The Design and Implementation of Halal Beef Wholly Quality Traceability System

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Abstract. In recent years, there are many food quality problems have happened. And they have had a serious effect on people's physical and mental health. The quality tracing of livestock products have arrested the intensively attention of the society of different parts. In NingXia, which is as the main living place of Hui National people, the industry of Halal beef and mutton is one of the leading industries for the development of local agriculture. Based on the requirement of agricultural informatization of NingXia and other similar regions in the West of China, according to the HACCP and GMP management concept，we have developed a feasible system to trace the Halal Beef quality during the whole production process. Details are as follows: realizing the information collection about beef farming process, and establishing the quality information database of the Halal beef products, and integrating the application of the RFID 、EAN/UCC-128 barcode、Pdf417 2-D barcode, GSM technology and Internet technology at the same time. The system makes it possible that the customer can trace the whole production process of the beef through SMS, Telephone, Internet, and scanning the barcode with smart phones or others means after shopping the beef. And the system realizes the whole quality tracing and Muslim tracing of the beef during the process of the farming, slaughtering and logistics. So the design and realization of the system are important technical basis of Islamic meat quality and safety for NingXia and other similar regions in the West of China.

Keywords: Beef, Quality tracing, Halal tracing, Rfid, Barcode

1 Introduction

Along with the enhancement of living standards and the changes in the dietary concept, the pursuit of high nutrition, high protein and green meat has become a trend. According to the analysis, it is predicted that 70% of our animal food demand will depend on the development of animal husbandry in the western region, which will provide a huge market space for the cattle and sheep industry of western region includes Ningxia. And for the epidemic of "mad cow" in European, China has become

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the first choice market for Europe and the United States to import beef and mutton. In recent years, the export quantity of high-grade beef and mutton has increased year by year in our country. And the future market space of high-grade beef and mutton will be more extensive.[1]

For Ningxia, which has been planned as the production place for high quality beef according to the government layout for new round of national dominant agricultural products, the cattle industry is the advanced and distinctive industry. When Ningxia meet the demand of high-quality beef in the Northwest, it also expands the market to the Muslim market of Central Asia and the Middle East. Ningxia, which is as the only Hui Autonomous Region in China, has the advantage of abundant resources and brand to develop Halal beef industry.

But over the past decade, the break out of animal epidemic situation (for example: the mad cow disease, foot and mouth disease, avian flu) and the safe food accidents ("clenobuterol hydrochloride ", water injection meat , rubbish pig) occur frequently, which have brought great threat to people's body and psychological health and have stricken the consumer's confidence to livestock products heavily[3] [4]. Safe problem of the livestock products has aroused the intensively attention of public. European Union, USA, Australia and other developed countries have set up laws and regulations to fix the compulsory request to guarantee the traceability of the quality safety of beef products [5] .

Currently the production management in large-scale cattle farm is mainly based on traditional methods. The disadvantage of traditional methods is lack of complete information in breeding, feeding, migration, epidemic prevention, slaughter and processing, marketing and other aspects. So it is difficult to achieve safe, high quality, efficient and the requirement of sustainability [5]. Though Ningxia's Halal animal products have certain characteristics, the whole scale is not large, and it is also lack of strict Halal certification program from product source to logistics of the Halal animal products, and lack of origin quality tracing in the whole process, which has seriously restricted further development of Halal Industry.

The aim of the design and implementation of Halal beef wholly quality traceability system is to meet the demand of the agricultural informatization of NingXia and other similar regions in the West of China. On the basis of the equipments in hand of the farming-zones and the slaughtering and processing corporations, according to the requirements of the users and the HACCP(Hazard Analysis Critical Control Point) and GMP(Good Manufacturing Practice）management system, we have researched and developed a series of valuable design and implementation of Halal beef quality traceability system. Details are as follows: realize the collection of the information of beef farming process, and establish the database of the Halal beef products' important quality information. Meanwhile, integrate the technology application of the RFID、EAN/UCC-128 bar code，Two-dimensional barcode，GSM technology and Internet technology all together.

The design and implementation of this system is helpful for standardization of the farming of Halal livestock husbandry, the standardization of the slaughtering and the informatization of the management processing in NingXia and other areas in the West. And it provides the advanced technical supports for popularity of Ningxia Halal livestock brand and the improvement of the brand international competitiveness.

2 Overall Structure of System

Through the research and analysis, this paper proposes a solution for the Halal beef wholly quality traceability system based on the Internet of things. In the farm, in order to identify each domestic animal, we can wear RFID tags to each cattle. Then related information can be recorded through the RFID identification, which includes the purchase, breeding cycles, use of forage, veterinary drug name for therapeutic use and epidemic prevention, quarantine, transport, being out of market and other sectors. Establish breeding records and collect data to the central server through the RFID reading and writing device. In the abattoir, the operator can read cattle ear tag by the handheld device. If the quarantine meets the requirement of standard, the operator will transfer ear code to the product label. Then the slaughter of the cattle is released and the information of beef products can be input into back-end database. The system prints quarantine certificate and bound the label on the cattle carcass; in the process of the division, prints the EAN/UCC-128 back yards and two-dimensional PDF417 security barcode and pastes them on the package, and collects data to the central server to enable consumers to get back yards after buying beef products. Then the consumers can date back to the key information of product by SMS, Internet and phone. The system hardware architecture is shown   in figure 1.
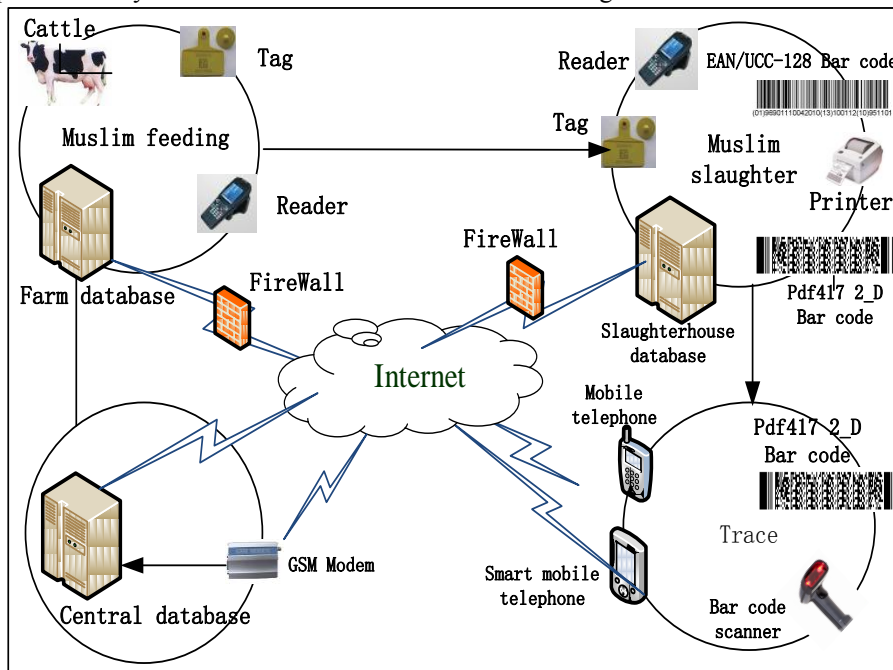

Fig. 1. Overall structure of system

3 Main Technologies

3.1 Cattle Identification Code Design

According to the requirements of "Animal identification and breeding records management practices" of Ministry of Agriculture, the implementation of a livestock animal identification must be one code only for one animal and the code must be unique. Animal identification code consists of a total of 15-digit serial number including the livestock and poultry species code, county administrative code and identification sequence number [6]. The composition of special bar code is shown in Fig.2.
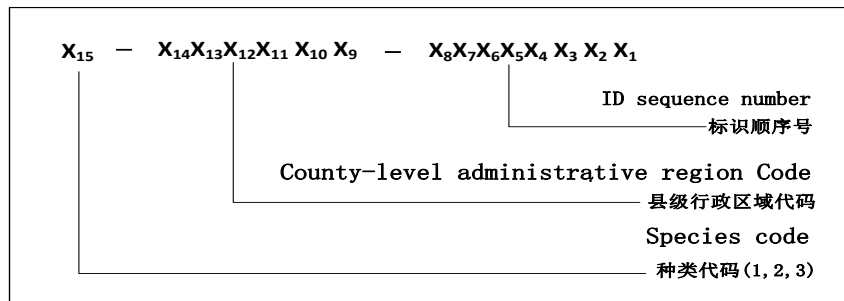
$$X_{15} \; - \; X_{14}X_{13}X_{12}X_{11} \, X_{10} \, X_9 \; - \; X_8X_7X_6X_5X_4 \, X_3 \, X_2 \, X_1$$

ID sequence number
标识顺序号

County-level administrative region Code
县级行政区域代码

Species code
种类代码(1,2,3)

Fig. 2. Labeling codes expression for a single livestock

Among them, the first digit shows the species of the animal. And species codes of pigs, cattle, sheep are respectively 1, 2, 3. The next 6-digit is on behalf of area code of the county (city) level administrative where farms or farmers are in, which following the rule of GB/T 2260-1999 standard; next 8 digits from the eighth to fifteenth represents the sequence number of the same species of livestock in the same administrative region. For example the code "264, 010, 500, 003, 268," it expresses that the type of animal is cattle, that the cattle is fed in Xixia district of Yinchuan city of Ningxia (administrative region code is 640105) and that the sequence of the designated cattle in Xixia is 00003268.

3.2 The scheme of RFID Applications

RFID is the abbreviation for Radio Frequency Identification. It identifies the target and gets relevant data automatically by its radio frequency signal and it can work in a variety of harsh environments without human intervention. Basic RFID system is composed of Tag, Reader and Antenna. RFID technology can identify fast moving objects and can also identify several tags at the same time and is easy to be operated. [7] The application of this system which uses RFID is shown in Figure 3. The passive tags on cattle can be read though fixed readers and handheld readers, so the cattle can be identified and tracked easily.
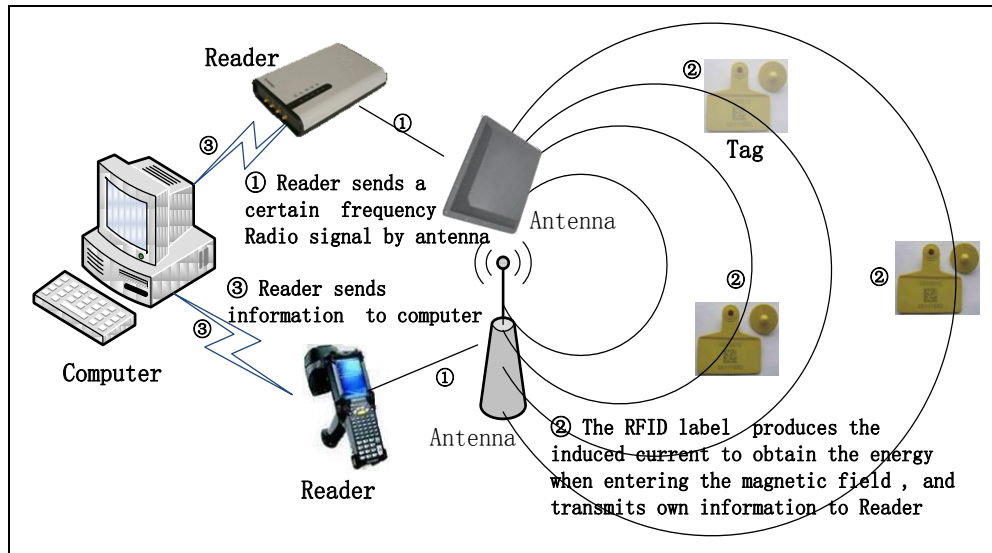
Fig. 3. The scheme of RFID applications

3.3 EAN/UCC-128 Trace Code Design

EAN-128 code is come from the information which has been changed into the bar code symbols according to the definition of EAN/UCC-128 standards. And it uses the logic 128 yards and has the characteristic of integrity, compactness, connectivity and high reliability. Based on the requirement of amount of the tracing information for beef products, and the existing experience as the reference, the research selects EAN/UCC-128 barcode as back yards of beef products and uses corresponding application identifier in the standard of GB/T 16986-2003 "EAN • UCC system application identifier" [8] . The code is shown in Fig.4：
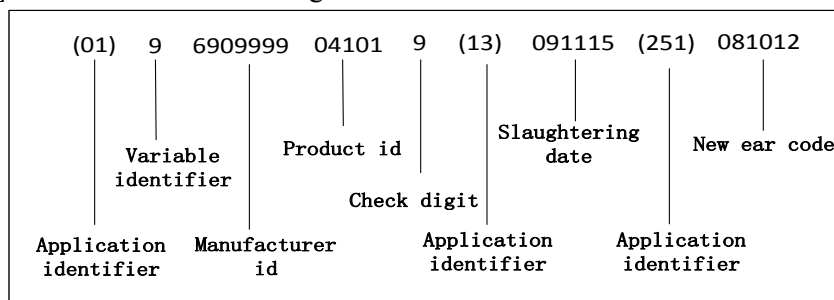

Fig. 4. Encoding Structure of EAN/UCC-128

The trade item identifier AI (01) is used to identify the beef product identification code; the production date AI (13) is used to identify the production date; the entity reference with the source code identifier AI (251) is used to identify the number of cattle in slaughterhouses (the original 15 cattle code is changed into the new 6-bit slaughterhouse code). Among them 14 digits of beef product identification consist of four parts, which are a variable identifier, seven manufacturers identification code + 5-bit product item code (or 8-bit manufacturer identification code + 4-bit product item code) and the last one for the parity bit.

3.4 PDF417

PDF is the abbreviation for portable data file. The symbol character of each barcode is consisted by four bars and four empty forms. If the composition of the most narrow bar or space is called a module, then the total number of the above four bars and four empty is 17, so it is called 417 yards or PDF417 code. Two-dimensional code PDF417 is a high-density, high throughput portable graphics data file and one of the ideal means of carrying and passing information and security [9].

3.5 Data Synchronization

Embedded databases usually use a data replication model (upload, download or mixed mode) and the server map database to meet the requirement of accessing any data in any location and any time. Because of data replication, in the system it could need all kinds of necessary controlling processes between the front-end and back-end server, even some or all front-end and intermediate data of the application should be synchronized [10]. In this paper, the merge replication in SQL Server CE data synchronization technology is adopted to realize data synchronization between hand-held readers and computers.

4 Architecture of System Function Module

Through the research and analysis, this study dives Total Quality Traceability System into four subsystems (Fig.5).
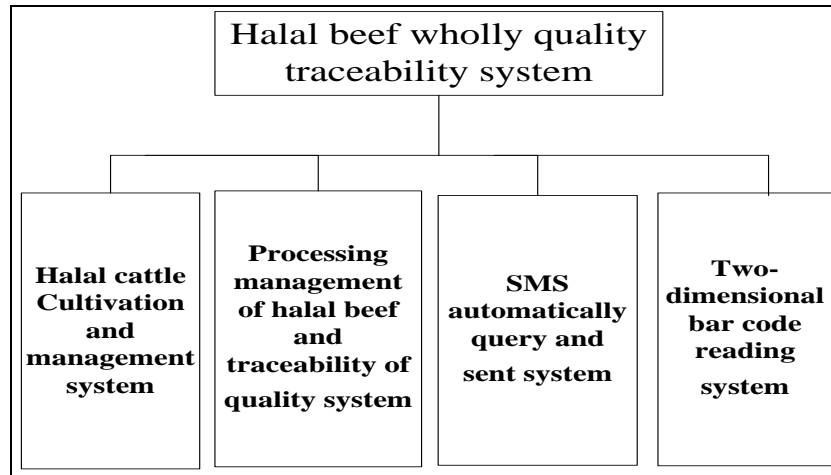
Fig. 5. Function of system modules

4.1 Halal Cattle Cultivation and Management System

It is supported by RFID technology, database technology and computer network technology, and based on basic data from farm cattle and breeding records, to conduct electronic management from purchasing cattle into the field, feeding, disease prevention to the quarantine and other production processes, to monitor all aspects of production to ensure scientific and standardized breeding. And the system ensure Islamic requirements from the source of cattle breeding by monitoring forage, drug manufacturers at the same time, which is not only to meet the needs of its daily management, but also to lay a foundation to realize the Halal products' traceability .

4.2 Processing Management of Halal Beef and Traceability of Quality System

It is supported by data synchronization and EAN/UCC-128 barcode technology. It manage the production process of the slaughter by electronic management such as admission cattle, cattle ear tag conversion, cattle quarantine, slaughter to packing, outbound and other production processes. During the slaughtering process, the system monitors slaughter methods and operator to ensure that products meet the requirements of Muslim consumption; at the same time the system adopts HACCP mechanism and GMP control systems to control the production process and the environment in the slaughter and processing strictly in order to ensure high standards and quality of all aspects in the processing; system uses the B/S structure and

consumers can trace the product when entering the bar code of beef products they've purchased in web page.

4.3 SMS Automatically Query and Sent System

Using GSM Modem and mobile communication technology, It can sent the query message of cattle farming to the mobile automatically according to the database of cattle numbers after it receives a query text message. Farming field can also send related information of the specified cattle to a designated mobile phone by the system.

4.4 Two-Dimensional Barcode Reading System

Software can drive the two-dimensional bar code scanning module on smart phone to identify encrypted two-dimensional PDF417 code, and parsing the information on beef products. Consumers need to download two-dimensional bar code reading system from *Processing management of Halal Beef and Traceability of Quality System* and copy it to the smart phone which has the function of two-dimensional code recognition. Then they can trace back the quality of beef production information and Islamic information in real-time via scanning labels of beef. At the same time management and business enterprises can quickly identify if the products and the packaging are fake.

5   Software Development Environment of the System

Based on the requirement of collecting information during the process of beef production, processing and distribution, and the requirement of tracing the quality and Halal information through the network, messaging, mobile devices and other means, this study adopts the current mainstream Microsoft. NET 2005 platform to develop breeding management system of cattle breeding and SMS automatically query delivery system, it selects C# language as the development language and selects cross-platform Java language to develop Online Halal beef processing standardization and quality traceability information systems; the two-dimensional barcode reading system on smart phones is developed by Microsoft VC++ which adopts SQL Server 2005 CE as embedded database. The operating system is the most popular system with most users-- Windows XP. The SQL Server 2005 is used for unified database.

6   Conclusion and Outlook

This research object of the study is to realize the traceability of Halal and quality of the beef product's, to established a critical information database for Halal beef product's quality by using RFID, EAN/UCC-128 barcode, two-dimensional barcode, GSM technology and Internet technology. This system realizes the function that the consumer can trace the beef production information after they purchased the beef through SMS, telephone, network and a smart phone which has the bar code scanning function and other methods，and that the whole quality and the Muslim information from breeding, slaughter processing to the logistics can be traced .

Beef cattle industry is the advantageous industry in the national economy in Ningxia, so it has been the government and enterprise's consensus to develop the halal beef industry and halal beef brand. It is imperative to research and develop a set of Halal animal quality traceability system. The study method adopted by this research, the product and the result's demonstration are beneficial for enterprises to ensure the product's quality safety, to guarantee the products to meet the requirement of Muslim food and to strengthen the confidence of consumers. At the same time they provide an effective means for product technical anti-counterfeiting and technical support for shaping a better enterprise brand image, and enhancing competitive ability of the Hahal products in the Halal markets of domestic and overseas and in the area of high-end consumption.

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