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Fish quality

CHANGES IN QUALITY OF BREAM (*ABRAMIS BRAMA* L.) DURING STORAGE IN ICE

ZMIANY JAKOŚCIOWE LESZCZA (*ABRAMIS BRAMA* L.) PODCZAS PRZECHOWYWANIA W LODZIE

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Bream from the spring catchery was subjected to sensory, microbiological and chemical analysis after various time of cold storage in ice. Results of analyses proved bream's quality to decrease at a slow rate during the first week of storage and at a high rate in the second one. Yet quality changes noted for fish tissue were about 3 times slower than for the whole fish. On the basis of the obtained results the shelf life of spring bream under cold storage in ice was 10 ±1 days, at a maximum.

INTRODUCTION

Changes occuring in fish during storage in ice were reported by various authors such as Shewan (1977), Conell (1980), Huss (1980), Sikorski et al. (1990), Burt and Hardy (1992), Ashie et al. (1996). The shelf-life of whole fish stored in ice depended on fish species, fishing grounds, fishing season (Nandanie et al. 1985; Botta et al. 1987; Kołakowska et al. 1992), fishing techniques (Botta et al. 1987; Hattula et al. 1995) and many other biological and technological factors.

A numerous literature on the quality changes of the sea and freshwater fish species under cold storage does not include data on bream (*Abramis brama* L.).

The bream (*Abramis brama* L.) is a fish species spread throughout, almost, whole Europe, as well as in part of the south-eastern Asia. In western Europe it has not been found at Iberian and Apennines Peninsulas, only (Brylińska and Bryliński 1968). In Poland it was identified in almost all types of water basins: from mountain streams to Szczecin and Vistula Lagoons. The bream states for 50% of the total annual freshwater fish catchery. Its percentage share in total fish catchery at Szczecin Lagoon equals to about 23 (Garbacik-Wesołowska 1991).

The objective of this work was to analyse quality changes occuring in the ice stored bream and to assess the shelf life of the fish, on such basis.

MATERIAL AND METHODS

Surveys were carried out on 4 batches of bream (*Abramis brama* L.), caught in March and May 1991 – 1993 (Tab. 1).

Table 1

Characteristics of material (*Abramis brama* L.)

Batch number	Date of capture	Place of catching	Gonad's maturity Maier's scale	Lipid content (%)	Days of storage
1	28.05.1991	Szczecin Lagoon	V	5.89 ±0.20	0,3,6,9,13
2	11.03.1992	Dąbie Lake	IV – V	4.57 ±0.05	0,3,6,9,13
3	27.05.1992	Dąbie Lake	V	6.20 ±0.08	0,3,6,9,13
4	13.03.1993	Dąbie Lake	IV	3.12 ±0.05	0,3,7,10,14

The above mentioned fish batches, few hours after capture, were divided into seven 10 kg samples. Fish samples, when placed into bowles with perforated bottom, were iced again (one ice layer at the bottom, and the second one on the top) and stored in the refrigerating chamber at 2°C ±1 with ice being supplemented succesively.

Each time, for the analyses, one bowl (10 kg of fish) was collected.

The sensory assessment was performed on whole fish and on cooked fish fillets. Prior to filleting fish were washed, deheaded and gutted, than washed again and filleted when soaked.

For chemical assays unskinned fish fillets were minced by a mincer with the seeve diameter of 2 mm.

Sensory analysis

The sensory assessment was performed by trained sensory panel consisted of 7 to 9 judges with the following techniques applied:

- odour and flavour profiles (according to Baryłko-Pikielna 1976) with 13 descriptors being used,
- graphic hedonic scale (according to Baryłko-Pikielna 1976) for freshness, odour and texture of raw fish,
- flavour of cooked fish according to Torry scale (Shewan et al. 1953),
- demerit of whole fish (Bremner 1985),
- classification according to EC standards (Council Regulation 33/89/EEC).

Microbiological analysis

Microbiological analysis was conducted on batch number 4, only (Tab. 1). Subjects of the analysis were fish tissue, collected under sterile conditions, and unskinned fish fillets minced under sterile conditions. An analysis included:

- estimation of the total viable count (TVC) of psychrophilic and psychrotrophic bacteria (CFU/g) on Frazier's medium (F) (PN-85/A-82051),
- estimation of the total count of proteolytic (P), lipolytic (L) and H_2S producers (H_2S) on F medium, Nutrient agar + Tween 80 (NAT) (PN-85/A-82051) and LAA medium (Levin 1968), respectively.

Chemical analysis

Chemical assessment included determination of:

- total volatile bases and trimethylamine (Conway 1953),
- TBA value (Vyncke 1970),
- pH (potentiometrically),
- lipid content in the extracts obtained by the Bligh-Dryer method (1959) determined gravimetrically,
- fatty acids composition by the gas chromatography method described by Kołakowska and Szczygielski (1994),
- peroxide value by means of thiocyanate technique according to Kołakowska (1974).

RESULTS

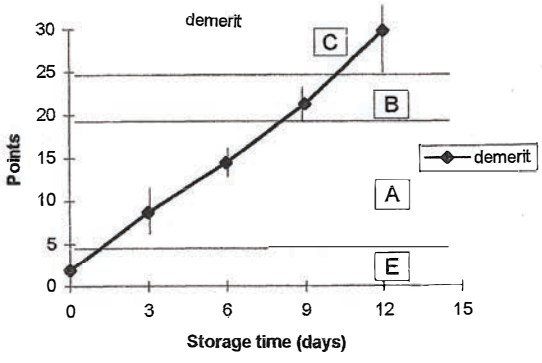

Fig. 1. Changes in demerit points of whole bream, during storage in ice

Presented figures include mean values for all fish batches; with the standard deviation value showing seasonal differences, caused by various date of catching.

The whole fish demerit results (Fig. 1), showing linear increase during the cold storage period (Tab. 2), indicated the highest quality (E class) of the bream to be short and last for 1–3 days (according to fish batch), while quality characteristics, typical for the A class fish, were kept longest—for 1 week.

Table 2

Changes in sensory characteristics (y) of bream during storage in ice (x days)

Characteristics	Batch	Parameters of linear equation			
		a	b	R	α
Demerit	1	5.30	1.89	0.96	0.001
	2	3.51	2.09	0.97	0.001
	3	0.10	2.74	0.96	0.001
	4	0.22	1.87	0.96	0.001
Freshness	1	9.04	0.67	0.96	0.001
	2	10.49	0.73	0.96	0.001
	3	10.18	0.56	0.94	0.001
	4	10.51	0.72	0.95	0.001
Texture	1	9.39	0.60	0.96	0.001
	2	10.10	0.75	0.98	0.001
	3	10.50	0.71	0.97	0.001
	4	10.34	0.60	0.89	0.001
Odour	1	8.66	0.63	0.96	0.001
	2	10.50	0.71	0.96	0.001
	3	10.43	0.63	0.97	0.001
	4	9.86	0.65	0.96	0.001
Flavour	1	9.25	0.29	0.94	0.001
	2	9.25	0.32	0.96	0.001
	3	–	–	–	–
	4	9.94	0.35	0.99	0.001

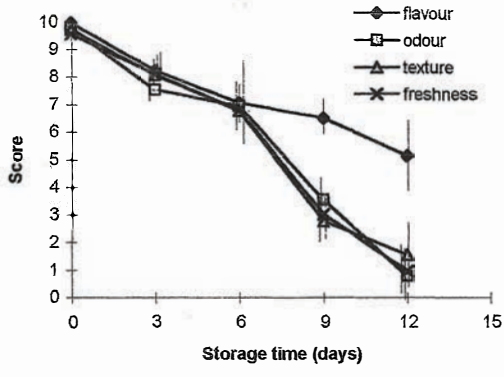

Fig. 2. Changes in sensory properties of filet bream during storage of whole fish in ice

The bream was nonconsumable (below B class) after ~ 11 days and was recognised as spoiled after 13–14 days of cold storage in ice. Changes in bream's quality during 2 weeks of fish storage, statistically essential (0.001) and described by linear equation, proved fish demerit to increase by 2 points each day of cold storage. Nevertheless, the whole fish demerit proved to change at slow rate during first and at a high rate during the second week of cold storage (Fig. 1, 2).

There was a linear correlation between the sensory changes of meat (odour, texture, flavour of cooked meat) and time of cold storage (Tab. 2) but, all the same, the sensory changes were more pronounced during the second week of storage. Yet sensory changes for the meat tissue were, by 3 times slower, than for the whole fish.

Odour and flavour of cooked, fresh bream meat were assessed as very desirable. The flavour profile (Fig. 3) was determined as typical with slightly noticeable seaweeds scent: while some evaluators determined it as slightly fishy and insipid.

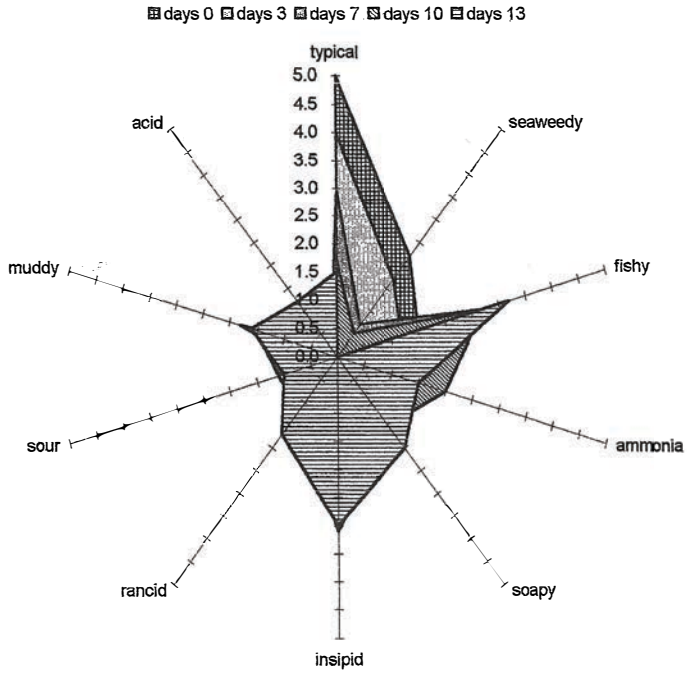

Fig. 3. Changes in odour profile of bream during storage in ice

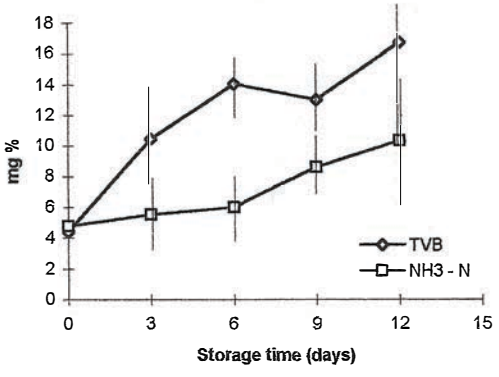

Fig. 4. Changes in volatile basis of bream during storage in ice

Worsening of odour parameters were connected with diminution of typical odour and, from the 7th day of storage, with appearence of clearly noticeable fishy and insipid ones. Those two off odours being dominant negative features of odour profile typical for bream at spoilage. The ammonium odour was markedly noticeable after 9–10 days of bream storage (Fig. 3). At that time increase in ammonium content was noted, while increase in total

volatile bases (TVB), although irregular, was noted throughout the storage period, with the maximum level of TVB-N not exceeding 16 mg% (Fig. 4).

Changes in meat flavour were simillar to the one for odour (Fig. 5, Tab. 2). Up to the 7th day of storage diminution of typical, sweet flavour of the fresh fish was noted, followed by appearence of some undesirable flavours, such as, in particular, insipid, muddy, and bitter ones.

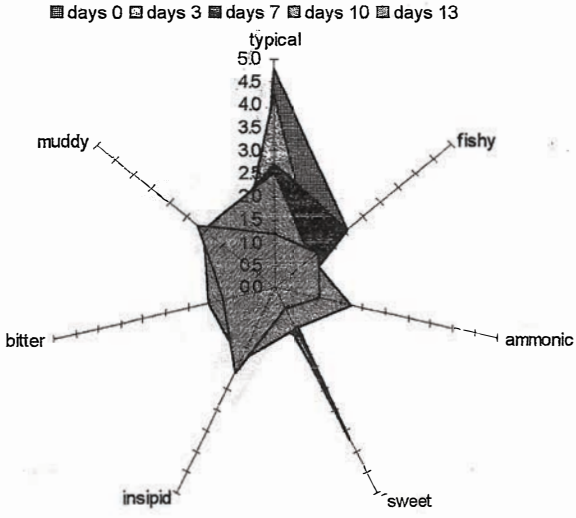

Fig. 5. Changes in flavour profile of bream during storage in ice

Table 3

Effect of cold storage in ice on changes in total viable counts (TVC), proteolytic (P), lipolytic (L), H_2S producing (H_2S), and luminescent (FI) bacteria in bream minced meat (CFU×10^5/g)

Days of cold storage in ice	TVC	P	L	H_2S	FI
0	0.31	0.12	0.02	0	0.02
3	0.62	0.11	0.01	0	0.11
7	2.1	0.49	0.14	0.03	0.04
10	61	6.3	5.2	0.17	0.46
14	140	53	6.4	3.4	3.3

Number of cold tolerant bacteria increased visibly after 7 days of bream's storage in ice reaching 6,1 × 10^6 CFU per 1 g of minced meat, with visible increase in H_2S producers, on the 10th day of cold storage (Tab. 3). Numbers of cold tolerant bacteria, in an initially sterile fish tissue, were much lower and reached, after 14 days of fish storage in ice, 6,1 × 10^5 CFU/g of fish tissue (Tab. 4). At that time proteolytic and lypolitic bacteria stated, respectively, for 65.6% and 31% of the total count of psychrophilic and psychrotrophic microorganisms. Luminescent bacteria were noted, at the detected level, after 14 days of fish storage in ice.

Table 4

Effect of cold storage in ice on changes in total viable counts (TVC), proteolytic (P), lipolytic (L), H_2S producing (H_2S), and luminescent (FI) bacteria in bream tissue (CFU×10^3/g)

Days of cold storage in ice	TVC	P	L	H_2S	FI
0	*	*	*	*	*
3	*	*	*	*	*
7	0.75	0.25	*	*	*
10	130	43	3.9	5.7	*
14	610	400	71	24	3.2

*numbers of bacteria below the detection level of method.

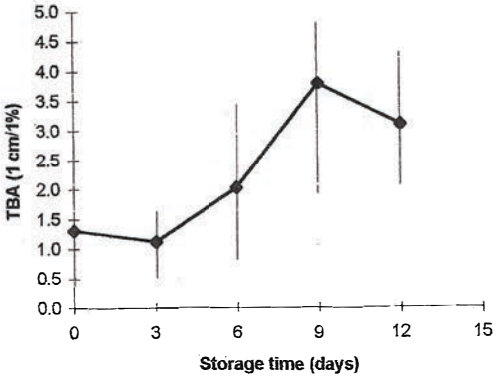

Fig. 6. Changes in TBA reactive substance of bream during storage in ice

Rancidity of bream stored in ice was almost undetectable sensorically. After 10 days of cold storage in ice rancid smell was at the detection level, while rancid flavour was not noticeable throughout whole storage period. Nevertheless, TBA value almost doubled between 3rd and 10th day (Fig. 6), with the peroxide value increasing almost 6 times after 10 days of storage. Analysis of the fatty acids in fresh bream and fish stored for 3 and 7 days in ice (batch 4) showed essential decrease in polyunsaturated fatty acids content within the first week of cold storage (Tab. 5, 6). Ecosapentaenoic acid and docosahexaenoic acid contents decrerased, respectively, by 14 and 30%.

Table 5

Fatty acid composition (%) in bream during storage in ice

Fatty acid	Fish stored in ice (days)		
	0	3	7
18:1	28.19	29.67	33.03
18:2	3.92	3.95	4.18
18:3	2.31	2.51	1.87
20:1	3.74	3.24	3.24
20:4	5.46	3.88	3.65
20:5	7.04	8.04	6.05
22:5	2.44	2.32	1.71
22:6	5.57	5.18	3.89

Table 6

Multiple range analysis LSD 95% for fatty acid in bream stored in ice

Contrast days	Fatty acid	
	EPA	DHA
0 – 3	*	*
0 – 7	*	*
3 and 7	*	*

* denotes a statistically significant difference.

DISCUSSION

Changes recorded during cold storage of bream in ice, did not differ from schemes presented by many authors for spoilage process of the fish under cold storage (Connell 1980; Huss 1988; Sikorski et al. 1992) The rate of quality changes, for bream under cold storage, was lower than, that noted for the Baltic herring (Kołakowska et al. 1992) or the roach from the same fishing area and under the same storage conditions (Daczkowska-Kozon et al. in press) but higher than for some freshwater fish species of warm water origin (Lima dos Santos 1981; Bremner et al. 1985; Poulter and Nicolaides 1985; Huss 1988). Fish of temperate waters origin spoils faster than the one of warm water origin mostly because their natural microflora is dominated by cold tolerant Gram-negative spoilage bacteria (Ashie et al. 1996).

A like as for the Baltic herring (Kołakowska et al. 1992) there was a linear correlation between changes of sensorical parameters and the storage time of the bream noted. During two weeks storage bream demerit value increased, each day, by 2 points. Similar changes were reported for roach from the same fishing area, tested under the same storage conditions. Apart from similarities in demerit value and shelf life of both fish species, under the same storage conditions, there was marked difference in the rate of the spoilage process. Fast spoiling proceses of the roach within the first week, slowed down visibly on the second week of cold storage, opposite than for bream where spoilage process was initiated, practically, after one week of fish storage (Kołakowska et. al. 1996). It gives evidence to the need for carefull essessment of fish quality within its consumption acceptability period.

The bream kept the highest quality parameters (Extra) for, rather, a short time (1–3 days according to fish batch) which do not differentiate this fish from the Baltic herring spoiling at a faster rate (Kołakowska et al. 1992). However, in case of bream, time of decreased quality (A class), where no off flavours and no off odours were noted, was long and lasted for almost a week. A characteristic for the bream at spoilage, apart from fishy and ammonium ones, typical for spoiling fish, were insipid (a dominating one) and muddy off odour and off flavour. At the time of off flavours and off odours appearence the total viable count (TVC) of cold-tolerant bacteria exceeded permitted level $<1.0 \times 10^6$ CFU/g (Zaleski 1985).

Muddy off odour and off flavour are, usually, connected with geosmine and 2-methylisoborneol production by phytoplancton present within the bream fishing area (Persson 1979) and not with fish spoilage. Off odours typical for H_2S and mercaptanes presence were not detected, though its detection level is very low (Shewan 1977). On 14th day of fish cold storage in ice total viable count of H_2S producers reached 3.4×10^5 CFU and 2.4×10^4 CFU per 1 g of minced unskinned bream fillets and fish tissue, respectively.

In this work changes in fish quality due to catching season (various dates of bream catching) has not been analysed. According to the standard deviations analysis, based on the mean value for all fish batches, one can presume, those differences to be more pronounced with a prolonged time of cold storage. One of possible explanation to that could have been differences in qualitative and quantitative composition of initial fish microflora.

Spoilage process of bream's tissue proceeded at a very slow rate. During the two week storage of fish in ice sensory assessment, flavour in particular, did not give any reason for fish disqualification. Results of microbiological analysis proved bacterial invasion into bream's tissue to be prolonged in time. Aside from the protective role of the fish skeen, tissue lipids were oxidized. It did not have a direct influence on sensory properties, however caused essential loses in polyunsaturated fatty acids (PUFA). A 30% drop in DHA content was noted after one week storage of bream in ice. There were no loses in n-3 PUFA after one week storage in ice of mackrel (Yuhua et al. 1993) and raya (Pastoriza et al. 1995) which can be an evidence to opinion on great susceptibility of bream's lipids to oxidation (Kołakowska et al. 1994).

It can be assumed that bream's meat of the A class freshness, although sensorically acceptable and regarded as save microbiologically, has decreased nutritive value due to the presence of oxidised fatty acids.

Term of fish shelf life has not been defined precisely (Howgate 1990). In the present work the basic criteria for the bream disqualification were demerit points by Bremner (1985), freshness ratings EC and the TVC of cold tolerant microbes (Zaleski 1985). The TVB level did not exceed the range suggested for sea fish (Kołakowski et al. 1969, cited after Sikorski et al. 1990). The histamine content, assessed on the same experimental material by Czerniejewska-Surma (1996), was low and did not exceed 3 mg/100 g which excludes pssibility of scombroid poisoning due to consumption of the bream stored in ice.

According to the above mentioned criteria, it can be assumed, that the shelf life of bream (*Abramis brama* L.) from spring catching, stored in ice as a whole fish is 10 days.

CONCLUSIONS

1. The sensory properties of whole bream as well as flavour and smell of fish meat change at a slow rate within the first weak of cold storage, than at a high rate, however changes noted for meat tissue were by 3 times slower than for the whole fish.
2. Spoilage appearence is accompanied by the total viable count of cold tolerant bacteria exceeding 1.0×10^6 CFU/g.
3. A one week storage in ice causes essential losses in n-3 PUFA content.
4. The shelf life of iced bream from spring catchary is 10 ± 1 days, at a maximum.

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ZMIANY JAKOŚCIOWE LESZCZA (*ABRAMIS BRAMA* L.) PODCZAS PRZECHOWYWANIA W LODZIE

STRESZCZENIE

Celem pracy było zbadanie zmian jakościowych leszczy podczas przechowywania w lodzie i na podstawie tych zmian próba ustalenia okresu ich trwałości.

Badania przeprowadzono na 4 partiach leszczy (*Abramis brama* L.), złowionych wiosną (11 marzec do 28 maja) na Zalewie Szczecińskim i przyległym do niego jeziorze Dąbie. Ryby w 10 kg porcjach, zalodowywano i przechowywano w temp. 2°C ±1, w komorze chłodniczej przez 2 tygodnie. Badania przeprowadzano po kilku godzinach od połowu, a następnie średnio nie rzadziej niż co 3 dni, pobierając do badań jedną 10 kg porcję ryb.

Przeprowadzano analizę sensoryczną, mikrobiologiczną i chemiczną. Sensorycznie oceniano ryby całe i filety (ze skórą) z niej sporządzone – na surowo i w próbie gotowania. Analizowano: wadliwość ryb całych, profil zapachu i smaku, zapach i smak wg skali Torry, świeżość, zapach i teksturę wg hedonicznej skali graficznej oraz stosowano klasyfikację wg ustaleń EC. Badania mikrobiologiczne przeprowadzono tylko na jednej partii, pobierając do analiz tkankę mięsną i pobrane w sposób sterylny filety ze skórą. Określano ogólną liczbę bakterii psychrofilnych i psychrotrofowych oraz ogólną liczbę bakterii proteolitycznych, lipolitycznych i wytwarzających H_2S. Analiza chemiczna obejmowała: oznaczenie lotnych zasad amonowych (LZA) i trójmetyloaminy (TMA), pH, oznaczenie zawartości lipidów wyekstrahowanych metodą Bligha-Dyera, oznaczenie liczby nadtlenkowej – metoda siarkocyjankowa, składu kwasów tłuszczowych (w jednej z badanych partii) metodą chromatografii gazowej (HP, kolumna kapilarna).

Właściwości sensoryczne leszczy wiosennych przechowywanych w lodzie, w postaci ryb całych zmieniały się powoli w pierwszym tygodniu przechowywania, chociaż okres wysokiej jakości (klasa E) był krótki i wynosił (w zależności od partii ryb) tylko 1–3 dni.

Po tygodniu przechowywania następował szybki spadek jakości – psucie się ryb. Sensorycznym oznakom psucia towarzyszyło przekroczenie granicy 1×10^6/g (rozdrobnione filety) ogólnej liczby bakterii zimnolubnych. Zmiany w mięsie zachodziły około 3-krotnie wolniej niż zmiany sensoryczne w rybach całych; nawet po 2 tygodniach przechowywania ryb, zapach i smak mięsa nie stanowił podstawy do dyskwalifikacji ryb.

Leszcze znajdujące się w okresie akceptowalności sensorycznej (klasa A) i jak można sądzić bezpieczne mikrobiolgicznie, wykazywały jednakże znaczący wzrost utlenienia lipidów i spadek wielonienasyconych kwasów tłuszczowych. Po tygodniu przechowywania leszczy w lodzie ilość kwasu dokozaheksaenowego zmniejszyła się aż o 30%.

W oparciu o uzyskane wyniki analizy sensorycznej, mikrobiologicznej i chemicznej można przyjąć, że maksymalna trwałość wiosennych leszczy przechowywanych w lodzie, w warunkach chłodniczych wynosi 10 ±1 dni.

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