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Research on Agent-based Bee Product Traceability Platform and Barcode system

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Abstract. Establishing agricultural product quality safety traceability platform and barcode system have become a worldwide trend. Bee product traceability platform that can be used to identify all aspects from farm to table has been laid out based on China law and global standards. An integrated bee product traceability system which involving all of the process along the supply chain can be applied to increase consumer confidence of bee products by making traceability data accessible to the consumer. In this bee product traceability platform, barcode system is of enormous significance and due to its applications in the all tracing stage of platform, standard barcode system architecture and infrastructure become very important.

In this paper, we study safety situation of bee product quality, research status of bee product traceability and barcode system. We construct bee product traceability platform by adopting agent technology, build barcode system by adopting GS1 global traceability standard as well as realize standardization barcoding of bee product data content during four links: materials collection, purchase, processing and sales. Applying barcode system and traceability platform in bee products distribution process can realize bee products tracking and tracing, offer strong guarantee for Chinese bee product quality safety and improve competitiveness of bee products in international market.

Keywords: bee product, traceability system, barcode

1   Introduction

1.1   Current Situation of Bee Products Quality Safety

The annual capacity of honey is about 293,000 tons at present in China, which including royal 3,000 tons jelly honey bee, 3,000 tons pollen and 350 tons propolis, the total output value of honey is about 8 billion RMB and annual export value is about $133 million [1]. As advantage products in our country, bee products have important function for export, human health. Bee products quality safety problems are not only in relation to the bee industry development, but also in relation to consumer

safety and the improvement of bees' international competitiveness. Consequently, Study the quality safety problems of bee products has important meaning to promote bee industry development [2].

In recent years the rapid growth of bee products processing industry, and meanwhile an extension of the industrial chain and bees industry itself exists many factors that caused various quality problems of bee products, which directly affect bee products export, and also shock Chinese domestic market. EU and some countries took trade barriers like forbid export and stop selling to Chinese honey in 2002 [3], which made great loss to Chinese beekeeping industry, seriously impacted normal development of beekeeping industry, and also caused Chinese government departments to pay attention to bee products quality problems. The key problem of bee products quality safety is doping fake and drug residue in China, and these kinds of problems have not been able to get fundamental solution [4]. The production and purchase link of Chinese bees industry especially the raw honey are loose management, small scale, and bad degree of organization, but effective supervision need reliable technical means, so the demand for bee products' quality safety traceability system is more pressing.

1.2   Current Situation of Bee Products' Traceability System Research

Bee products are particular agricultural products, so all countries in the world pay very attention on the quality safety, and the traceability research of bee products is actively developing at home and abroad.

On the law level, EU Traceability Regulations-Regulation (EC) No 178/2002 article 18 Traceability, trade operator must ensure product's traceability. Our country "Food Safety Law" and "Produce Quality Safety Law" also provide legal protection for the implementation of traceability system on legal level [5].

EU sixth framework program put forward the standard of record information during honey sales chain traceability process, the content of record is to achieve good traceability purpose, and detailed information that should be recorded in honey sales chain. Greece and Hungary proposed joint and implemented "Trace Honey" project, Hungary-Greece food network traceability and transparency research raised pilot research for honey production and processing and sales chain management. Argentina Agriculture Food Sanitation and Quality Bureau(SENASA) put forward honey refining room is the core of the traceability system; Refining room, beekeeping producers and honey barrels are required to pass through SENASA registered commercial Apitrack traceability system has been promoted in many countries [6-9]. Ontario, Canada agricultural food and rural affairs traceability pilot plan, also including bee products.

Due to long industry chain, no specified industry standard and many influencing factors for quality safety, currently research work of Chinese bee products quality safety tracing system is mainly conducted by Bee Research Institution and Agriculture Information Research Institution of Chinese Academy of Agricultural Science [10].

This article, through the analysis of the Chinese bee products quality safety and bar code system research status, proposes to introduce modern information technology

into bee industry in order to realize whole process trace of bee products, uses GS1 standard to set up bee products traceability bar code system, and constructs bee products trace platform which is based on Agent according to industry characteristics.

2 Research Status of Barcode System

Unified code system is the foundation of launching bee product traceability and the premise of information exchange and process in trace process. Bee product traceability barcode must have some standard principles: uniqueness, stability, versatility, extensibility and applicability. In trace process trace key points mainly include raw honey gathering barcode, honey purchase barcode, process barcode and the products barcode. All these key elements must be bar-code uniformly and standardly so that information of different trace link is unique identification. In this research GS1 system is used for realizing uniform and standard barcode of bee product.

2.1 GS1 System

The GS1 System is an integrated system of global standards that provides with accurate identification and communication of information regarding products, assets, services and locations. It is the most widely implemented supply chain standards system in the world. It is the foundation of a wide range of efficiency-building supply chain applications and solutions and is composed of the following two areas: GS1 barcodes and GS1 traceability.

GS1 unified label system performs an important function for physical implementation of agricultural products barcode, especially for agricultural products' standardized management in logistics links. GS1 system has been widely used in the logistics and retai industry of the global supply chain. It reduces system operation cost and avoids causing supply chain's uncertainty. Adopting global unified identification system can realize rapid and accurate seamless links between Information flow and material flow.

Table 1. Symbols and abbreviations. Table 1 shows symbol and abbreviation in GS1 system.

Symbol	Abbreviation
AI	GS1 system Application Identifier
GLN	GS1 system Global Location Number
GMP	Good Manufacturing Practice
GS1	Global Solution 1
GS1 system	Unique global identification system
GTIN	GS1 system Global Trade Item Number
ID	Identification
ISO	The international Organization for Standardization
n2 or n14,etc	GS1 identifier numbers consisting for 2 or 14, etc digits
SSCC	GS1 system Serial Shipping Container Code

2.2 Barcode Research Situation of Agricultural Product Traceability System

At present agricultural product traceability systems are widely developing in at home and abroad. Zheng has analyzed traceability chain of cooking oil products and designed cooking oil product system based on batch management, meanwhile, zheng proposed barcoding rules of core link which included origin, process and final product [11-12]. Liu has encoded Fruit and vegetable products. According to characteristic of lamb industry chain as well as actual information level of lamb manufacturing enterprises, Wang has developed lamb barcode system. Xiong has realized pork quality safety traceability. Deng has studied producing area code of agricultural product, divided tea planting area and uniformly encoded tea. Sheng has developed beef traceability barcode system.

In general most research organizations have carried out traceability barcode system research according to pork, beef, lamb, grain and oil, fruit and vegetable [13]. However, research about bee product traceability barcode system has not been reported. Developing bee product barcode system is a difficult task because that collection source of bee product scattered and honey adulteration are widely spread.

3 Agent-based Bee Products Traceability Platform

Agent theory and technology, as a part of distributed artificial intelligence, has developed rapidly since it arose from 1970s, it is a popular direction of artificial intelligence now [15-16]. The researches on agent have received a great deal of attention because of its characteristics, such as autonomy, collaboration, intelligence, mobility, and the potential to build complex systems [17]. In recent years agent theory and technology research have been rapidly developed, many studies, which including agent-oriented development language, development framework, and method, decision support system and collaboration work model, make good progress. Agent and multi-agent system technology have given us a new way to look at distributed systems and provided a path for more robust intelligent applications [18].

In food processing, the term traceability refers to the recording through means of barcodes & other tracking media, all movement of product and steps within the production process. One of the key reasons is in instances where an issue of contamination arises, and a recall is required. Where traceability has been closely adhered to, it is possible to identify, by precise date & location which goods must be recalled, and which are safe, potentially saving millions of dollars in the recall process. Traceability within the food processing industry is also utilized to identify key high production & quality areas of a business, versus those of low return, and where points in the production process may be improved.

This research has built agent-based bee products traceability platform which based on agent theory and quality tracing method. In figure 1, on account of the characters of independent interaction among the key control points in the bee product traceability platform, a development platform and multiple principal body system of bee product traceability are designed with agent-based method, the platform agent is adopted to perform data acquisition, bar code manufacturing, data inquiry,

information surveillance and task management; and task management agent is employed to realize bee farm management, supplier management, processing management and sales management. And data acquisition system developed in this paper is managed by data acquisition agent, the data thus obtained is transmitted via ACL language to the platform management agent to achieve data sharing and surveillance, as well as to fulfill the purpose of bee product information traceability.
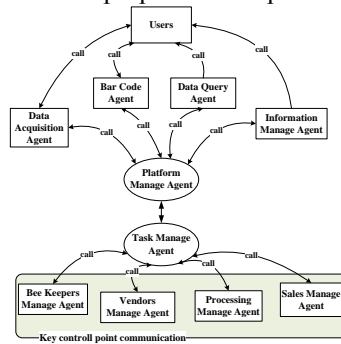

Fig. 1. Agent-based Bee products traceability platform.

4　Barcode System of Bee Product Traceability

Bee product traceability platform mainly consists of the following flows (Figure 2): tracking process (clockwise direction) begins from the origin of honeybee, covering a couple of key control points like place of production, distributor, processing plant and seller, so raw material purchase process, honeybee processing process, product selling process and retail process are traced. Tracing process (counter-clockwise direction) is traced back from customers, including the tracing of selling, production, raw material and place of origin. By means of the bee product traceability platform, tracking and tracing of several key control points like place of origin, distributor, processing plant, seller and customer can be realized, and bee product quality safety can be safeguarded.
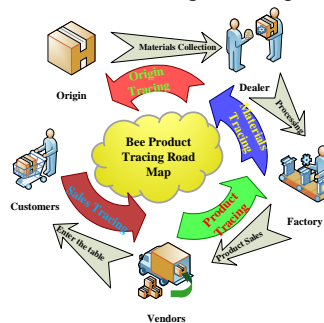

Fig. 2. Bee product traceability road map.

In various links of bee products tracking and tracing, GS1 system was used for barcoding and providing uniform code standards. Standardization bar code can provide accurate, safe and reliable traceability information.

Table 2. Barcode system information of bee product supply chain. Table 2 shows information exchange process of bee products traceability links.

Supply chain	Gathering	Purchase	Process	Sale
Diagram	→	→	→	
Label type	Apiary label	Purchase label	Process label	Logistics label
Code system	EAN-128	EAN-128	EAN-128	EAN-128
Key information	AI(7030) AI(13) AI(10)	AI(7030) AI(13) AI(10)	AI(01) AI(10)	AI(01) SSCC
Attribute information	Apiary information Honey kinds Honey origin Production date ……	Factor Honey kinds Bee pasture Honey origin Date of packaging ……	Processors Honey kinds Honey origin Processing date Processing country ……	Processing country country of destination Global trade code ……

4.1 Honey Gathering Process

When bee farmers finished gathering honey in apiary, they attach different apiary honey traceability label to different honey barrels. Table 3 shows barcode information and label text information in apiary traceability links. And Figure 3 indicates apiary traceability barcode label which including necessary text and barcode. The traceability information can be used in information exchange between apiary and purchase trader or between apiary and processing factory.

Table 3. Barcode and information of gathering process.

Data content	Data name	UCC/EAN-128	Example	Categorisation	
				Shall	may
Gathering process					
Traceability code of gathering honey	PROCESSOR+ PACAK DATE + LOT	AI(7030)+AI(13)+AI(10)	(7030)156510183010 01(13)080527(10)011	✓	
Apiary code	PROCESSOR	AI(7030)	n4+n3+an…27		✓
Production date	PACK DATE	AI(13)	n2+n6		✓
Lot number	LOT	AI(10)	n2+an…20		✓
Global location number of honey	GLN	AI(414)	n3+n13		✓
Honey kinds	REF.TO SOURCE	AI(251)	n3+an…30		✓
Honey weight	NET WEIGHT	AI(3100)	n4+n6		✓

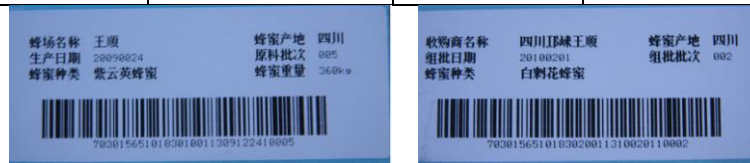| Global location number of supplier | GLN | AI(412) | n3+n13 | | ✓ |
Apiary name text	Text information	——	Sichuan Wangshun	✓	
Production date text	Text information	——	2008-05-27	✓	
Lot number text	Text information	——	025	✓	
Honey origin text	Text information	——	Hubei	✓	
Honey weight text	Text information	——	100kg	✓	
Honey kinds text	Text information	——	Eucalyptus honey	✓	

Fig. 3. Honey gathering label and Honey purchase label.

4.2 Purchase Process

When purchase traders buy honey from bee keeper, they need to attach purchase traceability label to their honey barrels. Table 4 displays barcode information and label text information in purchase traceability link. And Figure 3 shows purchase traceability barcode label which consists of necessary text and barcode. The traceability information can be used in information exchange between purchase trader and processing factory.

Table 4. Barcode and information of purchase process.

Data content	Data name	UCC/EAN-128	Example	Categorisation	
				Shall	may
Purchase process					
Traceability code of purchase honey	PROCESSOR+ PACAK DATE + LOT	AI(7030)+AI(13)+AI(10)	(7030)156420804020 01(13)090621(10)025	✓	
Purchase code	PROCESSOR	AI(7030)	n4+n3+an…27		✓
Production date	PACK DATE	AI(13)	n2+n6		✓
Lot number	LOT	AI(10)	n2+an…20		✓
Global location number of honey	GLN	AI(414)	n3+n13		✓
Honey kinds	REF.TO SOURCE	AI(251)	n3+an…30		✓
Honey weight	NET WEIGHT	AI(3100)	n4+n6		✓
Global location number of supplier	GLN	AI(412)	n3+n13		✓
Purchase trader name text	Text information	——	Hubei Heqingbiao	✓	
Package date text	Text information	——	2009-09-13	✓	
Lot number text	Text information	——	025	✓	
Honey origin text	Text information	——	Hubei	✓	
Honey weight text	Text information	——	100kg	✓	
Honey kinds text	Text information	——	Cole honey	✓	

4.3 Processing Process

Processors package honey products according to consuming unit or distribution unit as well as transport products through highway, aviation or sea transportation. Table 5 presents barcode information and label text information in process traceability link. And Figure 4 shows process traceability barcode label which is made of necessary text and barcode. The traceability information can be used in information exchange between processing factory and seller.

Table 5. Barcode and information of processing process.

| Data content	Data name	UCC/EAN-128	Example	Categorisation	
				Shall	may
Processing process					
Traceability code of process honey	PROCESSOR+ PACAK DATE + LOT	AI(7030)+AI(13)+AI(10)	(7030)156510106030 01(13)100310(10)001	✔	
Global trade number	GTIN	AI(01)	n2+n14		✔
Lot number	LOT	AI(10)	n2+an…20		✔
Package date	PACK DATE	AI(13)	n2+n6		✔
Production date	PROD DATE	AI(11)	n2+n6		✔
Date of minimum durability	BEST BEFORE	A(15)	n2+n6		✔
Global location number of honey	GLN	AI(414)	n3+n13		✔
Honey kinds	REF.TO SOURCE	AI(251)	n3+an…30		✔
Global location number of supplier	GLN	AI(412)	n3+n13		✔
Processor name text	Text information	——	Hangzhou Changqing	✔	
Production date text	Text information	——	2010-10-03	✔	
Lot number text	Text information	——	001	✔	
Honey origin text	Text information	——	Sichuan	✔	
Net weight text	Text information	——	1.5 kg		✔
Honey kinds text	Text information	——	Sophorae honey	✔	
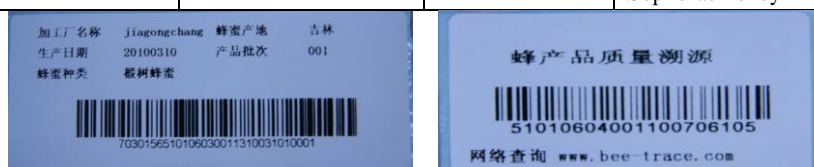
Fig. 4. Product process label and Commodity sale label.

4.4 Sale Process

When dealer affords product to consumer necessary traceability information includes bar code for commodity and traceability code. Table 6 displays barcode information and label text information in sale traceability link. And Figure 4 demonstrates shows sale traceability barcode label which composed by necessary text and barcode.

Through querying traceability barcode in website, consumer can get all traceability information of bee product.

Table 6. Barcode and information of sale process.

Data content	Data name	EAN/UPC	Example	Categorisation Shall	Categorisation may
Sale link					
Bar code for commodity	EAN-13	EAN/UCC-13	6901234567892	✔	
Commodity traceability barcode	PROCESSOR+PAC AK DATE + LOT	EAN-128	51010604001100706105	✔	
Processor name text	Text information	——	Hangzhou Changqing		✔
Production date text	Text information	——	2010-07-06		✔
Lot number text	Text information	——	105		✔
Honey origin text	Text information	——	Sichuan		✔
Net weight text	Text information	——	1.5 kg		✔
Honey kinds text	Text information	——	Sophorae honey		✔

5   Conclusions

Agricultural products quality safety becomes the hot topic which the people at home and abroad generally pay attention to in recent years. As ways of guaranteeing quality safety, tracing and tracking technology have been widely used in the developed countries such as America, Canada, Japan, New Zealand and so on. In recent years Chinese government has been paying much more attention to food quality safety and also has done a lot of work for quality safety and traceability. As the largest bee-keeping country in the world, beekeeping is Chinese traditional industry, in addition honey is important traditional product of foreign exchange income. So how to use tracing and tracking technology to further strengthen bee product safety control and management is an urgent affair. On the basis of analyzing the present situation of Chinese bee product quality safety, this paper proposes developing bee product traceability platform and barcode system and finally realizes bee product general quality control.

1) This paper first analyzes bee product quality safety status and research situation of bee product traceability system. We should develop bee product traceability barcode system and quality safety platform which are suitable for Chinese situation.

2) Secondly based on GS1 system we respectively encoded in four links of bee products circulation. Unique and standardization bee product barcode system are used in traceability platform.

3) Finally we developed agent-based bee product quality traceability platform which could realize farm-to-table traceability.

6   Acknowledgments

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