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MICROBIOLOGICAL QUALITY OF POULTRY DISHES PREPARED IN COOK-CHILL TECHNOLOGY

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Key words: poultry dishes, cook-chill, microbiological quality

The aim of the research was to estimate microbiological safety and shelf life of poultry dishes prepared in cook-chill technology and stored at a temperature 3°C±1°C by 6 days and assessment of the microbiological stability. The prepared and stored dishes were processed in an institutional catering factory of efficiency of 3000 dishes per day.

Based on the results, it can be stated that microbiological quality of the analysed dishes was differentiated in series realized at spring and autumn and in processing cycles. Probably, it reflected the differences of quality of the raw materials used for processing. Additionally, GHP and GMP rules were fulfilled, especially the personal hygiene and cleanness of technological equipment. Low quality of dishes was due to a lack of the defined parameters of cooking and chilling process.

There is the necessity of standardization of technological processes and exact monitoring of observed technological parameters. These days, the technological process is realized at high risk of food-borne diseases level and should not apply cook-chill technology for preparing poultry dishes.

INTRODUCTION

Quality of poultry products is built by safety, sensory attractiveness, nutritional value, ability to retailing and usefulness for consumers [Álvarez-Astorga *et al.*, 2002]. Poultry meat is often used as dishes ingredient of catering. The culinary usefulness of poultry meat is a result of its sensory value [Gras, 1999], high digestibility, good nutritional value, considering the optimal amino acids composition [Chizzolini *et al.*, 1999; Kijowski, 2001], as well as competitive price [Kijowski, 2000].

Generally, meat with regard to the high proteins content acidity (pH=6) and other components is a good medium for the growth of microorganisms. Extent of microorganism increase and in consequence the stability of meat depends on the contamination level of raw meat, temperature, pH and water content. Low contamination at the beginning of meat storage effects in the longer shelf life [Kortz, 1997; Kijowski, 2001]. Especially, bacterium *Salmonella* (*S. enteritidis, S. typhimurium, C. jejuni*) and *Campylobacter* are a significant hazard of the poultry products [Corry *et al.*, 1995; Szeleszczuk, 2001].

It is necessary to pay attention to microbiological safety of poultry meat and prepared dishes, as well as possibility to extend their shelf life by adequate processing parameters. Recently, food-borne diseases induced by consumption of poultry meat are of the specific importance [Avens & Morton, 1999]. Alterkruse *et al*. [1996] indicated that the tendency of higher consumption of meat dishes out of home exposes to the food-borne diseases, especially children, elderly people, and pregnant women. Results of Wall *et al.* [1995] showed that the reason of many food-borne diseases are food products mishandling at restaurants and catering business (in canteens, schools, hospitals, prisons *etc.*).

The aim of the research was to estimate microbiological safety and the shelf life of poultry dishes prepared in cook-chill technology and stored at a temp. 3°C±1°C for 6 days and to assess their microbiological stability, *i.e.* maximum storage time of meat dishes which, approximately, may correspond to their shelf life [Kołożyn-Krajewska, 1998]. It was assumed that a safe dish was achieved when the number of microorganism did not exceed 10^5 cfu/1 g of product.

MATERIAL AND METHODS

The material for research were 3 types of poultry dishes: poultry force meat-balls, Chinese chicken and turkey fillets coated in bread-crumbs and egg, prepared and stored in catering enterprises which represents the institutional catering of efficiency to service 3000 person per day. Selection of this type of establishment resulted from the fact that as much as 36% of registered incidences of disease occur after eating dishes produced in such catering establishments [Yi–Mei & Ockerman, 2005]. Determination of the total plate count of bacteria (TPC) and the total count of psychrotrophic bacteria of meat dishes was carried out directly after the heat treatment and during 6 days of storage at 3°C±1°C.

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Dishes processing. The composition of dishes and heat treatment parameters were presented in Tables 1 and 2.

Heat treatment of all the dishes was conducted up to a temperature above 75°C in their geometrical centres.

Blast chilling. Blast chilling was performed by a blast chiller with the capacity of 20 x GN 1/1 with ability to use house trolleys from a convection oven. The examinations were conducted when full load of the blast chiller was achieved. The time of dishes chilling from the temperature of 65°C to the temperature of +3°C was measured. Chilling was performed in GN1/1 containers of the height of: 65 mm for Chinese chicken and 40 mm for poultry force – meat ball and turkey fillets. The temperature was measured in the geometrical centre of the dish by the probes installed by the manufacturer of the chiller. Time of chilling was controlled: turkey fillets – 85 min, poultry force meat-ball – 55 min, Chinese chicken – 129 min.

Microbiological analysis of dishes after processing and storage. Microbiological analyses were determined in samples of dishes prepared in the cook-chill technology, just after dish preparation as well as each day of 6-day storage at 3°C±1°C. The study was carried out in two series at the spring and the autumn of 2006, each in three processing cycles. Total plate count of bacteria (TPC) and total count of psychrotrophic bacteria (expressed in log cfu/g) were determined with the traditional plate method, according to Polish Standards [PN-A-82005-6:1994; PN-85/A-82051; PN-ISO-17410:2003] on the Noack Polen agar plates. In the case of total plate count of bacteria, the samples were incubated at 37°C±1°C for 48 h, and in the case of total count of psychrotrophic bacteria at 7°C±1°C for 10 days.

Samples of dishes were collected to sterile plastic bags and closed hermetically by sealing. Samples of solid consistence, for example meat-balls, were collected as a one ball as a sample, whereas samples of semifluid consistence were stirred before collection. Before spreading, dishes were homogenized in a Stomacher apparatus (type 80) for 120 s with standard speed. From the comminuted material, 5-g samples were collected under sterile conditions and transferred to a sterile plastic bag, which was then filled with 45 mL of peptone water. Afterwards, the samples were homogenized in a Stomacher apparatus for 60 s, at a constant speed. This way, the first dilution of 10^{-1} was obtained that was used to prepare serial decimal dilutions by transferring (under sterile conditions) 1 mL of bacterial suspension from the previous dilution into a test-tube with 9 mL of sterile peptone water. Each tube was thoroughly stirred using a Heidolph microbiological stirrer. One mL of bacterial suspension, from three subsequent suspensions, was poured out on Petri dishes in three replications. After pouring the dishes over with liquid cool agar, they were stirred, turned back and put into an incubator. Dishes containing from 15 to 300 colonies were selected for bacterial count determinations

TABLE 1. General composition of studied dishes.

Type of dishes	Composition of dishes
Turkey fillets coated in bread-crumb and egg	poultry fillets, bread-crumbs, wheat flour, eggs, oil
Poultry force meat-ball	poultry force meat, bread-crumbs, pepper, eggs, stale roll, oil
Chinese chicken	poultry goulash, onion, frozen paprika, tomato concentrate, potato flour, ketchup, sweet-acid, sugar, fix spices for Chinese dish, vegetables

TABLE 2. Parameters of heat treatment of studied dishes.

Dish	Parameters of heat treatment
Turkey fillets coat in bread-crumbs and egg	Frying on the pan (fat temperature 180°C±2°C)
Poultry force meat-ball	Heat treatment by conventional-steamer oven (container GN 1/1 40 mm) at the temperature of 180°C±2°C without evaporation during 20 min. and then with 50% evaporation during next 20 min.
Chinese chicken	Preliminary frying on the frying pan (fat temperature of 180°C±2°C) during 20 min, and then stewing in the stewing pot during 120 min

Statistical analysis. The statistical analysis of the results was performed using the statistical software Statistica PL for Windows 5.5. The results were elaborated by simple analysis of variance.

RESULTS AND DISCUSSION

Based on the results (Table 3), it can be stated that microbiological quality of the studied dishes was differentiated and characterised by a high level of the total count of bacteria (TPC). Dantas & Conceição [1988] reported on high microbiological contamination of poultry dishes, too. They researched dishes prepared in canteen and noted 24% of unacceptable quality samples among 266 samples, and detected bacteria of *Salmonella* genus in a few samples.

The starting value of TPC at the day of processing of Chinese chicken was 3.90±0.85 log cfu/g (at the first series – in spring), and 4.99±1.02 log cfu/g in the 3rd day of storage. The values qualified these dishes as not allowed for consumption with regards to microbiological safety. In autumn (second series) the dishes were characterised by higher total plate count of bacteria – 6.73±1.27 log cfu/g.

High differences in TPC between the experimental series and between processing cycles showed that the process was out of standards of hygiene (which was also indicated by a high value of standard deviation). Distinct differentiation in TPC between experimental series indicated a lack of standardization of the technological process (differences of the quality of raw materials, not complying with hygiene rules and lack of the properly defined parameters of heat treatment and chilling process).

It is worth mentioning that the catering establishment has just been preparing to implementation of the cook-chill technology. Many authors [Weingold *et al.,* 1994; Barrie, 1996; Coleman & Griffith, 1998] as the major reason of food-borne diseases after consumption of food pointed to improper heat treatment and chilling, especially meat chilling, and preparing dishes several

TABLE 3. Total count of bacteria (TPC) in studied dishes during storage.

Dish	Term of analysis	Time of storage (days) Total count of bacteria – TPC log (cfu/g) $\overline{X}$ ±SD						
		0*	1	2	3	4	5	6
Turkey fillets	spring	3.88±0.90	4.38±0.57	4.01±1.06	4.31±0.74	5.17±0.6	5.61±1.16	7.02±1.27
	autumn	4.78±0.66	5.42±1.45	5.88±1.60	6.56±1.72	8.59±1.35	9.07±1.78	10.17±2.36
	average	4.42±0.87	5.01±1.27	5.12±1.67	5.77±1.72	6.88±2.04	7.34±2.30	8.87±2.51
Poultry meat balls	spring	2.88±0.39	3.63±0.33	4.83±0.79	4.60±0.34	4.45±0.14	4.44±0.39	6.23±0.10
	autumn	3.91±0.61	4.43±0.57	4.99±0.55	4.73±1.12	5.65±0.81	6.24±0.43	6.17±0.43
	average	3.27±0.62	4.16±0.62	4.93±0.60	4.68±0.87	5.31±0.88	5.64±0.98	6.18±0.39
Chinese chicken	spring	3.90±0.85	3.69±0.98	4.27±0.68	4.99±1.02	4.61±1.07	4.32±0.87	4.75±0.60
	autumn	6.73±1.27	6.26±1.23	6.74±0.82	8.23±1.17	9.74±0.45	10.84±0.48	10.89±0.62
	average	5.27±1.8	5.16±1.57	5.54±1.2	6.63±2.22	7.17±2.79	7.59±3.47	7.55±3.25

* – the day of processing, $\overline{X}$ – mean value, SD – standard deviation

TABLE 4. Total count of psychrotrophic bacteria in studied dishes during storage.

Dishes	Term of analysis	Time of storage (days) Total count of psychotrophic bacteria log (cfu/ g) $\overline{X}$ ±SD						
		0*	1	2	3	4	5	6
Turkey fillets	spring	2.0±0.50	3.10±0.19	4.34±0.2	3.53±0.80	4.36±0.78	5.71±1.08	5.18±1.10
	autumn	4.10±1.10	5.17±2.04	3.32±0.47	3.77±0.45	5.39±0.66	4.69±1.23	6.43±1.13
	average	3.95±1.19	4.34±1.87	3.85±0.65	3.67±0.62	4.88±0.88	5.11±1.26	5.98±1.25
Poultry meat ball	spring	1.24±0.34	1.35±0.49	3.21±0.63	4.33±0.09	5.04±0.43	4.07±0.15	6.56±0.49
	autumn	2.88±0.64	3.62±0.65	4.72±0.53	4.86±1.30	4.99±1.47	5.55±1.40	5.16±0.74
	average	2.51±0.92	2.97±1.24	4.10±1.07	4.65±1.01	5.22±0.57	5.18±1.16	5.63±0.94
Chinese chicken	spring	2.41±0.54	3.59±1.76	3.88±1.77	5.08±0.89	5.59±0.43	5.69±1.52	6.03±0.80
	autumn	4.22±0.41	3.79±1.28	4.16±0.81	5.13±0.71	7.20±1.86	10.74±0.74	10.31±1.12
	average	3.32±1.04	3.98±1.31	4.02±1.34	5.10±0.65	6.53±1.62	7.71±3.29	7.34±2.23

* – the day of processing, $\overline{X}$ – mean value, SD – standard deviation

hours before serving. Martinez-Tomé *et al.* [2000] paid attention to the necessity of increasing the number and scope of GHP and HACCP system trainings, including practical knowledge, as well as to the necessity of continuous monitoring of temperature in the production area in order to reduce the number of microorganism in dishes prepared in the catering business.

In the case of poultry meat ball (dishes prepared from force meat) and turkey fillets, total plate counts of bacteria were different depending on the experimental series but these differences were far smaller. In the day of preparation, average TPC values in poultry meat balls accounted for 2.88±0.39 log cfu/g achieving the value of 6.23 ±0.10 log cfu/g in the sixth day of storage. The numbers of aerobic microorganisms determined in poultry meat balls in two experimental series were similar. It was a consequence of using quality balanced raw material, derived from one producer in two research series.

In the case of turkey fillets in the first series, TPC estimated in the day of preparation reached 3.88±0.90 log cfu/g, achieving the value of 5.17±0.6 log cfu/g in the fourth day of storage. Quality of that dish in the second series was a little worse (5.42±1.45 log cfu/g in the first day of storage).

Results obtained in the study confirmed that a high initial count of microorganisms leads, consequently, to a shorter shelf life of a dish. As Freedman *et al*. [1989] reports bacteria able to grow at lower temperatures initially constitute only a negligible part (ca. 10%) of product microflora. In the course of chill storage, however, they are observed to grow rapidly, thus producing metabolites responsible for deterioration of taste and aroma. Similar dependence was observed in the case of the total count of psychrotrophic (Table 4).

Spoilage of meat and its preserves is affected by many complex physical, chemical and microbiological transformations evoked by extrinsic factors connected with storage conditions (temperature, moisture, gas atmosphere, access of light, method and conditions of packaging and operation in technological process) as well as by intrinsic factors resulting from the type of food (water activity, acidity – pH, redox potential, content of nutrients, kind and initial count of microorganisms, presence of resting spore bacteria and natural preserving substances). Decisive effects have also factors connected with the technological process and interactions between microorganisms. Natural microflora of products

affects these transformations as well [Huis in't Veld, 1996; Gram *et al*., 2002].

Researches of Blakeslee & Penner [1999] related to beef dishes preparation demonstrated a 50% reduction in the number of aerobic bacteria and elimination of coli group bacteria in spite of a considerable initial count of aerobic bacteria – 5.38-5.63 log cfu/g after cooking and blast chilling as well as after restitution of stored dishes. In the case of the examined dishes it seems necessary to improve the technological process and carry out hygiene trainings.

CONCLUSIONS

1. It can be stated that the total count of bacteria of the analysed dishes significantly differed in series realized at spring and autumn. Probably, it was caused by differences in the quality of the raw materials used for processing. Additionally, GHP and GMP rules were fulfilled, especially the personal hygiene and cleanness of technological equipment. Low quality of dishes was a consequence of not keeping critical parameters of technological process that is to say lack of the defined parameters of cooking and chilling process.

2. There is the necessity of standardizing technological processes and precise monitoring of observed technological parameters.

3. It is necessary to continue researchers to estimate unequivocally the period of microbiological safety as well as to pay attention to restricted compliance of technological regimes connected with the cook-chill technology.

4. It seems that under conditions of the technological process run in that establishment there is too high risk of foodborne diseases infections; thereby that technology should not be used for preparation of poultry dishes.

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JAKOŚĆ MIKROBIOLOGICZNA POTRAW Z MIĘSA DROBIOWEGO PRZYGOTOWANYCH W TECHNOLOGII COOK-CHILL

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Celem badań była ocena bezpieczeństwa mikrobiologicznego potraw przygotowywanych z mięsa drobiowego w technologii cook-chill (gotuj i schłódź), przechowywanych w warunkach chłodniczych (temp. 3°C ± 1°C) w czasie do 6 dni oraz określenie terminu trwałości mikrobiologicznej. Potrawy przygotowywane i przechowywane były w zakładzie gastronomicznym, reprezentującym tzw. catering instytucjonalny i serwującym posiłki z przeznaczeniem dla 3000 osób. Wykazano, że występują duże różnice w ogólnej liczbie drobnoustrojów pomiędzy poszczególnymi seriami badań (wiosna, jesień), a także pomiędzy poszczególnymi cyklami produkcyjnymi co może wskazywać na różnice jakościowe surowców użytych do produkcji oraz na nieprzestrzeganie zasad GMP i GHP, głównie higieny osobistej pracowników i czystości urządzeń technologicznych. Zła jakość potraw może być również konsekwencją nieprzestrzegania krytycznych parametrów procesu technologicznego tzn. braku utrzymania reżimów obróbki cieplnej i procesu schładzania. Powyższe stwierdzenia wskazują na konieczność standaryzacji procesów technologicznych i ścisłego przestrzegania reżimów technologicznych. Wydaje się, że w warunkach procesu technologicznego prowadzonego w tym zakładzie jest zbyt duże ryzyko zachorowania i nie powinno się stosować tej technologii do przygotowania potraw z drobiu.