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TRACEABILITY OF SELECTED FISH PRODUCTS

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The paper presents identification methods of foodstuffs, according to the requirements of the traceability system given in the respective standard PN-EN ISO 22005:2007, based on the traceability of "Herring fillets in tomato sauce" as the final product and peas as a raw material used in fish processing. Identification consisted in following the processing history of a selected product and raw material and their distribution. Based on information collected from individual departments of the plant and available documentation, the history of the analysed products in the production chain was recreated. Results indicate that it is possible to trace the selected product and raw material used in the analysed plant; however, certain flaws were discovered in the course of the study. These include errors and gaps in records kept at individual departments of the plant, discrepancies found between records coming from different departments and data in the computer system, infrequent updates of information stored in the computer system and problems with a review of records which are kept at different locations at the plant.

INTRODUCTION

Traceability of food origin is an essential element required in order to provide and manage health safety of a product, thanks to appropriate product management at all stages in the food chain [Derrick & Dillon, 2004; Pugh, 1973; Moe, 1998]. The traceability system makes it possible to follow food pathways through all stages of production, processing and distribution. It includes the origin of materials, processing history and distribution of the analysed food [Czarnecki, 2005; Kijowski&Nowak, 2006].

An appropriately implemented and functioning traceability system contributes to the assurance of health safety of food as well as facilitates the realization of the following objectives: documentation of product history or origin, product recall from sale or turnover, identification of appropriate organizations, more effective verification of specific data on the product and transfer of information to respective partners or consumers [Kijowski & Cegielska-Radziejewska, 2008].

The obligation to implement the traceability system starting from 1 January 2005 was imposed on food industry enterprises by the Directive of the European Parliament and Council no. 178/2002/EEC concerning food safety. Requirements connected with the application of this system are given in article 18 of the above mentioned directive, according to which European Union member countries are obliged to provide traceability not only for foodstuffs, but also suppliers of raw material and buyers of final products, as well as labels or identifies (for example mark, bar coding) of foodstuffs in order to facilitate their later traceability.

Principles and basic requirements concerning the design and implementation of the traceability system are given in the standard PN-EN ISO 22005:2007: *Traceability in the feed and food chain – General principles and basic requirements for system design and implementation*. This standard may be useful in every organization involved in the feed or food chain, which intends to implement this system or by organizations cooperating within this chain [PN-EN ISO 22005:2007].

The first information concerning the traceability system was published by Pugh [1973], who gave the basic principles of this system. Later Kim *et al*. [1995] and Sarig [2003] presented the structure of the system and its main pillars, while Moe [1998] listed advantages of the traceability system and indicated its potential applications in the food chain. The structure of the traceability system was also presented by Smith & Furness [2006], who described the most frequent weak points of this system and proposed methods to eliminate them. In turn, Regattieri *et al.* [2007] and Miotrag [2001] presented techniques used in traceability.

The application of traceability to follow products in the food chain was extensively analysed by Stein [1990], Ramesh *et al.* [1995], Furness & Osman [2003], while Dillon & Thompson [2003] described in detail the recall of a defective product using the traceability system.

Based on available literature we may conclude that although the theory of the traceability system is well-developed, there is limited information on traceability in individual branches of the food industry. It results from literature sources that to date the traceability system in the fish industry has been analysed by very few authors. Derrick & Dillon [2004] described main requirements concerning the traceability system, with examples of different available methods, facilitating

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the recreation of product history. They also presented a structural approach to the creation and assembly of required documentation. In turn, Frederiksen *et al.* [2002] presented the theory of application for traceability in the fish industry.

However, data on the manner in which foodstuffs are to be traced/tracked in industry are lacking in available literature. Well-conducted traceability procedures facilitate both the identification of possible non-conformance of the produced foodstuff to the requirements of the standard and the recall of the defective product from turnover. In practice it is sometimes necessary to withdraw the entire lot of such a product from the market. Then on the basis of documentation kept within the traceability system the supplier of the product and the customers may be identified. This makes it possible to withdraw the defective product from turnover and take appropriate measures against the producer. Moreover, after tracing the product from the acceptance of the raw material through production to its distribution the cause of revealed defect of the condemned product may be determined. For example, when the defect results from poor quality of the raw material, its supplier may be identified and an appropriate fine may be imposed. Specific knowledge on this subject may be useful for the management of food industry plants. Thus the authors decided to supplement this gap in literature and conduct their investigations in a selected fish processing plant X.

The aim of the study was to present tracking and tracing of certain fish products. Tracking aims at the identification of *e.g.* the producer, supplier or raw material lot number in order to verify the cause and source of the hazard. In contrast, tracing makes it possible to determine destination of the defective product lot.

MATERIALS AND METHODS

Materials

The experimental material consisted of "Herring fillets in tomato sauce" and peas. The identification of the product from the final product to the raw material was performed for "Herring fillets in tomato sauce", while peas, an ingredient of many fish products, was used to trace the product from the raw material to the final product.

"Herring fillets in tomato sauce" were collected from the final product warehouse of a fish processing plant, at which investigations were conducted, while peas – from the raw material warehouse of this plant.

Experimental material comprised also documentation kept at individual departments of the plant, as listed below: production orders, the acceptance protocol of fish material, sensory examination protocols, a register of raw materials and additives used in the production process, documents of weight control, metal detection and product temperature measurements, and a list of production orders.

Methods

The traceability system aims at tracing the product over the entire food chain starting from the delivery of raw materials, through production, distribution and up to the sale of final products. There are two levels of implementation of this system: internal traceability and supply chain traceability. The latter level is more complicated as it requires the flow of information over the entire food chain and concerns all organizations participating in this chain. The authors verified the internal traceability system operating in the analysed plant. In the course of the conducted investigations they focused on information flow concerning raw materials, semi-finished products and final products inside the plant.

In tracing fish products,first of all documents found at individual departments of the plant were used, while computer data base was used to a lesser extent since in the analysed plant the operating traceability system was based mainly on hand-written records on filled-in forms. It was not a completely computerized system. Such a system is based on filling, keeping and reviewing records maintained at each processing stage. The management of most plants prefers the operating traceability system to be computerized and based on bar code technology; however, this technology requires considerable outlays, which many plants cannot afford.

It also needs to be stressed that the traceability system is implemented by the management in food industry plants not only in order to meet legal requirements, but first of all to ensure health safety of food produced. Thanks to this, high safety of the produced items may be assured. In the analysed plant the traceability system was implemented also to increase competitiveness of their products and minimize costs related with potential recall of defective products from turnover.

Investigations conducted at fish processing plant "X" consisted in tracing "Herring fillets in tomato sauce" from the production planning department, through the fish raw material acceptance department, the laboratory, the raw material preparation department, the production department up to the final product warehouse, whereas in case of peas it was from the quality control laboratory, through successive departments up to the final product warehouse.

Two research methods were applied: (1) tracking a fish product from the final product to the raw material, and (2) tracing the product from the raw material to the final product.

Tracking a fish product from the final product to the raw material

"Herring fillets in tomato sauce" were tracked following the diagram of tracking for fish products from the final product to the raw material (Figure 1).

Investigations were started at the production planning department, in which based on the production order from the last production of "Herring fillets in tomato sauce" the following data were determined: the date of production for this product, expiry date, product number and fish lot number. Next, in the fish raw material acceptance department, on the basis of fish lot number a respective protocol of fish raw material acceptance was found, from which the most important information was read, *e.g.* delivery date of fish raw material and the name of the supplier. Next, based on the number of the above mentioned production order, sensory examination protocols for "Herring fillets in tomato sauce" were collected from the quality control laboratory. Then, on the basis of data from the raw material preparation department a list of raw

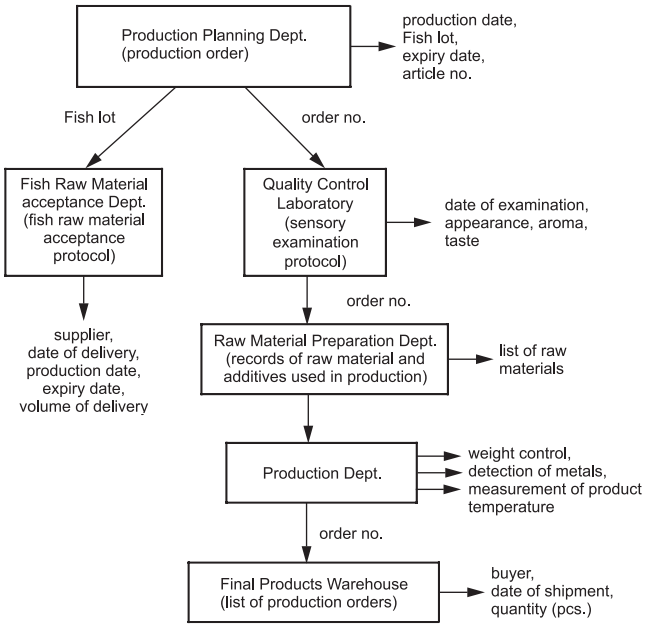

FIGURE 1. A diagram of tracking for fish products (from final product to raw material).

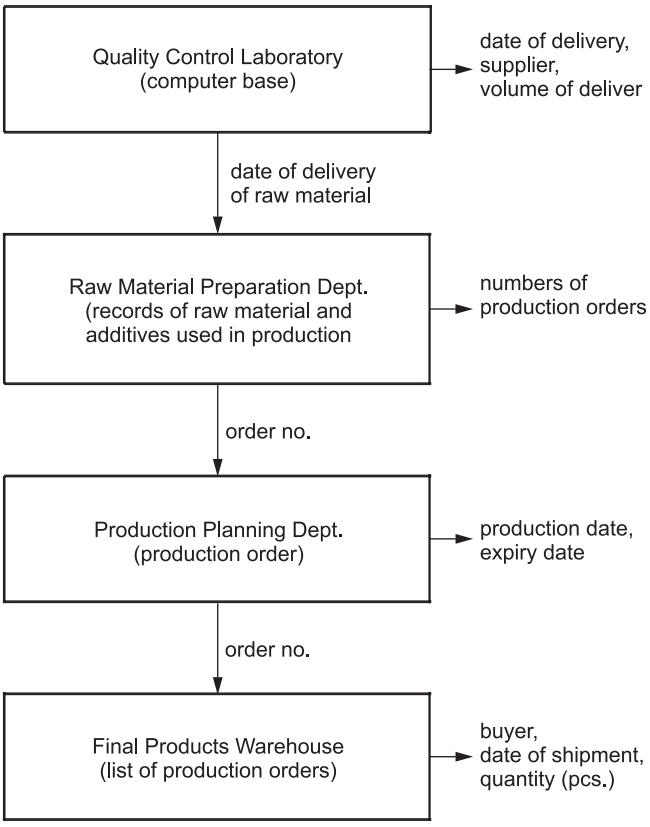

FIGURE 2. A diagram of product tracing (from raw material to final product).

materials contained in the examined product was prepared. At the production department the documentation of weight control (required weight), metal detection in the final product and product temperature measurements was analysed. Next, based on the production order number a list of production orders was collected for the investigated product from the final product warehouse and thus the recipient of the product, shipment date and ordered quantity of the product were determined.

Tracing the product from the raw material to the final product

A raw material (peas) was traced following the diagram of tracing products from the raw material to the final product (Figure 2).

Peas tracing was started by verifying the delivery date of this raw material, delivered quantity and the name of the supplier at the quality control laboratory. Next, on the basis of delivery date numbers of production orders were found at the raw material preparation department, for items containing peas, and then respective orders were collected from the production planning department. Using these documents production dates and expiry dates were determined for these products and lists of production orders were collected from final product warehouse. On their basis the recipient of products, their shipment date and ordered quantity of the product were determined.

RESULTS AND DISCUSSION

Results concerning traceability of "Herring fillets in tomato sauce" are presented in Tables 1-3.

Table 1 gives information concerning "Herring fillets in tomato sauce", *e.g.* production date, quantity of produced goods and expiry date. Moreover, it results from this table that fish raw material with batch number 5300, supplied by "Laguna", was used in the production of "Herring fillets in tomato sauce". This piece of information may prove very useful in the case when product defect was caused by poor quality raw material being used in production. Table 1 contains also information concerning sensory examination of "Herring fillets in tomato sauce" (item 2), results of weight control (item 5), presence of metals in the final product (item 6) and product temperature measurements (item 7). These data are also crucial if a defect is found in the final product. Table 2 lists raw materials contained in "Herring fillets in tomato sauce" along with their delivery dates, suppliers, delivery size, production dates and expiry dates. Such data may be useful assuming that any of the raw materials used could have posed health hazard to consumers or an inappropriate attribute of the final product. In turn, Table 3 provides recipients of this product together with ordered quantities and shipment dates of this product. These data may be used in a situation when it is necessary to recall the entire lot of a product from the market, as all recipients of "Herring fillets in tomato sauce" have to be identified.

Results of tracing peas as a raw material are presented in Tables 4-6.

Table 4 gives data concerning peas, *e.g.* the supplier of this raw material, delivery date, delivery size and expiry date. This information may be useful when it is suspected that the defect of the final product results from poor quality of peas used in the production process. It results from Table 5 that peas were used in the production of "Herring fillets Hawai-

TABLE 1. Herring fillets in tomato sauce.

1. Basic data	
Product no.: 406009	Fish lot: 5300
Date of production: 06.07.2006	Production order: 818794
Expiry date: 07.09.2006	Produced quantity: 650 pcs.
2. Sensory examination report for the final product	
- date of examination: 07.07.2006	- appearance, aroma, taste, consistency of product – appropriate
3. List of raw materials	
Raw materials for the production of "Herring fillets in tomato sauce" are presented in Table 2.	
4. Description of fish raw material	
- fish lot: 5300	- supplier: Nord Capital / Laguna
- date of delivery: 19.06.2006	- expiry date: 25.07.2006
- volume of delivered material: 19 000 kg	- temperature of supplied raw material: – 16°C
5. Product weight control	
- date: 06.07.2006	
- required product weight: 180 g	- actual product weights: 187; 186; 185; 184; 183; 182; 181; 180 g
6. Detection of metals in the final product	
- date: 06.07.2006, at 4:00 p.m.	- no metals detected in the final product
7. Measurement of temperature of product	
- date: 06.07.2006	- temperature: 15.3°C
8. Release of article no. 406009 and expiry date 07.09.2006.	
Distribution of "Herring fillets in tomato sauce" with expiry date 07.09.2006 is presented in Table 3.	

TABLE 2. Raw materials for the production of "Herring fillets in tomato sauce".

Raw material	Date of delivery	Production date	Expiry date	Supplier	Volume of delivery
Stabilized egg yolk	21.06.06	19.06.06	19.09.06	Milano	15000 kg
sugar	27.06.06	31.10.05	-----	Esco	23000 kg
salt	?	09.06.06	09.06.07	Marko	22000 kg
Powdered milk	27.04.06	13.04.06	13.04.07	Gostyń/Mlekpol	100 kg
Sodium benzoate	17.03.06	08.11.05	08.11.07	Supero	800 kg
Potassium sorbate	19.06.06	18.03.06	03.2007	Supero	200 kg
Vegetable oil	05.06.06	-----	-----	Milo	-----
Citric acid	04.05.06	03.02.06	01.2008	Supero	-----
Tomato sauce	27.06.06	24.06.06	10.2007	Tomilla	15098 kg
Yoghurt	29.06.06	28.06.06	12.2007	Mlekpol	7097 kg
Pickled onion, strips	30.06.06	01.06.06	01.09.06	Hortexia	4080 kg
Cucumber, strips	27.06.06	19.06.06	19.09.06	Hortexia	2520 kg
Apple, cubes	28.06.06	02.02.06	02.02.08	Hortexia	1540 kg

ian style", "Chicken salad with peas", "Fish salad with peas" and "Salmon salad with peas". This information may be used to identify possible defects in lots of final products. Moreover, Table 5 lists, among other things, the expiry date of listed products, which is important for the consumer in the case of a complaint. Table 6 in turn gives recipients of the products listed above together with the ordered quantities and shipment dates for these products. These data may be used to determine all recipients of the above mentioned products in case it is necessary to recall the goods.

In the course of the investigations numerous problems were observed, which indicates inadequacies of the traceability system, operating in this plant. These include:

– errors in handwritten records, kept at individual production departments (Table 2); according to data kept at the production department the supplier of powdered milk was Mleczarnia Gostyń, whereas actually it was Mlekpol,

– errors in handwritten records, kept at the department of fish raw material acceptance (Table 1, point 4); in the fish raw material acceptance protocol Nord Capital was given

TABLE 3. Distribution of "Herring fillets in tomato sauce" no. 406009 and expiry date 07.09.2006.

Ordered quantity	Date of shipment	Consignee
50 pcs.	12.07.2006	TESCO Poznań
10 pcs.	12.07.2006	Real Gdynia
90 pcs.	12.07.2006	BIG FISH Warszawa
50 pcs.	12.07.2006	TESCO Kraków
100 pcs.	12.07.2006	FISHER Warszawa
10 pcs.	12.07.2006	Auchan Poznań
40 pcs.	12.07.2006	Market Piotr i Paweł Łódź
100 pcs.	12.07.2006	BIG FISH Kraków
200 pcs.	12.07.2006	PROFISH Rzeszów

TABLE 4. Peas.

1. Basic data	
Article no.: 2-58-710	Date of delivery: 05.07.2006
Supplier: Hortexia	Volume of delivery: 1 320 kg
Expiry date: 31.05.2007	
2. Application of peas in individual products	
The utilization of peas in different products is given in Table 5.	
3. Distribution of "Salmon salad with green peas"	
Distribution of "Salmon salad with green peas" is presented in Table 6.	

TABLE 5. Peas in individual products.

Order no.	Production date	Expiry date	Product	Qty (pcs.)
521959	09.07.06 / 07.09.06	07.09.06	Herring fillets Hawaiian style	4320
521910	16.07.06	13.09.06	Chicken salad with green peas	660
522164	17.07.06	18.09.06	Herring fillets Hawaiian style	1620
522745	16.07.06	15.09.06	Fish salad with green peas	1320
522996	19.07.06	15.09.06	Salmon salad with green peas	300

TABLE 6. Distribution of "Salmon salad with green peas" to consignees.

Ordered quantity	Date of shipment	Consignee
12 pcs.	31.07.2006	Real Gniezno
120 pcs.	31.07.2006	TESCO Gorzów Wielkopolski
12 pcs.	31.07.2006	FISHER Katowice / BIG FISH Katowice
30 pcs.	31.07.2006	ROMA Kraków
6 pcs.	31.07.2006	Neptunek
60 pcs.	31.07.2006	TESCO Szczecin
60 pcs.	31.07.2006	Auchan Poznań

as the supplier, which was incorrect, since the only supplier of herring fillets was Laguna,

– gaps in the documentation found at the department of raw material preparation (Table 2); data concerning the date of salt delivery are missing (thus the question mark in the table),

– discrepancies found between records coming from the production planning department and data recorded in the computer system (Table 5); according to data from the production planning department "Herring fillets Hawaiian style" with production order no. 521959, which contained tested peas, were produced on 09.07.2006, while it results from computer data that it was 07.09.2006,

– infrequent updates of data found in the computer system (Table 6); the buyer, FISHER from Katowice changed its name to BIG FISH, which was not updated in the computer base,

– difficulties in surveys of records found in different parts of the plant.

Considerable problems during the collection of information originated from discrepancies in records coming from production and those found in the computer system. Thus, in the course of the analyses first it was necessary to determine which information was correct and only later to continue the identification of the selected product. Based on the conducted observations it was found that errors were committed most frequently by workers at the Production Department, who did not supplement the documentation sufficiently thoroughly. They entered incorrect production order numbers, which hindered further identification of products. Some data were not recorded at all and if they were, not all details were recorded. In the course of analyses it was found that *e.g.* not all raw materials were recorded in the documentation, which made it impossible to identify raw materials used to produce the product, which for this reason was not presented in this paper.

Analyses showed also that data found in the computer system were rarely updated. Occasionally the article number was not changed despite a change in the formulation of a given product or this change was introduced with considerable delay, which made it difficult to find the analysed product in the computer data base (Table 1 and Table 4 point 1).

Moreover, a certain problem was also to review records in different parts of the plant. In order to collect all information required to recreate the history of the analysed product, it was necessary to visit all departments, since the documentation was found at different locations at the plant.

CONCLUSIONS

The paper presents two methods to verify the traceability system operating in the food industry through identification of the selected product and identification of the raw material at the analysed plant. Collected information made it possible to evaluate the functioning of the system at a fish processing plant X.

Based on the observations made in the course of this study it was found that using the results and diagrams of traceability for products: from the final product to the raw material and from the raw material to the final product in the investigated plant, the history of processing and distribution of "Herring fillets in tomato sauce" may be traced, together with the history

of pea origin and its application in fish products. Traceability of a product is possible thanks to the maintenance of the continuity of information flow over the entire production chain. This continuity is provided thanks to the knowledge of production order number, since on this basis information on this product and raw material may be obtained from successive departments of the plant.

In the case of a potential irregularity in the production process on the basis of results presented in tables the stage at which it appeared may be identified and it is also possible to find the cause of the potential defect in the final product.

Although it is possible to trace products in the analysed plant, it was also shown that the traceability system operating therein has its flaws, as it is manifested in the problems observed in the course of this study. Defects of this system may be eliminated by the introduction of improvement proposed by the authors.

In order to improve the operation of the traceability system in a fish processing plant X the following actions were proposed:

– internal audits of the system need to be conducted more frequently than at present and corrective actions need to be undertaken immediately,

– it is recommended to focus on the monitoring of records concerning traceability, used at the plant,

– supervisors of individual production areas should control records on production and complete missing information on the on-going basis.

Regularly conducted internal verification of the traceability system facilities prompt identification and elimination of occurring problems. Records from control activities need to be kept and maintained in order to prevent repeated occurrence of similar problems. Moreover, it is necessary to regularly review documentation in order to eliminate errors on the ongoing basis and supplement gaps in the records. This will facilitate traceability of products. It is also important to update data in the computer system. In the opinion of the authors, a good solution would be to unify the documentation. All data recorded by hand at individual departments of the plant need next to be entered in the computer data base.

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