ŽIVKOVIĆ, 1989).

Results and discussion

Firstly, it needs to be stressed that results of bacteriological tests show that all 148 samples of ready- cooked meals met the stipulated microbiological standard with regard to total number of mesophylic bacteria ($<10^4$ cfu/g) as well as showing a negative finding of provisionally pathogenic bacteria (*Salmonella* spp., *S. aureus*, *E. coli* and sulphide-reducing clostridia) in the stipulated quantities. This can be explained by existing appropriate hygienic and technological conditions of foodstuffs and correct thermal treatment during culinary preparation. The same conclusion was previously arrived at by SIMONSEN et al. (1987), CHRISTENSEN (1989), BEUMER et al. (1994), and GRIFFITH and WORSFOLD (1994), according to whom disregard of hygienic and technological standards during preparation can result in the growth and multiplication of bacteria, which compromise the sanitary state of ready-cooked meals and, therefore, consumer health.

Given the foregoing, it is important to point out that through applying the HACCP-concept in a central food preparation area, in which the control of contamination of ingredients and implementation of appropriate cooking standards (at 75 ºC), of both cold (7 ºC) and warm (55º) storage, as well as the reheating (75 ºC) of food, are designated as point of effective control of contamination of ingredients and ready-cooked meals by salmonella and other pathogenic bacteria can be ensured. This is particularly important if one bears in mind the frequent findings of *Salmonella* spp. in chicken giblets (especially the liver), as well as in dressed chicken and chicken meat on the carcass sold in a market place, which makes the purchase of such products for use in food preparation a high-risk factor with regard to the hygienic quality of ready-cooked meals in restaurants (HORTUNG, 1993). The foregoing relates primarily to the possibility of subsequent contamination of cooked meals by salmonella and other pathogenic bacteria.

Application of the HACCP-concept in restaurants involves implementation of adequate sanitary measures and maintenance of an appropriate level of cleanliness of work surfaces, eating utensils and the hands of employees. Contrary to our previous findings regarding a higher level of bacterial contamination, including the finding of provisionally pathogenic bacteria, in the present research only 45 (2.24%) of the total of 2005 samples of swabs and rinses failed to meet the standards of microbiological cleanliness stipulated by the earlier mentioned bylaws (Table 1) The number of unsatisfactory samples varied from 0 to 4.3% per individual restaurant, which can be regarded as a good level of microbiological quality.

Table 1. Results of bacteriological testing of swabs and rinses taken from students restaurants

Restaurant	Number of samples						
	1994		1995		Total		
	N	n	N	n	N	n	%
Faculties							
1	115	3	152	4	267	7	2.62
2	71	0	40	3	111	3	2.70
3	60	4	33	0	93	4	4.30
4	64	0	39	0	103	0	0.00
5	26	0	36	0	62	0	0.00
Total	336	7	300	7	636	14	2.20
Student Residences							
6	191	4	333	7	524	11	2.10
7	158	5	181	2	339	7	2.06
8	78	1	198	4	276	5	1.81
Total	427	10	712	13	1139	23	2.02
Central food preparation area							
9	105	8	125	0	230	8	3.48
Total (1-9)	868	25	1137	20	2005	45	2.24

N = overall number of tested samples; n = number of bacteriologically unsatisfactory samples

The above mentioned smaller number of tested swabs and rinses taken prior to food preparation of work surfaces and to the issue of eating utensils failed to meet stipulated standards with regard to overall number of aerobic mesophylic bacteria, while the result regarding enterobacteria and enterococcus was negative for all tested swab samples (10 cm^2) and rinses (1 ml). The number of unsatisfactory samples of swabs and rinses therefore totaled 3.7% on work surfaces, 2.1% on eating utensils, and 1.0% on the hands of employees (Table 2)

Table 2. Results of tests for total number of mesophylic bacteria in swabs and rinses

Material	Number of samples						
	1994		1995		Total		
	N	n	N	n	N	n	%
1. Work surfaces (>10 cfu/cm^2/ml)	172	10	335	8	507	18	3.35
2. Work surfaces (>30 cfu/cm^2/ml)	175	6	120	3	295	9	3.05
Total (1-2)	347	16	455	11	802	27	3.37
3. Eating utensils (>500 cfu/ml)	216	7	301	4	517	11	2.13
4. Employee's hands (>100 cfu/cm^2)	185	2	201	0	386	2	0.35
5. Employee's hands (>2000 cfu/cm^2)	120	3	180	2	300	5	1.67
Total (3-5)	305	5	381	2	686	7	1.02
Total (1-5)	868	28	1137	17	2005	45	2.24

N = total number of tested samples; n = number of bacteriologically unclean samples; cfu = colony forming units

Everything stated above points to the conclusion that microbiological cleanliness in Studentski centar restaurants is on the same level with regard to results of research carried out by NJARI and KOZAČINSKI (1993), although they additionally proved the presence of enterococci in 1.35% of *S. aureus* in 0.15% and of *E. coli* in 0.15% of tested samples taken from work surfaces

and eating utensils in restaurants of the same type. Likewise, the results of our analysis are significantly better in comparison with results of research undertaken by PFEIFER et al. (1983) and MIOKOVIĆ et al. (1991), who concluded that the hygiene of work surfaces used for the preparation of ready-cooked meals in restaurants and hotels was unsatisfactory. This applies also to swabs taken from work surfaces in Studentski centar restaurants found to have a very high level of bacterial contamination and a significant number of findings of provisionally pathogenic bacteria and which prior to introduction of the HACCP-concept, according to our earlier findings reached as high as 20%.

In conclusion, it is clear that the presented results, as well as our evaluation, taken together with other data reported in literature, indicate that application of the HACCP-concept can significantly improve the microbiological quality of ready-cooked meals, as well as the cleanliness of work surfaces, particularly with regard to the control of critical points of their bacterial contamination. This relates primarily to control of ingredients and thermal treatment in the culinary preparation of food, as well as control of the microbiological state of work surfaces, eating utensils and the hands of employees. At the same time, we concur with MOSSEL and STRUIJK (1992), and BEUMER et al. (1994), who state that hygiene control and microbiological tests of products are not in themselves a guarantee of food safety.

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SAŽETAK

Prikazani su rezultati bakteriološke pretrage 148 uzoraka gotovih jela te 2005 uzorka obrisaka i ispiraka s radnih površina, pribora za jelo i ruku uposlenih djelatnika u 9 restauracija "Studentskog centra" u Zagrebu. Također su procijenjeni su higijensko-tehnološki uvjeti pripreme gotovih jela. S obzirom na negativni nalaz patogenih bakterija (*Salmonella* spp., *S. aureus*, *E. coli*, sulfitreducirajućih

klostridija) u svim pretraženim uzorcima, može se smatrati da je mikrobiološki rizik prehrane u spomenutim restauracijama na primjernoj razini kontrole kritičnih kontrolnih točaka pripreme jela (HACCP). To se odnosi na kontrolirane uvjete toplinske obrade jela (75 °C) te na osobnu higijenu djelatnika i mikrobiološku čistoću radnih površina u pripremi i rukovanju jelima. To ne znači da spomenute i ostale uvjete ne treba stalno nadzirati i unaprjeđivati sukladno prikazanim odrednicama HACCP-koncepcije.

Ključne riječi: gotova jela, bakteriološka ispravnost, čistoća radnih površina, HACCP-koncepcija, restauracije