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Designing and Implementation of Traceability Barcode of Dates Products Based on UCC/EAN-128 Barcode Scheme

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Abstract. Recently, the food safety issue of agricultural products has attracted focus all over the world. Due to a long supply chain compared with the animal or other kinds of products and the complex processes with huge links. The Food safety traceability system (FTS) is an effective way to verify of food safety and healthy. This research was designed and implemented traceability barcode for an agricultural product (Dates) followed the common encoding scheme (UCC/EAN-128) with enhancing by added human readable information about the most significant data for the end consumer such as expire and production date. The proposed system takes DTS barcode as an information carrier which identifies dates products closely related to farming, processing, packing, transportation and distributing. DTS adopts on Web Service Technology for tracing and extracting all information related to the date product using barcode. Customers can scan or typing the barcode in the system website. The Web Service interface provided by DTS will return all traceability information to the end consumer. Using the proposed code has proved by practice that it can extract all information in high accurate level as well as acceptance from the end consumer because important information is written in a language he/she understands.

Keywords: Traceability, Barcodes, Food processing, UCC/EAN-128, Food safety.

1. Introduction

Safety of agricultural products is a terrible issue [1]. Due to a long supply chain compared with the animal or other products [2]. This problem effects directly on human health as well as farming trade [1]. The Food safety traceability system (FTS) over barcodes is an effective means to verify of food safety [1, 3, 4].

The barcode concept has been developed and integrated for tracking in the 20th century [5]. Barcode considered as fast, accurate and reliable identification technology [4, 5] .This technique is widely used in the FTS around the world, it presents as a group of parallel black and white bars with a certain thickness and order [2, 5].

The UCC/EAN-128 encoding standard is a worldwide scheme for coding huge data between companies [2]. The main feature of this scheme is that provide a list of "Application Identifiers" (AI's) use to making the data meaning [2, 5].

In light of popular use for this encoding scheme, this research analyzes the supply chain for dates safety model, and establishes the Web-Based, three-Tiers Architecture model of dates traceability system (DTS) based on the UCC/EAN-128 standard with

human readable information to extract all traceability information while using.

The rest of the research is ordered as: Section II, related work. Section III, describes DTS barcode design. Section IV, presents the concept of DTS barcode. Section V, explains barcode implementation. Section VI, tests and validates the barcode. Section VII, discusses the result. Finally, concludes research and suggests the future work.

2. Related Work

This section will represent a brief description for different scientific papers related to the research subject.

Yiying *et al.* [3] (2019), designed an entire food traceability system for meat products, aimed at increase food safety in the whole of the meat supply chain. However, two internal barcodes were used to generate that final barcode. Firstly, in breeding stage, an internal barcode “Production ID barcode” was created to keep all traceability data to the system database of individual animal. This code used in order to carry other production information to the next stage. Then, in transportation stage, the system management platform reads the "Production ID barcode" and creates "Slaughter ID barcode". Both of internal barcodes are registered in the system database, in the transfer stage, the XOR operation was performed between the two internal barcodes to create the final barcode to meat products. This led to decreased around 128 bits each time of generation.

Another study designed a barcode for Coffee Machine. In [6], Bodhale and Kulkarni (2017) **,** They benefited from barcode concept to design a coffee machine. Each coffee capsule identified by barcode. The barcode was used to determine the ingredient's percentages and the quantity of water needed to dissolve the capsule. The barcode read by a high sensor camera. Then, the preparing process is done. They generated the capsule's barcode by ready to use software (HMI and ACU).

Huoguo *et al.* [2] (2007), used UCC/EAN- 128 standards to designed traceability label. The label had 21 digits and composed of two sections: the commodity ID label and the batch label (Fig.1). The first section of the label (commodity ID) composed of: (1) Enterprise ID, (2) Code of commodity item (3) Check code, it also mentions to the Application ID (01) in the UCC/EAN-128 standard (Fig. 2).

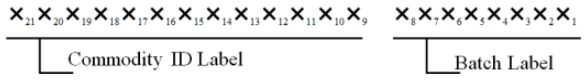

Fig. 1. The structure of the traceability label.

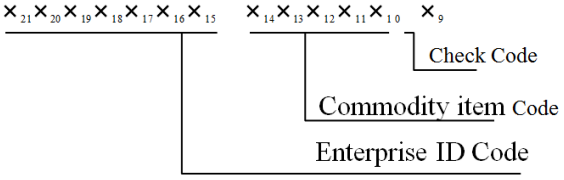

Fig. 2. The structure of the commodity label.

The second section of the label (batch code) composed of: (1) Production or packing date, (2) producing or packing line. (Fig. 3).

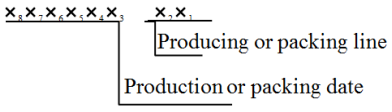

Fig. 3. The structure of the batch label.

Also Archipelago Marine Research Ltd in [7] (2005), used EAN/UCC scheme for developing a fish traceability barcode. They assigned a unique ID for each stage and process such as: Products, shipments, locations, production lines, boats and trucks. Besides, the EAN/UCC scheme offers the ability to record important information such as: the expiry date and the weight.

The fish barcode consists of: Company Prefix which is uniquely identifies a company anywhere through a distinguish ID of 6-10 digits. Traceability mostly needs identification of entities involved in the food supply chain. This constraint applies by using the EAN/UCC scheme. Global Location Number (GLN) with 13-digits is used to identify locations (farms, factories), physical assets (cars, ships) and legal entities (growers, packers, and customers) in the supply chain. It composes of three parts: Prefix of Company, Location Reference Number (LRN) and Check Digit. The LRN consists of 5- digits which specified by the licensed user of Company Prefix. The Check Digit consists of one digit and located at the end of GLN code. Moreover, the important traceability information like: weight, Expiration date represented using (AI's). AI's is a shortcut to the word "Application Identifier" and means numerical descriptors used on the EAN/UCC scheme. It aims to provide meaning to the numbers in a barcode. The number 029411, for example, is a simple number without any meaning, but when it preceded by AI, the system will read the number as part of product information. For example, AI 15 refers to date of format Year, Month, Day. In another word, when a number is preceded by 15, the system will read it as a date (e.g. (15) 050207 will be read as Feb 7, 2005).

The Beef Traceability Case Study In [8] (2005), used EAN-128 to encode identification information related to a traceable product. They also used AI to encode supplementary information such as the expiration date and the batch number. AI is a prefix used on EAN-128 to identify structures and determine the length of data that follows; also it used to provide meaning for the barcode numbers. For example, (01) means the product ID while (15) means the expiry date.

3. DTS Barcode Design

Most of the end consumers are keen to choose the fresh products with open traceability policy. There are two ways for the end consumer in DTS to show traceability information: (1) Using their smartphones to scan the barcode or (2) Typing the barcode directly in the website. Figures 4 and 5, show these two ways.

Fig. 4. Scan the barcode by smartphone.

Fig. 5. Typing the barcode in the website.

DTS is designed on the UCC/EAN- 128 standards. There are two barcodes within DTS. The first barcode works internally (the initial barcode). It will be sent with the initial product from an agriculture stage to a manufacturing stage, and will be used by growers and packers only. Whilst, the second barcode will be used by the end consumer (the final barcode).

The initial barcode composed of 8 digits order as: (1) 3-digits for a farm ID (2) 4-digits for a product ID (3) 1-digit for a check code. The structure and example are depicted in Fig. 6.

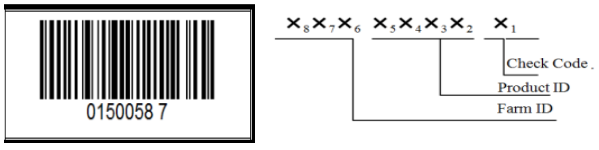

Fig. 6. Structure and example of the initial barcode.

DTS final barcode composed 21 digits and consisted of two sections: a primitive code

and a packing code. The Primitive code composed of 6-digits ordered as :(1) 5-digits for Operation ID (2) 1-digits for Number initial products. Moreover, the packing code composed of 15 digits order as: (1) 3-digits for packing country ID, (2) 6-digits for primitive code, (3) 3-digits for factory ID, (4) 3-digits for distributor ID. Figures 7 and 8 illustrate the primitive code and the packing code structure respectively while Fig. 9 presents the final barcode structure.

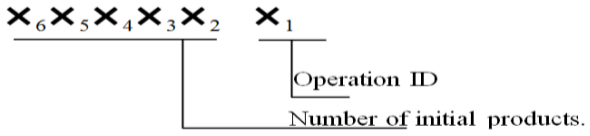

Fig. 7. The structure of primitive barcode.

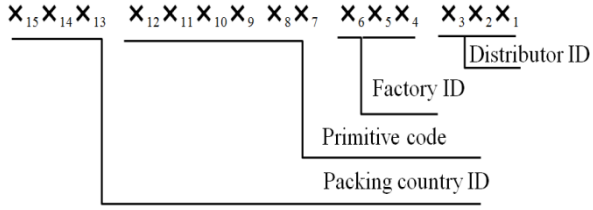

Fig. 8. The structure of packing barcode.

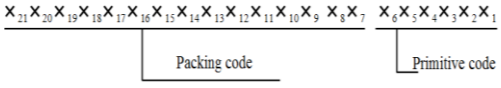

Fig. 9. The structure of final barcode.

4. DTS Barcode Concept

For further clarification, the concept of initial barcode use within DTS is shown in Fig. 10.

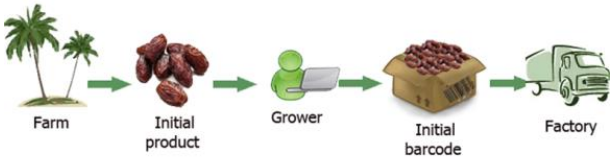

Fig. 10. The concept of internal barcode.

First, a grower logs into the system. He/She can register new information about initial products only on farms that he/she has an account on. Also he/she can modify other information of farm products. After he/she finished the initial products information, he/she prints the initial barcode and puts it with the initial product then sends them to the factory. Figure 11 below shows the grower scenario.

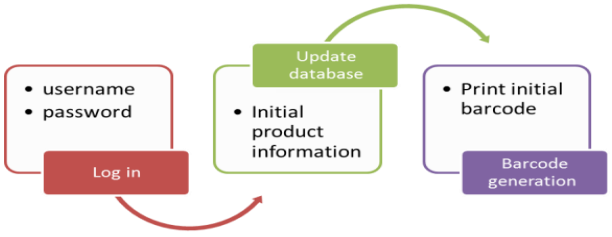

Fig. 11. The grower scenario.

The flow chart in Fig. 12 below shows the steps of generating initial barcode.

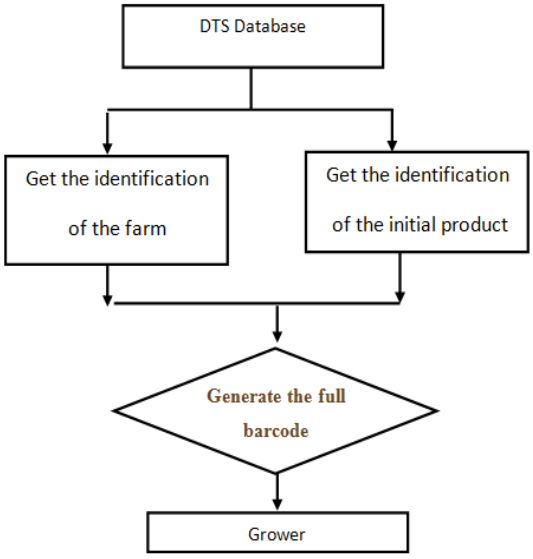

Fig. 12. The steps of generating initial barcode.

Then, when the packer receives the initial product on the factory (Fig. 13 shows the final barcode concept), he/she enters its barcode to the system after he/she signed in. Then the system checks the barcode; if it is correct, the system will allow the packer to

register packing information only on the factory who has an account on which assign by the system administrator. When he/she finished the packing information, he/she prints the final barcode and sends it with the final product to the distributors. Figure 14 shows for the packer scenario, Fig. 15 shows the steps of reading internal barcode and Fig. 16 shows the steps of generating final barcode.

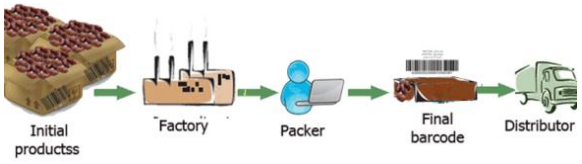

Fig. 13. The concept of the final barcode.

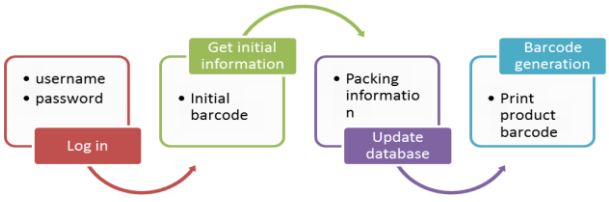

Fig. 14. The packer scenario.

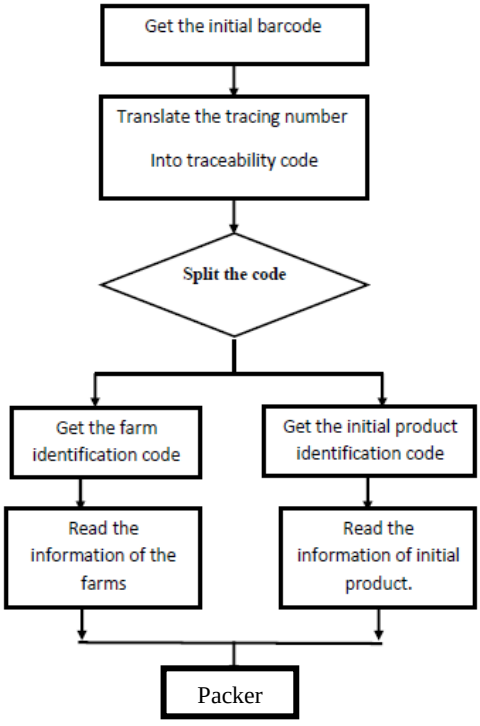

Fig. 15. The steps of reading initial barcode.

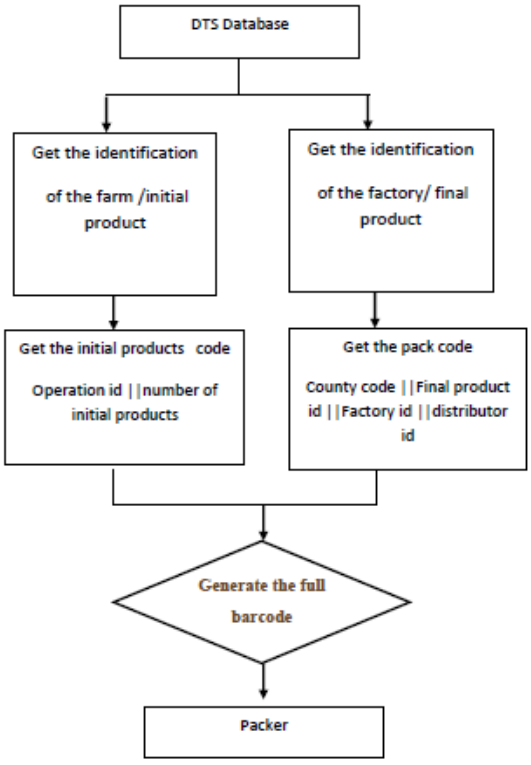

Fig. 16. The steps of generating final barcode.

Finally, when the consumer wants to buy the product, he/she visits the system website and enters the product barcode on the system homepage. The system reads the barcode and shows all traceability information to the consumer. Figure 17 shows the consumer scenario.

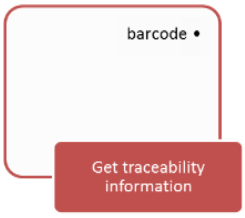

Fig. 17. The consumer scenario.

The flow chart in Fig.18 shows the steps of generating final barcode (tracing process).

5. Implementation of DTS Barcode

This project proposed Web-Based, three-Tiers Architecture where the three tiers are the database server; the web server and the

application. Web is chosen due to its powerful ability to achieve the objectives of DTS. Usually, A client acts on the first tier which is application or interface tier. The database server represents the data storage tier which stores and executes data come from the web application tier. The last tier is the middle tier which is a web server which responsible for providing the availability, scalability, and performance characteristics for the organization's web environment. The system has implemented by using

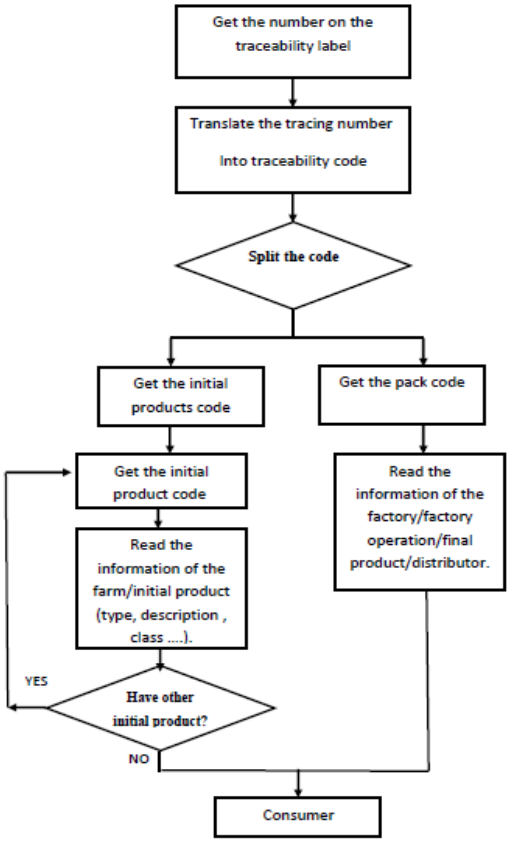

Fig. 18. Tracing process.

ASP.net with VB.net. The illustration of proposed system architecture is shown in Fig. 19.

The DTS final barcode has implemented with a distinguish feature which is containing important information for the final consumer written in a language that he/she understand like: expire date, production date and the price. The following Fig. 20 presents instance of DTS barcode.

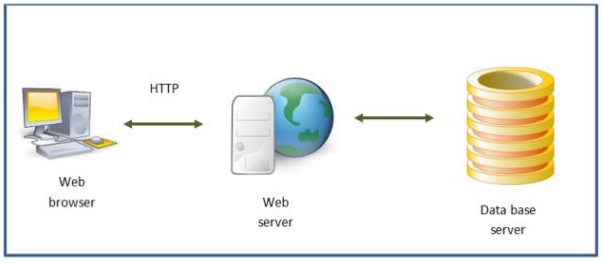

Fig. 19. The proposed architectures.

Fig. 20: Instance of final barcode.

6. Testing and Validation

This section will visualize the DTS by providing screenshots of reading and generating process for the two proposed barcodes by represent a small scenario from the first step on the farm till the final product reach the consumer. All tests were successful**.**

- First, when the grower in the farm finishes the product growing, he/she logs in to the system. Figure 21 shows grower login interface.

Fig. 21. Grower logs in interface.

- After he/she log in to the system, he/she inserts the growing information about

his/her farm product. Figure 22 shows inserting initial information by the grower.

Fig. 22. Inserting initial information by the grower.

- Then he/she prints the initial barcode, and sends it with the product to the factory. Then he/she logs out of the system. Figure 23 shows printing initial barcode by the grower.

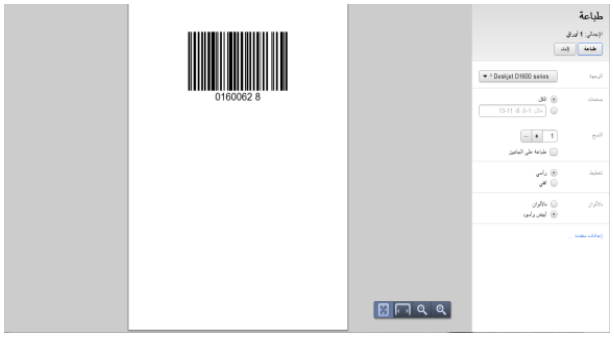

Fig. 23. Printing initial barcode by the grower.

- When the initial products arrive to the factory, the packer logs in to the system and insert the initial barcode and factory operation. Figure 24 shows inserting factory operation information by the packer.

Fig. 24. Inserting factory operation information by the packer.

- After that, the packer inserts the final product information. Figure 25 shows inserting final product information by the packer.

Fig. 25. Inserting final product information by the packer.

- Then he/she prints the final product , and sends it with the final product to the distributor. Figure 26 shows printing final barcode by the packer.

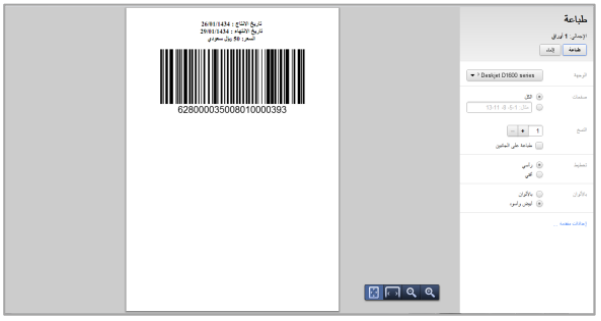

Fig. 26. Printing final barcode by the packer.

- When the consumer visits the distributor and wants to buy that product, he/she can use his/her smart phones or iPad to visit DTS web site then insert the product barcode. Figure 27 shows insert barcode by the consumer.

Fig. 27. Inserting barcode by the consumer.

• Then our system shows all traceability information. Figures 28, 29, 30 and 31 show the product traceability information.

Fig. 28. The product traceability information (Part1).

Fig. 29. The product traceability information (Part2).

Fig. 30. The product traceability information (Part3).

Fig. 31. The product traceability information (Part4).

7. Result and Discussion

While using and experiencing DTS barcode the result were distinct, it showcased the potential and challenges in realizing traceability objectives. Many pros have registered comparison with other kinds of barcodes which were reviewed. DTS barcode takes the advantage of UCC/EAN-128 scheme that it can encode huge data for a long food supply chain; also it is easy to read and understand due to using AIs which give a meaning for the numbers in the barcode. On the other hand, when we compare it with 2D barcode, DTS barcode doesn't need a special reader or hard ware to trace the products, it can either typing or scan by the smartphone camera. Finally, the major feature is that it has written information for important dates and the prices which protect products from manipulation or fraud and make it faster to get this urgent information.

8. Conclusion

This research used the UCC/EAN-128 standard for implementing traceability barcode in DTS with enhancing by added human readable information about the most significant data for the end consumer. DTS barcode can effectively decrease the costs and the efforts of applying food safety meanwhile; it provides broader space to the application of traceability system for agricultural products. The result shown that barcode has been successfully applied with high levels of accuracy, speed and wide acceptance of written information.

They suggest applying the proposed barcode in other kinds of products in order to make easy to trace the products with readable information of significant data as a future work.

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تصميم وتنفيذ شفرة تتبع لمنتجات التمور طبقا لنظام الترميز UCC / EAN–128

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المستخلص. في الآونة الأخيرة، مع ارتفاع ظهور العديد من الأمراض المرتبطة بسلامة الأغذية، مثل انفولونزا الطيور وغيرها من الأمراض، ازداد الاهتمام بقضايا سلامة الأغذية بشكل عام، وللمنتجات الزراعية بشكل خاص، في جميع أنحاء العالم. وذلك بسبب سلسلة التوريد الطويلة للمنتجات الزراعية، مقارنة مع المنتجات الحيوانية أو غيرها من المنتجات. نظم تتبع سلامة الأغذية هي وسيلة فعالة للتحقق من سلامة سلسة التوريد للأغذية. في هذا البحث تم تصميم وتنفيذ نظام للتتبع منتجات التمور باستخدام تشفير معلومات التتبع في باركود خاص بالمنتجات الزراعية. يتبع هذا التصميم نظام الترميز المشترك (UCC / EAN – 128) مع تعزيز بوجود معلومات قابلة للقراءة بلغة الإنسان لأهم البيانات للممستهلك النهائي، مثل تاريخ الإنتاج وتاريخ الانتهاء. في هذا النظام المقترح يعتبر الباركود الناقل للمعلومات الذي يحدد كافة المعلومات لمنتجات التمور في مراحل الزراعة والمعالجة والتعبئة والتوزيع. ويعتمد تنفيذ نظام التتبع المقترح على تقنية الويب لمعالجة واستخراج جميع المعلومات المتعلقة بالمنتج باستخدام الباركود. يقوم العملاء في هذا النظام بمسح أو كتابة الرمز أو الشفرة في موقع النظام، وستؤدي واجهة خدمة الويب التي يوفرها النظام إلى إرجاع جميع معلومات التتبع إلى المستهلك النهائي. لقد أثبت استخدام الشفرة المقترحة من خلال الممارسة أنه يمكنه استخراج جميع المعلومات بمستوى عالٍ من الدقة والسرعة مع قبول واسع من المستهلك النهائي، وذلك لوجود المعلومات الهامة مكتوبة بلغة يفهمها.

الكلمات المفتاحية: التتبع، شفرة، تجهيز الأغذية، UCC / EAN-128، سلامة الأغذية.