

## Cold chain maintaining in food trade

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### Abstract

The concept of food safety has lately acquired a new approach due to globalization and free trade in food. Introducing a HACCP system in the production and trade in food has become a necessity. The term “food trade” indicates all the postproduction procedures, from storage, transport and distribution to retail, including export and import. The aim of our 2002 survey was to analyse the situation of cold chain maintaining in food trade in Ljubljana, the capital of Slovenia. The research was based upon two hypotheses: in the first one we supposed that a cold chain is interrupted in retail and in the second one we supposed that the handling of food in retail varies. Seventeen stores were divided in three groups, according to sales area of the store: large ones, medium ones and small ones. Temperature conditions in cooling appliances for storage of 1688 perishable food products were measured. Products were inspected by two criteria, by the “best before” date and by the storage temperature. The results confirmed both of the hypotheses. The storage conditions were properly labelled on the packages of the products inspected. In most of the cases the temperatures measured differed from the required ones, even for up to 10 °C. The biggest differences were detected between temperatures indicated on cooling appliances and temperatures measured by our calibrated thermometers. Conditions during food storage and in retail stores were not documented and there was no system to control the cold chain. Our findings have shown that retailers are not familiar with the importance of maintaining a cold chain. The result of that can be a shorter durability of highly perishable foodstuffs and their safety for consumers is questionable.  
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### 1. HACCP in food trade

Lately food safety has acquired a great importance due to the globalization and free trade in food. In the past food retail has always adapted to new social circumstances in a short time and is one of the oldest and vital human activities. Introducing HACCP systems to the production and the food trade enables food traceability and ensures safe food according to sanitary requirements. The term “food trade” indicates all the postproduction procedures: storage, transport, distribution and retail of final products, their export and import. The cold chain maintaining in retail represents the big-

gest problem to producers and retailers. According to legislation (Rules<sup>b</sup>, 1993), stores are classified with regard to sales areas: classic stores (above 12 m<sup>2</sup>), self-service stores (above 40 m<sup>2</sup>) and supermarkets (above 1000 m<sup>2</sup>). In Slovenia food safety and safety of products that may come into contact with food is regulated by the law (Act 2000, 2002). In Slovenia a HACCP system is compulsory since January the 1st 2003. It is a responsibility of salesmen to ensure food traceability and food safety by internal control in all trade phases. The purpose of our survey in April 2002 was to analyse the current situation in maintaining a cold chain in food trade.

#### 1.1. Cold chain and food durability

For highly perishable foodstuffs a cold chain below 5 °C or at temperature that is indicated on a label and

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required by the producer is essential. These requirements represent a problem in retail stores. According to regulations on the labelling of pre-packaged foodstuffs (Rules<sup>a</sup>, 1999) proper information should be labelled on the products. Highly perishable foodstuffs, such as dairy products, fresh meat, fresh fish etc. are foodstuffs with a short durability and sellers should pay more attention to correct storage of such foodstuffs (Rules<sup>c</sup>, 1999). The date of durability should be checked daily and follow the rule: “first in, first out”. For foodstuffs with longer durability the appropriate micro-climatic conditions are necessary and the products should be sold only within their durability. All foodstuffs have to be stored in original, undamaged packaging with a clear and complete labelling in Slovenian language. Labelling should include special storage conditions and instructions for use where appropriate.

### 1.2. When a foodstuff should be removed from sale

The labelling of the date of minimum durability is compulsory for all foodstuffs (Rules<sup>a</sup>, 1999). The date of durability has to be labelled on foodstuffs and could be indicated as “Best before”, “use by” or “best before end” date. On highly perishable foodstuffs (such as dairy products) it is indicated as “use by” date. After that date a perishable foodstuff is not allowed to be sold to consumers. It is important to know how long the food retains its best quality. The shortest date of durability informs the consumer that food may be consumed even after that date but its quality will suffer. In both cases it is necessary to act according to producer’s requirements in order to retain high quality and safety of the products.

### 1.3. Handling foodstuffs which date of durability is approaching

Legislation regarding consumer protection (Consumer, 1998) contains provisions which require price labelling on the products. Merchandise, which date of durability is approaching and is offered at a reduced price, should be clearly labelled. If the store is reducing the prices of highly perishable foodstuffs it is not enough to label foodstuffs “action” or “sale” as the consumer could be misled. The store is responsible to warn the consumer, that date of durability for that product will run out on that particular day and thus enabling him to decide to purchase or not. Regulations protect consumers from being misled by actions described above and similar ones and price reductions (Rules<sup>a</sup>, 1999). The regulation requires that foodstuffs which date of durability is approaching must be put on sale separated from ordinary foodstuffs and the fact that their durability will expire shortly must be clearly marked. It is understood that after the date of durability has passed (the longest or the shortest one) foodstuffs may not be sold.

## 2. Materials and methods

### 2.1. Materials

Our survey was conducted in April 2002 in large, medium and small sized stores in Ljubljana, the capital of Slovenia. The study performed was divided in two parts. In the first part we were interested if foodstuff handling differs between stores with different sales area size. The storage conditions and the dates of durability of eight different types of perishable foodstuffs (pre-packaged poultry, pre-packaged frankfurters, butter, yoghurt, cottage cheese, cream, ice cream and eggs) in three different types of stores were controlled. Seventeen retail stores in Ljubljana were divided into large (supermarkets), medium (self-service stores) and small ones (classical stores) according to regulation (Rules<sup>b</sup>, 1993).

In the second part, questionnaires were distributed among consumers, who were passing by the store during our investigation. A total of 217 consumers were involved in the survey. The questions were designed to obtain information if consumers are familiar with the date of durability, consumer’s rights and food storage conditions.

Consumers were interviewed by personnel trained in conducting face-to-face interviews and administrating questionnaires. Consumers were encouraged to answer honestly. Face-to-face method of interview gave us the opportunity to avoid any possible misunderstandings of answers and questions.

### 2.2. Sampling

At the time of investigation the date of durability, labelling, the handling of products which date of durability is approaching were checked and storage temperature of foodstuffs were measured. The lowest, the highest and the average values of different type of temperatures observed were compared: (1) temperatures shown on control thermometers placed in cooling appliances (refrigerators, freezers) or shown on displays (air temperature control—ATC); (2) temperatures measured with our calibrated thermometer (air temperature measurement—ATM; Testo 926) and (3) temperatures measured on the surface of foodstuffs with an infrared thermometer (non-contact temperature measurement—NcTM; Testo 826-T4).

## 3. Results

### 3.1. Perishable foodstuffs examined

In seventeen retail stores, out of which seven small, six medium and four large sized stores, 1688 perishable foodstuffs were examined and results are shown in Table

1. By measuring temperature conditions of products the maintaining of cold chain and functioning of cooling appliances used were established.

### 3.1.1. Storage conditions

Producers indicated storage conditions on packages correctly, but the question is how they are respected by shop assistants. We noted differences (Table 1) between the three types of temperatures checked in cooling appliances: (1) shown on control thermometers or on displays in the stores (ATC), (2) temperature measured (ATM) and (3) product temperatures measured on the surface of foodstuffs (NcTM). The biggest differences of the average values of temperatures were found between ATC and NcTM in all types of stores, especially in the small ones, which do not regularly control cooling appliances. Comparison of average values between ATC and ATM in refrigerators and freezers showed small differences between different types of the stores for all the

products observed. In small stores the average values of NcTM exceeded required temperatures: pre-packaged frankfurters for 3.7°C (allowed 0–4°C); dairy products: butter for 3.5 °C, yoghurt for 0.7°C, cream for 1.5°C (allowed from +2°C to +6°C); ice cream for 1.5°C (allowed less than –18°C). In medium sized stores similar results of NcTM were concluded, except for butter, which exceeded the labelled temperature for 6°C. The biggest differences between the lowest and the highest NcTM were observed in small stores. The highest NcTM of all the inspected dairy and meat products, much higher than indicated by the producers, were observed in small stores. For example maximum NcTM value for pre-packaged frankfurters was for 6.5°C and for butter for 8°C higher than required. In medium sized stores similar situation for dairy products (maximum NcTM value of butter was for 10 °C and of yoghurt for 7°C higher than indicated) was found. In the large stores salespersons are more familiar with temperature

Table 1

Differences in large, medium and small sized stores between the lowest, the highest and average values for ATC, ATM and NcTM in comparison with foodstuffs' storage temperature required by producers

Foodstuffs	Size of store	N <sup>a</sup>	D <sup>b</sup> (°C)	ATC <sup>c</sup> (°C)			ATM <sup>d</sup> (°C)			NcTM <sup>e</sup> (°C)		
				Min <sup>f</sup>	Max <sup>g</sup>	x <sup>h</sup>	Min <sup>f</sup>	Max <sup>g</sup>	x <sup>h</sup>	Min <sup>f</sup>	Max <sup>g</sup>	x <sup>h</sup>
Pre-packaged poultry	Small	7	From 0 to +4	-4.0	-4.0	4.0	3.0	3.4	3.2	3.0	5.1	4.1
	Medium	26		-1.0	6.0	2.5	0.1	9.5	4.8	2.0	7.0	4.5
	Large	76		-1.0	4.0	1.5	-1.7	4.7	1.5	2.0	2.0	2.0
Pre-packaged frankfurters	Small	31		-4.0	12.0	4.0	-2.0	10.0	4.0	4.9	10.5	7.7
	Medium	79		-4.0	7.0	1.5	0.6	12.2	6.4	5.0	8.0	6.5
	Large	56		-1.5	8.0	3.2	-1.1	8.5	3.7	0	0	0
Butter	Small	119	From +2 to +6	-1.5	8.5	3.5	-2.2	9.1	3.5	5.0	14.0	9.5
	Medium	46		0.3	5.0	2.6	3.3	8.5	5.9	8.0	16.0	12.0
	Large	130		0	5.0	2.5	3.5	6.0	4.7	0	0	0
Yoghurt	Small	46		-4.0	8.5	2.2	-2.2	9.0	3.4	2.8	10.5	6.7
	Medium	113		-1.1	7.0	2.9	0.5	8.7	4.6	2.5	13.0	7.7
	Large	199		4.5	5.0	4.7	1.8	7.2	4.5	5.0	9.0	7.0
Cottage cheese	Small	23		-4.0	4.8	0.4	-2.2	7.2	2.5	4.0	7.5	5.8
	Medium	43		-1.3	8.0	3.3	-0.5	8.0	3.7	4.0	8.0	6.0
	Large	74		3.9	8.0	5.9	4.0	10.4	7.2	5.0	5.0	5.0
Cream	Small	47		-2.0	8.0	3.0	-2.2	7.5	2.7	3.5	11.5	7.5
	Medium	62		-0.6	8.0	3.7	-0.5	9.3	4.4	4.0	6.5	5.2
	Large	109		3.8	8.0	5.9	5.2	9.3	7.2	0	0	0
Ice cream	Small	29	Less than -18	-26.0	-15.0	-20.5	-22.0	-10.5	-16.3	-23.0	-10.0	-16.5
	Medium	49		-24.0	-18.0	-21.0	-21.7	-15.8	-18.7	-18.5	-13.0	-15.7
	Large	79		-22.0	-14.0	-18.0	-22.2	-17.0	-19.6	-14.0	-12.5	-13.3
Eggs	Small	53	Up to +15	0	8.5	4.2	0.3	15.0	7.7	8.0	17.0	12.5
	Medium	96		0.4	11.5	5.9	3.5	12.5	8.0	6.0	8.5	7.2
	Large	96		2.0	9.1	5.5	3.9	9.3	6.6	0	0	0

<sup>a</sup> n—number of samples.

<sup>b</sup> D—temperature required by producer (°C).

<sup>c</sup> ATC—air temperature control (°C).

<sup>d</sup> ATM—air temperature measurement (°C).

<sup>e</sup> NcTM—non-contact temperature measurement (°C).

<sup>f</sup> Min—the lowest value (°C).

<sup>g</sup> Max—the highest value (°C).

<sup>h</sup> x—average value (°C).

control of cooling appliances, although deficiencies in storage of frozen foodstuffs were detected: unclosed cabinets, direct exposure to artificial lights and improper loading (above the red line). The highest differences between the lowest, the highest and the average NcTM in large stores were observed for ice cream (the average NcTM value was higher than indicated for 4.7°C). We got the impression that salespersons paid more attention to advertising products than maintaining the cold chain.

Storage temperatures for eggs corresponded with temperatures indicated required by the producer on the label (up to +15°C), except for one sample in a small store (max value of NcTM was +17°C). Salespersons easily achieve proper egg storage at indicated temperature, since in the majority of cases eggs are kept on lower shelves in refrigerated cabinets for milk and dairy products, where temperature should not exceed +6°C.

Storage temperatures for eggs, dairy and meat products read (ATC) from control thermometers or displays located inside cooling appliances were in accordance with required storage temperatures. This was in contradiction with our measurements (ATM). The suitability of measuring equipment in stores was checked by using calibrated thermometer. Comparison between average values of ATC and ATM showed small deviations (Table 1) for almost all the products examined in the majority of stores observed. In refrigerated cabinets in small stores average values of ATM were for dairy products lower compared to average values of ATM in large and medium sized stores. The average values of ATM (Table 1) exceeded the required temperatures: in small stores (ice cream for 1.7°C), medium sized stores (pre-packaged poultry for 0.8°C; pre-packaged frankfurters for 2.4°C) and in large shops (cottage cheese and cream for 1.2°C).

### 3.2. Considering the date of durability

Law requirements on handling foodstuffs which date of durability was approaching were respected only in one of larger stores in Ljubljana. Foodstuffs which date of durability was approaching were stored in a special

place in the refrigerated cabinets or on shelves with the date of durability and with the price before and after its reduction visibly marked. Such way of conducting business enables the consumer to obtain all necessary information to decide to purchase food. In most cases the salespersons reduce price of such products and label them “price cut” or “reduction in price” or “reduced” and leave the consumer to notice whether the date of durability of a foodstuff will shortly expire or whether there is a promotional sale or whether price of such a product is reduced on that day only. Such behaviour of the stores misleads the consumers.

### 3.3. Maintaining a cold chain perceived by consumers

A total of 217 consumers took part in the survey. Consumers answered differently to questions in the questionnaire: Q1. “Are foodstuffs stored as required by the producers?” (Fig. 1). More than one half of consumers believe, that in stores producers’ requirements are respected and therefore they do not check the storage conditions in cooling appliances. They do not read labels on the products. Less than 10% of consumers answered that in stores the required temperature conditions are respected only occasionally. A large number of consumers that purchase in small stores (30%) never check the date of durability of foodstuffs as they trust salespersons.

Q2. “What do consumers think about the date of durability?” The majority of consumers in large, medium and small stores never purchase a foodstuff which date of durability has passed (Fig. 2). At an average of 35% they answered affirmatively to the question whether they have ever purchased a foodstuff which date of durability has expired.

Q3. “What do you do, if you discover a foodstuff’s date of durability has expired?” The steps that consumers take when discover a foodstuff which date durability has passed differ and depend upon the type of a store (Fig. 3). More than one half of consumers (52.5%) in large stores put back the foodstuff which date of durability has already passed on the shelf and take a product



Fig. 1. Consumer’s answers to the questionnaire’s question: “Are foodstuffs stored as required by the producers?”.

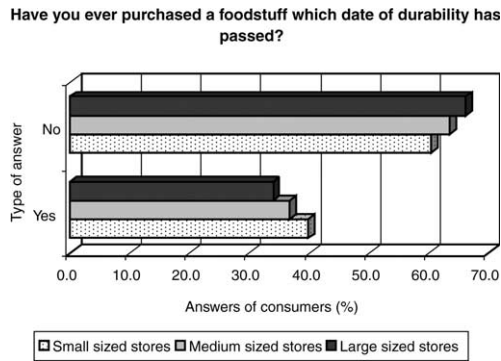


Fig. 2. Consumer’s answers to the questionnaire’s question: “Have you ever purchased a foodstuff which date of durability has passed?”.



Fig. 4. Answers of consumers to the questionnaire’s question: “Are the foodstuffs which date of durability has passed separated from the regular foodstuffs for sale in stores?”.

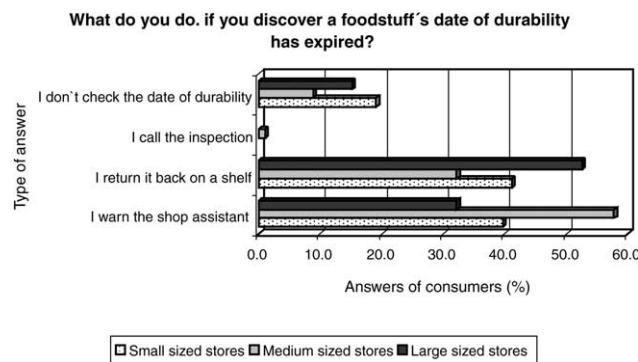


Fig. 3. Consumer’s answers to the question: “What do you do, if you discover a foodstuff’s date of durability has expired?”.

within date of durability. The percentage of consumers that do not check the date of durability is important, too (15.3%). Only one third of consumers (32.2%) pointed out to a shop assistant that product’s date of durability has expired. We obtained different results in medium stores in which the majority (57.8%) of consumers pointed out to a shop assistants that product’s date of durability has passed and one third of consumers put the product back on the shelf and took another product—the “right” one without any comments. Compared to large stores the percentage of consumers not checking the date of durability is smaller (8.9%) in small stores where the consumers trust the sellers (19.1%) or call their attention if they discover a product which date of durability has passed (39.7%). Percentage of consumers returning the product which date of durability has passed without any comments is high (41.2%).

*Q4. Are the foodstuffs which date of durability has passed separated from the regular foodstuffs for sale in stores?* In the average large stores respect the law requirements regarding visibly and readably labelled date of durability of products (Fig. 4). This was observed also by consumers (55.9%). Separate storage of such items from regular foodstuffs to be sold is respected only by some stores, mostly by medium and large ones.

More than one half of consumers (51.5%) believe that small stores do not respect this requirement.

#### 4. Discussion

##### 4.1. Storage conditions

In the majority of cases in all types of stores temperatures measured differed from required ones mainly in refrigerators for dairy products and in freezers for ice cream. When comparing the average temperatures between ATM, ATC and temperatures required differences for butter, yoghurts, ice cream, fresh pre-packaged poultry and pre-packaged frankfurters were found. It was obvious that sales persons do not regularly check, calibrate thermometers and maintain cooling appliances. The majority of small stores do not record temperature conditions in cabinets which are not equipped with control thermometers. Before introducing a HACCP system the stores will have to establish a regular control of cooling appliances’ functioning and their maintenance. They will have to set control thermometers in cabinets if they are not provided yet. HACCP system requires a control of temperature conditions during food storage and assurance of safe products with required date of durability. Keeping the records of temperature conditions during highly perishable foodstuffs storage would be an important contribution to the benefit of consumer and seller. Consumer could compare the actual temperature and required food storage conditions. Sellers will have to establish a regular control of storage conditions and to maintain cold chain which is compulsory for the highly perishable foodstuffs handling.

In the majority of small and medium stores butter is placed on the upper shelves of refrigerators for milk and dairy products. Surface temperatures measured differ markedly from the required ones due to inappropriate illumination of cabinets. Foodstuffs on the top shelves

are exposed to the lights which are warming the stored food and as a consequence food has a shorter durability. In freezers ice cream are put nearly to the top of the open cabinets. We conclude that sellers emphasize food promotion and not food safety. Open freezing cabinets in which food is covered with drops of fluid (because of defrosting) do not attract the consumers as they cause doubts of food safety. Sellers have their own explanation how to provide a suitable place and temperature conditions for food storage in their stores. The usual answers of sellers about an inappropriate storage of foodstuffs have been: (1) lack of space; (2) the sales area must be attractive to consumers and (3) lack of means to satisfy all the criteria.

#### 4.2. Consideration the date of durability

Results of the food dates of durability inspections have shown that sellers have taken food control seriously and that they do register the dates of durability. We believe that some foodstuffs which date of durability has passed still remain on shelves which in large stores have been “probably” overlooked and in small stores they were left on shelves in expectation of being purchased—without difficulties. Up to now sellers have been orientated to the market in handling foodstuffs which date of durability is approaching; in other words they are “misleading” their consumers and should be re-orientated to a cooperation with buyers. Our survey has shown that general public awareness of food safety importance is rising. So, in the future is expected that the consumers will choose to purchase in the stores where conditions of food safety are respected.

#### 4.3. Consumers’ perceptions of cold chain maintaining

The majority of consumers, especially in small stores, believe that sellers respect all the food safety require-

ments. So they do not check storage conditions and the date of durability while purchasing foodstuffs. We conclude that in small and medium sized stores the relation between consumer and shop assistant is on a personal basis. Sellers are more familiar to consumers as shops are situated near their homes or in the neighbourhood which they visit regularly. There is no personal relation between consumer and seller in large stores. Generally we could conclude that consumers’ are more aware of food safety and they are more particular about selecting food, but only the ones that purchase in large stores.

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