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MICROBIOLOGY OF PRECOOKED FROZEN FOODS MANUFACTURED IN
MEAT FACTORY "MITROS"

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A little more than a year ago, the first production of precooked frozen foods in Yugoslavia had been started by meat factory "Mitros". Bacteriological surveys of the precooked frozen foods have been carried out simultaneously with the advancing of the production, in order to ensure a regular technological processing for the manufacturer, to get hygienically faultless products with a high keeping quality and a standard quality.

In the bacteriological sense, the precooked frozen foods differ a great deal from those in cans, as the latter are after the finishing processing put into the aluminum foil containers, without additional thermal treatment, and besides, those containers are not hermetically closed. The temperatures of boiling and roasting only, are not sufficient to kill all bacteria, so the infection can increase during the treatment of foods, especially at the moment of pouring them into the aluminum foil containers. The still existing bacteria will then be given the possibilities of germinating under certain conditions of storage, and so they can not only minimize the keeping quality of the product, but also endanger the lives of consumers.

- . A review of literature

The first investigations of precooked frozen foods were carried out in U.S.A. in the periods from 1930. till 1933., but they were chiefly concentrated to the technological direction. In the last two decades there can be found in the

literature more and more data concerning the bacterial flora of precooked frozen foods, with such works still increasing after the year 1947. Proctor and Phillips appear at just that time with their work about the bacterial flora, which included more than a hundred sorts of precooked frozen foods. There can also be found numeral and very important data about precooked frozen foods in the book written by Tressler and Evers. By the number of published works and the variety of problems concerning precooked frozen foods, the periods from 1955. till 1957. are the richest ones.

Paralelly with the beginning of the production of precooked frozen foods in U.S.A. in mass, also appear the first standards defining a maximum of bacteria count. With the introducing of precooked frozen foods into the table of feeding of the U.S. Air-Force in 1951., are also brought the standards by which the total count of bacteria in those foods must not be over 100.000 per gram., but coliforms must not be more than 10 per gram. The civilian regulations are still more rigorous, suggesting for the standard the count 50.000. as the maximum per gram.

In Czechoslovakian standards no definite number of bacteria in precooked frozen foods is fixed, but it is required that in frozen beef tripes and frozen beef goulash must not be any pathogens, nor a high number of any bacteria that would indicate a high deterioration.

In Yugoslav technic literature there can be found no data concerning microflora in precooked frozen foods, and since so far there was no such production, those foods are not mentioned in existing regulations.

Methods and materials

For bacteriological survey of precooked frozen foods, manufactured in meat factory "Mitros", have been taken 253 samples, as follows: 183 samples of one-dish meals, and 70 samples of three-dish meals. The survey included the whole assortment of the production, and that is: 5 sorts of one-dish meals, and 4 sorts of three-dish meals, packed in aluminum foil containers.

In the examinations the usual standard technique has been used. We were defining: a/ The total plate counts of mesophilic bacteria, b/ The number of sporogenous mesophilic aerobic bacteria, c/ The number of proteolytic bacteria, d/ The number of sporogenous thermophilic bacteria, e/ Colititer, f/ Salmonella, g/ Fecal streptococci, h/ Sporogenous anaerobic bacteria, and i/ Staphylococci - with a special view to the coagulase positive.

Results and discussion

The average total plate count of bacteria in the samples of one-dish meals have been from 313 to 37.733. /see table 1./ and in those of three-dish meals from 18 to 51.306. bacteria per gram. /see table 2./. An extremely high total number of bacteria has been found only in two single cases, as follows: In one sample of beef tripe - 836.000., and in one sample of three-dish meal - meat patty with potatoes in sauce - 416.000.

For the comparison of our results of the total plate count of bacteria we shall use a few data from foreign literature, in which these problems are treated. For example, Proctor and Phillips, having carried out a bacteriological

survey of precooked frozen foods being marketed in England in 1947. and 1948., have found out that the total plate count differed greatly, with the evaluations in some cases being over 1,000.000. per gram. Buchbinder and co. have in more than 50 per cent of surveyed samples of chicken a la king found over 1,000.000. per gram.

Contrary to those data, Huber and co. have in 1.282. samples of precooked frozen foods found 86 per cent of samples having the total plate count under 50.000. per gram. Doreen and Thatcher, have obtained similar results having examined 117 samples of precooked frozen foods, originating from nine Canadian and American plants. The average total plate count of bacteria per gram of chicken have been 24.000, of turkey 90.000., and of beef 4.000.

Probably on the ground of these and other similar surveys have been made the American sanitary regulations, the maximum of plate count of bacteria per gram of precooked frozen foods being 50.000.

If our values of the total count of bacteria in precooked frozen foods, manufactured in "Mitros", are compared with the above cited foreign data from literature of standards, it can be observed that they are only exceptionally over those values. From the data quoted in tables 1. and 2., there can be observed wider variations of the total number of bacteria between some sorts of foods, but it is also clear that there are some very extreme differences between the samples of the same sorts of meals.

It is very remarkable that, on the ground of the data quoted in table 3., concerning one-dish meals, in more than 50 per cent of samples the total plate count was less than

- 5 -

1.000. per gram. Not even in one sample of meat patty with potatoes, beef goulash, and bean soup with bacon the number of bacteria, was over 50.000. per gram. Only in several samples of beans with sausages, and beef tripes in sauce, the total number of bacteria was over 50.000., resp. 100.000. per gram.

The three-dish meals, with regard to their components, have the higher bacteria count in comparison with those of one-dish meals. Only in some single cases, which is a very small percentage indeed, in relation to the number of surveyed samples, the total plate count overpass the number of 50.000., or 100.000. per gram. In all those cases the question is about meals made of ground meat.

The variations of the bacteria count in precooked frozen foods, led Hartman and co. to conclude that the bacteria count in different samples of the same food depend on the season, the day of the week, and even on the hour during the working time.

By all means the initial infection and the technological processing play a decisive part in the bacteria count in the final product. The boning out and the chopping of meat are very important, and a long time ago noted factors.

For the purpose of estimating the rate of the initial infection, Proctor and Phillips had been defining the total count of bacteria using both direct microscopic and culture methods. In such ways had been obtained the data of the number of living bacteria in relation to that of killed ones.

As the proteolytic ferments of micro-organisms are capable of decomposing of proteins, and in that way influencing the keeping quality of precooked frozen foods, we were

also defining in our examinations the number of proteolytic bacteria.

With the found values of proteolytic bacteria we can be absolutely satisfied, as their number is high only in single cases /see tables 1. and 2./. Unfortunately we have not been able to find any similar data of examining of proteolytic bacteria in available foreign literature.

In some samples of surveyed precooked frozen foods, the number of sporogenous bacteria were over 1.000. per gram /meat patty with potatoes, meat patty, sauce piquante, spaghetti/ Such a finding might indicate an initial infection and points out to a need of devoting greatest care to the hygienic view of manufacturing.

From the table 5. it turns out that the number of spores of thermophilic bacteria in more than 95 per cent of the cases were less than 50.000. per gram. Under 10.000. spores were found in 93,6 per cent of samples of meat patty, in all examined samples of beef goulash, in 89,5 per cent of samples of bean soup and in 60,9 per cent of samples of tripes.

In three-dish meals the situation has been somewhat different concerning the spores of thermophilic bacteria, and there have been samples with over 100.000. per gram, in about 20 per cent.

Similar data concerning the count of spores of thermophilic bacteria in precooked frozen foods could not be found in foreign literature.

In some samples of one-dish, and those of three-dish meals, has been found a positive colititer in the dilution

of 1:10 and 1:100, but not even in one case by later determination could be isolated *E. coli*.

Our finding of streptococci in one-dish and three-dish meals /see tables 7. and 8./ differs widely from those in foreign literature. Ercole and co. have found them in nearly all examined samples of precooked frozen foods, while Huber has isolated them at one plant from about 30 per cent of examined samples. Doreen and co. had in precooked frozen foods been finding even the number of 2.510 streptococci per gram.

In the tables 7. and 8. are also showed the results of findings of coagulase positive staphylococci. For these examinations we have decided because of well known reasons, for staphylococci can endanger public health causing toxic-infections. In spite of the fact that in our examinations haven't been included the findings of the total count of staphylococci, but only their presence, we are able to state that the examined precooked frozen foods, notwithstanding the finding of coagulase positive staphylococci, had never been of potential danger, for the total number of bacteria in them went only to the maximum of 836,000 per gram. If the total count of 836,000. per gram has all been consisted of only coagulase positive staphylococci, it would probably be, by the citation from foreign literature, insufficient to cause food-poisoning and intoxication of people. Elek quotes that a very abundant growth of staphylococci is required for making food dangerous for human health. Frazier thinks that only the number of several millions of these micro-organisms can possibly cause an appearance of symptoms of an intoxication. Dack and Tanner bring out the examples of foods that had caused the intoxications of people, from which it can be observed that the number of staphylococci per gram varied

widely from 5,000.000. to several hundreds of millions per gram.

In his very interesting work, Peterson has surveyed the possibility of multiplication of staphylococci in precooked frozen foods. The same author has found out that in defrosted precooked frozen foods, kept on the temperature between 20°C and 37°C, staphylococci multiply a great deal slower than coliforms and other microorganisms, and the product becomes thoroughly organically changed before the count of staphylococci multiplies sufficiently to cause a disease.

Not in a single of inspected precooked frozen foods have we been able to note Salmonella /see tables 7. and 8./. Similar results can also be found in foreign literature, with a single exception of the work of Ercole, stating that in five to ten per cent of inspected samples of precooked frozen foods has been observed Salmonella. Usually Salmonella can be isolated from those samples that have had an exceptionally high total bacteria count, so there supposedly was the question of low hygienic conditions in the manufacturing.

In relatively small number of examined samples we have been able to find spores of anaerobic bacteria /see tables 7. and 8./. It is a pity that we have not been able to find any such data in foreign literature, so no comparison can be made.

S u m m a r y

If we now in the end summarize the results of bacteriological surveys of precooked frozen foods, manufactured at meat factory "Mitros", with regard of all difficulties that

inevitably follow the introduction of new products into regular manufacturing, we can be absolutely satisfied with results so far obtained. The established total plate count indicate that the technological processing of the production, though with still plenty of manual labour, has been on a good hygienic level, which has been the reason that the survival of microorganisms after cooking has been within the limit of foreign norms. Let us believe that, with the further mechanisation and technical improvements, the still existing deficiencies will be removed, and precooked frozen foods of a high technological and hygienic quality will be manufactured.

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THE RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF ONE-DISH
PRECOOKED FROZEN MEALS

Table 1

Name of the meal	Number of examined samples	Count of mesophylic bacteria			Thermo- philes
		Total	Proteolitic	Sporogenas	
Beef patty with potatoes	31	1.729 40-13.000	175 0-1.500	48 0-1.000	3.986 0-78.000
Beef stew with macaroni	31	1.715 0-28.000	39 0-190	20 0-120	1.434 0-5.600
Beans with bacon or smoked meat	38	313 0.3.360	23 0-125	7 0-80	4.580 0-20.300
Beans with sausages	42	7.084 0-180.000	325 0-1.500	33 0-560	7.494 0-47.200
Tripes in sauce	41	37.733 0-836.000	100 0-2.000	23 0-280	16.419 0-53.750

THE RESULTS OF BACTERIOLOGICAL EXAMINATIONS OF THREE-DISH PRECOOKED
FROZEN MEALS

Table 2

Item	Number of examined samples	Name of meal	Part of meal	Count of mesophylic bacteria			Thermo- philes
				Total	Proteolytic	Sporogenes	
1	5	Beef steak with sauce, potatoes, salad	Beef steak	42 0-100	-	2 0-10	-
			Fried potatoes	18 0-60	-	4 0-20	-
			Salad	264 0-710		4 0-10	4200 0-12.000
2	15	Beef patty, sauce potatoes	Beef patty	5.480 0-58.800	96 0-300	405 0-6080	17.395 0-224.000
			Fried potatoes	34.733 0-416.000	41 0-200	14 0-50	9.205 0-67.390
			Sauce	2.836 0-39.200	30 0-110	922 0-13.600	69.735 0-616.000
3	20	Veal stew, salad, macaroni	Veal stew	9.320 0-10.300	16 0-100	21 0-110	62.570 1930-492.000
			Macaroni	51-306 10-40.000	105 0-1600	348 0-3840	63.101 40-592.000
			Salad	13.737 0-164.000	16 0-100	20 0-130	44.298 0-240.000
4	30	Boiled beef, toma- to sauce, potatoes	Boiled beef	1474 0-29.600	124 0-2500	14 0-100	1530 0-312.000
			Boiled potatoes	17191 0-6450	44 0-520	9 0-40	1071 0-25.700
			Tomato sauce	92 0-415	39 0-300	5 0-60	788 0-15.000

THE NUMBER OF MESOPHYLIC BACTERIA IN EXAMINED SAMPLES OF ONE-DISH
PRECOOKED FROZEN MEALS

Table 3

Name of meal samples	Number of examined	Total count of mesophylic bacteria in 1 g											
		Sterile		1 - 1.000		1.000-10.000		10.000-50.000		50.000-100.000		more than 100.000	
		Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%
Beef patty with potatoes	31	-	-	20	64,5	10	32,2	1	3,2	-	-	-	-
Beef stew with macaroni	31	2	6,4	21	64,5	7	22,5	1	3,2	-	-	-	-
Beans with bacon or smoked meat	38	5	13,1	29	76,5	4	10,5	-	-	-	-	-	-
Beans with sausages	42	2	4,7	21	50,0	16	38,3	2	4,7	-	-	1	2,3
Tripes in gravy	41	5	12,1	28	68,2	4	9,7	-	-	1	2,4	3	7,3

THE NUMBER OF MESOPHYLIC BACTERIA IN EXAMINED SAMPLES OF THREE-DISH
PRECOOKED FROZEN MEALS

Table 4

Item	Name of meat	Part of meal	Number of examined samples	Total count of mesophylic bacteria in 1 g											
				Sterile		1-1.000		1.000-10.000		10.000 - 50.000		50.000 - 100.000		more them 100.000	
				Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%
1	Beef steak with sauce, potatoes, salad	Beef steak	5	2	40	3	60	-	-	-	-	-	-	-	-
		Fried potatoes	5	2	40	3	60	-	-	-	-	-	-	-	-
		Salad	5	1	20	4	80	-	-	-	-	-	-	-	-
2	Beef patty, sauce potatoes	Beef patty	15	1	6,6	10	66,7	2	13,3	1	6,6	1	6,6	-	-
		Fried potatoes	15	3	20	9	60,0	1	6,6	-	-	1	6,6	1	6,6
		Sauce	15	2	13,3	11	73,3	1	6,6	-	-	1	6,6	-	-
3	Veal stew, salad, macaroni	Veal stew	20	1	5	16	80,0	2	10,0	1	5,0	-	-	-	-
		Macaroni	20	1	5	11	55,5	4	20,0	4	20,0	-	-	-	-
		Salad	20	1	5	11	55,5	4	20,0	1	5,0	1	5,0	2	10,0
4	Boiled beef tomato,sauce, potatoes	Boiled beef	30	3	10,0	20	66,6	6	20,0	1	3,3	-	-	-	-
		Boiled potatoes	30	1	3,3	25	83,3	4	13,3	-	-	-	-	-	-
		Tomato sauce	30	5	16,6	25	83,3	-	-	-	-	-	-	-	-

THE NUMBER OF THERMOPHILIC BACTERIA IN EXAMINED SAMPLES OF ONE-DISH
PRECOOKED FROZEN MEALS

Table 5

Name of meal	Number of examined samples	Count of sporogene thermophiles in 1 g											
		Sterile		1 - 1.000		1.000-10.000		10.000-50.000		50.000- 100.000		more them 100.000	
		Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%
Beef patty with potatoes	31	16	51,6	7	22,5	6	19,3	1	3,2	1	3,2	-	-
Beef stew with macaroni	31	14	45,5	7	22,5	10	32,2	-	-	-	-	-	-
Beans with bacon or smoked meat	38	17	44,7	8	21,0	9	23,7	4	10,5	-	-	-	-
Beans with sausages	42	17	40,4	3	7,1	15	35,7	1	2,3	-	-	-	-
Tripes in gravy	41	18	43,9	1	2,4	6	14,6	15	36,6	1	2,4	-	-

THE NUMBER OF THERMOPHILIC BACTERIA IN EXAMINED SAMPLES OF THREE-DISH
PRECOOKED FROZEN MEALS

Table 6

			Count of sporogene thermophiles in 1 g												
Item	Name of meal	Part of meal	Number of examined samples	Sterile		1-1.000		1.000-10.000		10.000- 50.000		50.000- 100.000		more them 100.000	
				Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
				of samples		of samples		of samples		of samples		of samples		of samples	
=====															
1	Beef steak with sauce, potatoes, salad	Beef steak	5	5	100	-	-	-	-	-	-	-	-	-	-
		Fried potatoes	5	5	100	-	-	-	-	-	-	-	-	-	-
		Salad	5	2	40,0	1	20,0	1	20	1	20	-	-	-	-
2	Beef patty, sauce potatoes	Beef patty	15	2	13,3	3	20,0	8	53,3	1	6,6	-	-	1	6,6
		Fried potatoes	15	-	-	4	26,6	6	40,0	1	6,6	2	13,3	2	13,3
		Sauce	15	-	-	5	33,3	7	46,6	1	6,6	2	13,3	-	-
3	Veal stew, salad, macaroni	Veal stew	20	7	35,0	-	-	5	25,0	6	30,0	-	-	2	10,0
		Macaroni	20	7	35,0	3	15,0	4	20,0	4	20,0	1	5,0	1	5,0
		Salad	20	7	35,0	-	-	5	25,0	3	15,0	1	5,0	4	20,0
4	Boiled beef, tomato sauce, potatoes	Boiled beef	30	26	86,6	2	6,6	-	-	1	3,3	-	-	1	3,3
		Boiled potatoes	30	26	86,6	2	6,6	1	3,3	1	3,3	-	-	-	-
		Tomato sauce	30	26	86,6	3	10,0	-	-	1	3,3	-	-	-	-
=====															

THE RELATIONSHIP OF BACTERIAL GROUPS ISOLATED FROM ONE-DISH
PRECOOKED FROZEN MEALS

Table 7

Name of meal	Number of examined samples	Bacterial group							
		Streptococci		Staphilococci		Salmonella		Spor.anaerobes	
		Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%
Beef patty with potatoes	31	3	9,6	2	6,4	-	-	1	3,2
Beef stew with macaroni	31	1	3,2	2	6,4	-	-	2	6,4
Beans with bacon or smoked meat	38	-	-	4	10,5	-	-	1	2,6
Beans with sausages	42	-	-	2	4,7	-	-	2	4,7
Tripes in gravy	41	-	-	3	7,3	-	-	10	24,3

THE RELATIONSHIP OF BACTERIAL GROUPS ISOLATED FROM THREE-DISH
PRECOOKED FROZEN MEALS

Table 8

Item	Name of meal	Part of meal	Number of examined samples	Bacterial group							
				Streptococci		Staphilococci		Salmonella		Spor. anaerobes	
				Count of samples	%	Count of samples	%	Count of samples	%	Count of samples	%
1	Beef steak with sauce, potatoes, salad	Beef steak	5	-	-	-	-	-	-	-	-
		Fried potatoes	5	-	-	-	-	-	-	-	-
		Salad	5	-	-	-	-	-	-	-	-
2	Beef patty, sauce potatoes	Beef patty	15	-	-	1	6,6	-	-	1	6,6
		Fried potatoes	15	-	-	2	13,3	-	-	1	6,6
		Sauce	15	-	-	1	6,6	-	-	-	-
3	Veal stew, salad, macaroni	Veal stew	20	-	-	2	10	-	-	6	30
		Macaroni	20	3	15	2	10	-	-	1	5
		Salad	20	-	-	2	10	-	-	3	15
4	Boiled beef, toma- to sauce, potatoes	Boiled beef	30	-	-	1	3,3	-	-	-	-
		Boiled potatoes	30	-	-	2	6,6	-	-	-	-
		Tomato sauce	30	1	3,3	2	6,6	-	-	-	-

МИКРОБИОЛОГИЯ ЗАМОРОЖЕННЫХ ГОТОВЫХ БЛЮД ВЫРАБОТАННЫХ В ПРОМЫШЛЕННОЙ СКОТОВОИНЕ "МИТРОС"

Р. Жакула, З. Бем, и Любица Николич

Содержание

В труде разработаны результаты микробиологического исследования 253-ех образцов замороженных готовых блюд, выработанных в промышленной скотобоине "Митрос".

Были определены следующие микроорганизмы: а/ общее число мезофильных бактерии; б/ число споровых мезофильных аэробных бактерии; в/ число протеолитичных бактерии; г/ число споровых термофильных бактерии; д/ колититр; е/ сальмонелы; ж/ фекальные стрептококки; з/ споровые анаэробные бактерии и стафилококки, а в отдельности коагулаза позитивных.

Бактериологическая картина исследуемых замороженных готовых блюд, за малым исключением, соответствует зарубежным бактериологическим нормам.

Можем быть вполне довольны достигнутыми результатами если учесть все затруднения, кот. возникают при производстве новых товаров в регулярной промышленной деятельности.

MICROBIOLOGIE DES PLATS CUISINÉS CONGELÉS PRODUITS A
L'ABBATOIR INDUSTRIEL "MITROS"

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SOMMAIRE

Dans ce travail on a donné les résultats d'examen bactériologique sur 253 échantillons des plats cuisinés congelés, produits à l'abbatoir industriel "Mitros". On a déterminé les microorganismes suivants:

- a) le nombre total des bactéries mésophiles, b) le nombre des bactéries sporogènes mésophiles aérobienues, c) le nombre de bactéries protéolytiques, d) le nombre de bactéries sporogènes thermophiliques, e) coli-titre, f) salmonelles, g) streptocoques fécaux, h) bactéries sporogènes anaérobienues, i) staphylocoques - spécialement la coagulase-positives.

Le tableaux bactériologique de plats cuisinés congelés examinés correspond, en général, aux normes étrangères, à petites exceptions. Les résultats atteints dans l'industrie sont satisfaisants ayant en vue toutes les difficultés qui suivent l'inauguration de produits neufs à production industrielle régulière.

MIKROBIOLOGIE TIEFGEKÜHLTER SPEISEN ERZEUGT IN INDUSTRIE -
SCHLACHTHAUS "MITROS"

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Zusammenfassung

Die Arbeit brachte die Resultate der bakteriologischen Untersuchung von 253 Mustern tiefgekühler fertiger Speisen, erzeugt im Industrie-Schlachthaus "Mitros".

Es wurden folgende Mikroorganismen festgestellt:

a) Gesamt Zahl der mesophilen Bakterien, b) Anzahl der sporogenen mesophilen aeroben Bakterien, c) Anzahl der proteolitischen Bakterien, d) Anzahl der sporogenen thermophilen Bakterien, e) Kolititar, f) Salmonellen, g) Fekale Streptokokken, h) Sporogene anaerobe Bakterien, i) Staphilokokken - und besonders Koagulase-positive.

Das bakteriologische Bild der untersuchten tiefgekühlten fertigen Speisen entspricht - mit geringer Ausnahme - den ausländischen Normen. Mit den erzielten Resultaten der Erzeugung können wir zufrieden sein, wenn wir die Schwierigkeiten, welche die Einführung neuer Erzeugnisse in die ständige Produktion begleiten, in Betracht ziehen.