Identification of Variables and Information Requirements for Implementation of Traceability in Egg Production

Denise Belloni Ferrari Furlan [1]; Mario Mollo Neto[1]; Ricardo César Gonçalvez Sant'ana[1]; Leda Gobbo de Freitas Bueno[2]; Marcelo Marques de Magalhães[1], Danilo Florentino Pereira[1]

[1] São Paulo State University (UNESP), Faculty of Science and Engineering, Tupã/SP Brazil
Domingos da Costa Lopes Street, 780 - Jd. Itaipu - Tupã / SP - ZIP Code 17602-496
Phone: (55 14) 3404-4200

[2] São Paulo State University (UNESP), Faculty of Agricultural and Technological Sciences, Dracena/SP Brazil - Rod. Cmte João Ribeiro de Barros, km 651 - Bairro das Antas - Dracena/SP
ZIP code 17900-000Phone: (55 18) 3821-8200

Corresponding author: Mario Mollo Neto[1], **mario.mollo@unesp.br**

Abstract

Brazil is the 3rd largest egg producer in the Americas and for production to be achieved, it must be organized to produce with quality and productivity. For all quality requirements to be met, guidance documents such as EMBRAPA and the Brazilian Poultry Union cover all stages of the production process, from the origin of the inputs to the later stages of production. In addition to these instructions, other legislation dealing with traceability is used to regulate production processes in food chains. In this context, the objective of this work is to confront the main national and international standards related to traceability to verify common requirements and that can compose a system of data collection. The work was divided into three stages and presented as a result the common requirements: sanitary management in the breeding and rearing phases, lineage, input control, poultry vaccination, poultry feeding, sanitary monitoring, egg collection information, eggs, and biosafety, product description, batch identification, date of shipment and data of the sending company and data of the company of destination, in addition to the information retrieval system.

Keywords: Poultry keeping. Legislation. Food safety. Quality requirements.

1. INTRODUCTION

Brazil is the 3rd largest egg producer in America [1]. Its production chain is composed of input producers, poultry and egg producers, the processing industry, wholesale markets, retailers, and the egg industry and final consumer [2], [3].

Scandals due to outbreaks of bovine spongiform encephalopathy (BSE), birds contaminated with dioxin in Europe, E. coli O157: H7, the horsemeat scandal, coupled with the expansion of the supply chain

meant that there was a need to the improvement of food quality management processes [4], [5]. Traceability of information in food production has been implemented in industries to contribute to the availability and transparency of information [6].

The great difficulty in effectively implementing the traceability system is to integrate all links in the production chain through the registration link [4], [7], [5] and, in Brazil, there is no specific legislation that regulates the process for the egg production chain [8].

Based on the scenario presented, this work aims to analyze the main national standards that deal with food safety and traceability in laying poultry and compare them with international standards to verify the production and quality variables, and the production requirements. registration of information must be observed for the implementation of an information system for traceability.

2. LITERATURE REVIEW

Legislation on egg production

Brazilian egg-producing industries are governed by different regulations that address information that has been complemented over the years.

Historically, in Brazil, there was a sequence of laws that address the egg production system that evolved according to the food industry. In 1965, Decree 56,585 approved specifications for the classification and inspection of eggs. These specifications were used by the egg industry until the 1990s [9].

In 1990, the Ministry of Agriculture, Livestock and Supply (MAPA) created Ordinance No. 1, of February 21, 1990, which approved the general inspection rules for eggs and derivatives, which addresses from the definition of the common vocabulary to the egg production chain, going through the detailing of good practice actions, egg industrialization processes, such as pasteurization, freezing, cooling, hygiene aspects within the production processes, responsibilities for analysis and quality assurance [10].

Resolution No. 5 of July 5, 1991, brought the Identity and Quality Standard for Whole Egg to the production chain, among other products that emerged at the time, or that did not have an identity and quality standard for the industry to follow [11].

With application to all food industries, Ordinance No. 46, of February 10, 1998, brought the institution of the HACCP system to be gradually implemented in animal products industries.

According to the ordinance, HACCP is understood as an “analysis system that identifies specific hazards and preventive measures for their control, aiming at food safety, based on the prevention, elimination or reduction of hazards in all stages of the production chain. ” [12].

In 2007, MAPA issued Normative Instruction 56, of December 4 of that year. The instruction establishes procedures for registration, inspection and control of breeding and commercial poultry establishments, detailing the stages of the egg production process, and other establishments related to the poultry industry [13].

To organize and transmit information on conservation and consumption to consumers, on June 17, 2009, Resolution No. 35 was introduced, which deals with specific labeling for eggs [14].

To complement the information provided by IN 56, 2007, in 2012, the necessary information was added for the good management of farms through Normative Instruction 36, of December 6, 2012 [15].

In addition to the standards presented, some are directly related to good practices in egg production in Brazil, detailing the stages of production of a farm, they are i) Technical Circular nº 49 - Good Production Practices in Commercial Posture [16]; ii) Good Egg Production Practices Protocol [17].

Technical Circular No. 49, prepared in 2006 by EMBRAPA is a normative document that was created based on specifications of legislation, health requirements, and food hygiene standards aiming at food safety [16].

To complement these requirements, the so-called "*União Brasileira de Avicultura*" (UBA) was created in 2008, the Protocol of Good Practices for egg production, to be used as a guiding document for producers in Brazil.

In addition to being based on the requirements of Technical Circular No. 49, it is also supported by the *Codex Alimentarius* recommendations and production manuals of Brazilian and foreign companies. Its character is guiding, to improve the quality of the national production system, excluding its character of mandatory adoption by companies [17].

Applied to establishments that carry out activities of production, industrialization, storage, fractionation, transport, distribution, import and commercialization of food, RDC nº 24, of June 8, 2015, brought the criteria and procedures for the collection of food, containing the actions necessary to inform ANVISA and consumers of food recalls available on the market. This legislation indicates that companies must maintain records that allow the identification of non-compliant products distributed in the markets [18].

Identification and traceability system

Concern about the traceability of food products has arisen in the past two decades after outbreaks of spongiform encephalopathy in bovines -BSE [19], [4] and birds contaminated with dioxin in Europe [4], E. coli O157: H7 [19].

Outbreaks related to the variant of Creutzfeldt-Jakob disease through contaminated meat products in the late 1980s and early 1990s. Likewise, an outbreak of salmonella and Escherichia coli in Germany in 2011. Other outbreaks that caused interruptions in the supply of products were mainly the horsemeat scandal in 2013 that caused the biggest recall of processed meat from European retail companies, such as Tesco, Ica, and Ikea Foods [20].

The basic components of a traceability system can vary according to the objectives of the system and are i) product, which brings as essential information the type and quantity, and ii) process, addressing the type of process and the duration time. From these elements, other information can be added to the traceability process, such as species, variety, quality attributes, weight, volume, harvest or slaughter period, among others [21].

To guarantee food safety, there was a need to improve the systems for monitoring production processes. In parallel, there was a process of expanding the food supply chain and the available traceability systems were unable to guarantee the consumer all the necessary information about the product he was purchasing [4], [5].

One of the major difficulties in the effective implementation of the traceability system is to integrate all links in the production chain through the registration link [4], [7], [5]. These updated and linked records

are essential to obtain the necessary data to feed the system.

In addition to the inability to link records between food chain links, [3] also reported that there are inaccuracy and errors in the records, which causes delays in obtaining data when they are demanded. They also report the importance of systematized information across the chain and point out as the main problem the lack of common standards for coding and managing information between the chains. The regulation also points out that there is a need for effective monitoring of the food and feed sector. These can be compromised if it is not possible to identify its origin in cases of eventualities that impact food safety.

Among the various definitions of the concept of traceability, there are two ISO Standards that provide complementary information and are suitable for the food industry. The first is ISO 9000, which provides a more succinct definition that identifies traceability as "the ability to trace the history, application or location of what was considered as an object of analysis".

ISO 22005, on the other hand, provides the same definition, but it is a standard specifically applied for the traceability of the food industry. Alongside these two definitions, Codex Alimentarius says that traceability is about the "ability to follow the movement of food through specific stages of the production chain, in processing and distribution [22].

To complement these concepts, on September 19, 2011, EU Implementing Regulation No. 931/2011 regarding traceability requirements previously established appeared.

The regulation specifies the main points that should be noted when carrying out traceability in animal production food chains: a) exact description of the foodstuff; b) volume or quantity; c) name and address of the shipping company; d) name and address of the owner of the shipping company (if different from the previous item); e) name and address of the destination of the product; f) name and address of the owner of the destination company (if different from the previous item); g) batch or shipping reference; and, h) date of shipment.

In addition to the points needed to perform traceability, the TRU (Traceable Resource Unit) unit that deals with the definition of the size of the lots.

For production processes where the sizing of production occurs through the formation of batches, TRU is unique, addressing the characteristics unique to that processing. On the other hand, when the production process is continuous, the sizing of production and the change in TRU occurs when a raw material or processing conditions change [21].

Traceability plays a key role in ensuring food safety for consumers, as it guarantees the possibility of recalling, eliminates products not suitable for consumption, and mainly promotes the investigation of the causes of food safety issues [7]. According to the authors, the USDA (United States Department of Agriculture) ensures that a well-implemented traceability system can provide lower costs, reduced recall expenses, and higher sales of products with specific attributes, once the customer has access to all information regarding the product you are purchasing [7].

In this sense, in a study by [23] on consumers' perception of traceability, it was found that consumers are concerned with traceability, and relate its importance to the contribution to food collection, however, many believe that traceability can contribute to the increase in the price of food. even providing food security.

Ringsberg states that there is a lack of information between the academic area and the food sector to

contribute to the issue of traceability, causing important information to cease to be transmitted between sectors [20]. On the other hand, the author mentions that the exchange of information between food companies and government authorities is increasing due to the increase in the number of recalls caused by failures in Good Manufacturing Practices, in the process of labeling, packaging, and cross-contamination in the production lines, mainly for allergenic foods, such as eggs, peanuts, milk and gluten [20]. In addition to problems related to cross-contamination, recall processes can come from other causes, such as insufficient control of production conditions, the presence of microbial agents, chemical additives, or substances foreign to the process and product and also in the quality control of products. food, for example, temperature, humidity, or bacteria that can develop and compromise food safety and, subsequently, human health [20], [3].

Given the difficulties encountered by the food production chain in implementing an efficient traceability model and that there is communication between the links, there are technologies that are emerging to solve this problem. Some technologies used are the FTTO - Food Track and Trace Ontology (food tracking theory) [3], which guarantee interaction between heterogeneous databases and that merge at a given time to make the data available.

Other models used are the Critical Tracking Point - CTP combining with the Trace Food Framework model of food traceability [7], which offer advantages for improving the efficiency and compatibility of traceability systems. Both guarantee security, access to data, and ownership of information.

Furthermore, when analyzing traceability through the need that is inserted in all links in the supply chain, [20]; [24] demonstrated the importance of food labeling, especially single labeling, for single foods. Within this context, they mention the importance of an efficient packaging system in the food industry. The author also points out the use of RFID (Radio-Frequency Identification), which is the identification through radio frequency and barcode to improve the traceability of unitary products [20].

On RFID technology, [25] reported that they have many advantages such as the amount of data that can be inserted in a label, the reading speed, the possibility of simultaneous reading of several labels. On the other hand, the price of implementation is limiting.

Used in laying hens, the QR Code was developed in Japan in 1994 by Denso Corporation [26]. The Quick Response Code or Quick Response Code is a two-dimensional digital image that carries a set of data and can be easily accessed through the camera of a mobile device [27].

The possibilities of using the code are diverse and can be used in areas such as production, logistics, sales. A code is generated from algorithms, which are grouped sequentially until the QR Code is formed. [26]. Regarding the application and use of the QR Code in food, [25] identified products such as wheat flour and wine. Besides, there is an application of 2D barcode in layers, applying the code in the beak and feet. Technologies assist in the process of obtaining traceability data.

Each organization treats this system in different ways. In this sense, in 2015 the Chinese began, with the leadership of the FDA (Food and Drug Administration), a national program for the implementation of traceability systems in the food industries. For the process to start, there was a need to develop anti-fraud technologies for agricultural products, the initial stage of the supply chain. It was necessary to know all the links in the supply chain and, above all, to be able to monitor all the important points for traceability. To be able to register them efficiently, where information was not lost in the middle of the processes was also the

great challenge encountered by the Chinese [24], [6].

3. MATERIAL AND METHODS

This work is divided into three stages. The first consisted of assessing the main national laws that address the egg production system and identifying the quality requirements that can, or should be, tracked. This analysis was delimited in the documents of EMBRAPA, UBABEF, MAPA, and ANVISA.

A chronological approach to the legislation was carried out, and Technical Circular No. 49, prepared in 2006 by EMBRAPA, is a normative document that was created based on legislative specifications, health requirements, and food hygiene standards aiming at food security for poultry farming of posture [16].

To complement these requirements, the so-called "União Brasileira de Avicultura" (UBA) was created in 2008, the Protocol of Good Egg Production Practices, used as a guiding document for producers in Brazil. In addition to being based on the requirements of Technical Circular No. 49, it is also supported by the *Codex Alimentarius* recommendations and production manuals of Brazilian and foreign companies. Its character is guiding, to improve the quality of the national production system, not have a mandatory character [17].

To inform companies about the main requirements for carrying out food recalls, it appeared in 2015, applied to establishments that carry out activities of production, industrialization, storage, fractionation, transportation, distribution, import and commercialization of food, RDC nº 24, of 08 of that year, brought the criteria and procedures for the collection of food, containing the necessary actions to communicate to ANVISA and consumers the recalls of food available on the market.

In the second stage, the information registration requirements available in EU Regulation No. 931/2011 and ISO 22005: 2008 on traceability were analyzed, to define the conditions for registration.

In the third stage, the requirements raised in the previous stages were confronted, seeking to highlight the needs or care in the procedure of collecting this information so that the quality and integrity of the information in a future traceability system is guaranteed.

4. RESULTS AND DISCUSSION

As shown in Table 1, Technical Circular No. 49 and BPPO are laws that address good practices for the production process within poultry farms and in the previous and subsequent stages. Normative Instruction 56 of 2007 establishes procedures for registration, inspection, and control of poultry establishments and Normative Instruction 36 of 2012 complements this information. Collegiate Board Resolution No. 24 deals with recall procedures in the food industry.

Table 1 - Quality requirements required by the main national legislation.

Quality requirements	Standards				
	Technical Circular nº 49, 2006 (EMBRAPA)	BPPO, 2008 (ABPA)	IN 56, 2007 (MAPA)	IN 36, 2012 (MAPA)	RDC 24, 2015 (ANVISA)
Purchase, transport and accommodation of chicks	x	x	x		
Health management in the breeding and recreating phase	x	x	x		
Lineage	x	x	x		
Debicage	x		x		
Control of inputs	x	x		x	
Division by lots		x	x		x
Destination of dead birds	x	x			
Manure management and poultry litter	x	x		x	
Poultry vaccination	x	x		x	
Bird housing	x	x		x	
Health monitoring	x	x			
Poultry feed	x	x		x	
Type / quantity of egg collection	x	x			
eggs classification	x	x			
Biosecurity	x			x	
Construction of the aviary	x			x	
Personal and environmental hygiene	x				
Mandatory registration with competent agencies	x	x	x	x	
Record of all events involved in the process		x	x		x
Product identification at all stages		x			x
Integrated pest management	x	x		x	
Official physical and chemical analyzes		x	x	x	
Batch shipping data (date, invoice, quantity, customer)			x		x

Embrapa's Technical Circular no. 49 and the BPPOs have a guiding character, therefore they are not mandatory, and the quality requirements understood by them assume that safe food is produced in plants where these requirements are met.

The increase in productive potential is directly related to the genetic selection of broiler and laying poultry strains. At the same time, there is an increase in the incidence of diseases and behavioral problems and animal welfare [28] making it necessary to register the requirements for lineage, vaccination of birds, and biosecurity.

Salmonella is often found in poultry products. [29] reported that there is a greater chance of contamination by Salmonella when the product is stored at 30ºC and less possibility when refrigerated at

8ºC. Contamination can occur via shell or during egg formation, from the bird's infected reproductive tract [1]. Based on this information, it is necessary to register the sanitary management requirements of the breeding and rearing phase, sanitary monitoring, egg collection, egg classification.

In the stages of breeding and recreating, collecting egg classifications, sanitary control has a preventive character, providing greater safety to products from establishments that do so, to the detriment of those that do not offer conditions to do so. Besides, in hot climates, with high temperatures for much of the year, animals suffer from climate change, especially in the breeding system in sheds, which require forced ventilation and evaporative cooling through the sprinkling of microdroplets of water to cool the environment and make it more pleasant for birds, as well as a sealing system that reduces air losses and heat exchanges with the external environment. In open warehouses, at a lower cost, the ventilation system is natural, with or without the aid of fans [30], [31].

It is important to record the requirements for poultry feed and input control because the feed is exclusive of plant origin, and the addition of synthetic pigments and growth promoters is prohibited [3]. The acquisition of good quality inputs that meet the needs of birds at different ages is directly related to growth and production efficiency.

The identified requirements are pointed out in two or more standards presented, demonstrating the importance of recording this information in a system of traceability in egg production, whereas they may not be mandatory variables, and may not be adhered to the system of the producer.

When comparing this data with the requirements contained in EU Regulation No. 931/2011 (Official Journal of the European Union) and ISO Standard 22005: 2008 [32], according to Table 2, it is possible to observe that they deal with different requirements, but complementary.

These standards deal with the traceability system and thus point out important informational requirements for the process.

Regarding the necessary characteristics for a traceability system to be executable, [24] identified three basic characteristics: i) batch identification, ii) information about the production process and iii) a system that interconnects this data. For a product to be traceable it must have at least one traceable unit of information, such as the batch. Thus, the important information requirements to be registered are batch identification, documentation of material and information flow, and information retrieval system.

Table 2 - European and certification requirements.

	Standards	
Information requirements	**EU regulation 931/2011**	**ISO 22005:2008**
Product description	x	x
Lot ID	x	x
Shipping date	x	x
Shipping company details	x	
Product target company data	x	
The flow of documented materials and information		x
Records management		x
Information retrieval system		x

The documentation of the flow of materials and information is directly related to the information surrounding a product at the time of shipment, such as the description of the product, the date of shipment, the data of the selling and shipping company, in addition to the lot. In this sense, the registration of this information is essential for the process of tracking the products claimed through the dissemination of information through the later stages of the production chain [4], [7], [5].

European regulation is more specific when it mentions exactly the requirement that must be registered, whereas ISO 22005: 2008 does not specify all its important requirements, so organizations can have different interpretations and their records do not converge when feeding a system. On the other hand, it indicates that the organization has a responsibility to know its suppliers and customers, maintain updated information, meet customer specifications, facilitate consultations in case of product recall and facilitate the verification of information within the organization [33].

5. CONCLUSION

To guarantee the quality of the egg produced and the compliance with the legislation addressed, the traceability system must record quality variables related to health management in the breeding and rearing stages, lineage, input control, vaccination of birds, feeding of birds, health monitoring, information on egg collection, egg classification and biosecurity, associated with the registration of information variables, such as batch identification, material flow documentation, and information, including product description, shipping date, company data sender and data of the destination company, and information retrieval system.

6. ACKNOWLEDGMENT

This work was supported by the Brazilian National Council for Scientific and Technological Development – CNPq and São Paulo Research Foundation – FAPESP.

7. REFERENCES

[1] ALMEIDA, C.A; FRIEBEL, D; DA ROSA, R.B, GELINSKI, J.M.L.N. Avaliação das condições higiênico-sanitárias da casca e gema de ovos in natura. Anuário pesquisa e Extensão Unoesc. Videira, v.2, 2017.

[2] DONATO, D.C.Z; GANDRA, E.R de S.; GARCIA, P.D.S.R; DOS REIS, C.B.M; GAMEIRO, A.H. A questão da qualidade no sistema agroindustrial do ovo. In: CONGRESSO SOBER, 47, 2009, Brasil. Anais... Porto Alegre, 2009. p. 1-13

[3] PIZZUTI, T.; MIRABELLI, G.; SANZ-BOBI, M.A.; GOMÉZ-GONZALÉZ, F. Food Track & Trace ontology for helping the food traceability control. Journal of Food Engineering, v.120, p. 13-30, 2014.

[4] ZHAO. J.; ZHU.C.; ZHENZHEN X. Z.; JIANG, X.; YANG, S.; CHEN, A. Microsatellite markers for animal identification and meat traceability of six beef cattle breeds in the Chinese market. Food Control,

v.78, p. 469-475, 2017.

[5] GOGLIANO SOBRINHO, O; CUGNASCA, C.E.; FIALHO, F.B.; GUERRA, C.C. Modelagem de um sistema de informação para rastreabilidade na indústria do vinho baseado em uma arquitetura orientada a serviços. Engenharia Agrícola. v. 30, n. 1, p. 100-109, 2010.

[6] TENG, W.; MAO, B.; CAO, J. A Multi-level Traceability System Based on GraphLab. Procedia Computer Science, v.91, p. 971-977, 2016.

[7] BADIA-MELIS, R.; MISHRA, P.; RUIZ-GARCÍA, L. Food traceability: New trends and recent advances. A review. Food Control, v.57, p.393-401, 2015.

[8] DENADAI, J.C.; DUCATTI, C.; SARTORI, J.R.; PEZZATO, A.C.; MÓRI, C.; GOTTMANN, R.; MITUO, M.A.O. Rastreabilidade da farinha de carne e ossos bovinos em ovos de poedeiras alimentadas com ingredientes alternativos. Pesquisa Agropecuária Brasileira. v. 44, n. 1, p. 1-7, 2009.

[9] CÂMARA DOS DEPUTADOS. Decreto nº 56.585, de 20 de julho de 1965. Disponível em: http://www2.camara.leg.br/legin/fed/decret/1960-1969/decreto-56585-20-julho-1965-396950-publicacaooriginal-1-pe.html

[10] MAPA (Ministério da Agricultura, Pecuária e Abastecimento). Portaria nº1 de fevereiro de 1990. Disponível em: http://extranet.agricultura.gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=5594

[11] MAPA (Ministério da Agricultura Pecuária e Abastecimento) Resolução nº 5, de 5 de julho de 1991. Disponível em: https://www.google.com/search?ei=7kWEW5W6EYTAwASpnLuwBg&q=Resolu%C3%A7%C3%A3o+N%C2%BA+5%2C+de+5+de+julho+de+1991+&oq=Resolu%C3%A7%C3%A3o+N%C2%BA+5%2C+de+5+de+julho+de+1991+&gs_l=psy-ab.3...1736.1736.0.3155.1.1.0.0.0.0.228.228.2-1.1.0....0...1.1.64.psy-ab..0.0.0....0.q_rXmn8jgtw

[12] MAPA (Ministério da Agricultura pecuária e Abastecimento). Portaria nº 46, de 10 de fevereiro de 1998. Disponível em: http://extranet.agricultura.gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=1139

[13] MAPA. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 56, de 04 de dezembro de 2007. Disponível em: <http://sistemasweb.agricultura.gov.br/sislegis/-action/detalhaAto.do?method=visualizarAtoPortalMapa&chave=1152449158> .

[14] ANVISA (Agência Nacional de Vigilância Sanitária). Resolução Diretoria Colegiada nº35, de 17 de

junho de 2009.

[15] MAPA. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 36, de 06 de dezembro de 2012. Disponível em: <https://www.avisite.com.br/legislacao/anexos/20121012_in20120612.pdf>.

[16] EMBRAPA. Circular técnica nº49: Boas práticas de produção na Postura Comercial. Concórdia/SC: dezembro de 2006, 40p. Disponível em: < https://www.embrapa.br/suinos-eaves/busca-de-publicacoes/-/publicacao/443776/boas-praticas-de-producao-na-postura-comercial>.

[17] ABPA – ASSOCIAÇÃO BRASILEIRA DE PROTEÍNA ANIMAL. Protocolo de Boas Práticas de Produção de Ovos. JUNHO 2008. DISPONÍVEL EM: <http://www.ubabef.com.br/publicacoes?m=82>.

[18] ANVISA – Agência Nacional de Vigilância Sanitária. Resolução de Diretoria Colegiada n° 24, de 08 de junho de 2015. Disponível em: <portal.anvisa.gov.br/.../10181/.../RDC_24.../d0d99450-1152-4f7a-91b9-1130fcb17fa...>.

[19] HOBBS, J.E. Information asymmetry, and the role of traceability system. Agribusiness. v.20, n.4, p. 397-415, 2004.

[20] RINGSBERG, H. Perspectives on food traceability: a systematic literature review. Supply Chain Management: An International Journal, v.19, p. 558-576, 2014.

[21] MOE, T. Perspectives on traceability in food manufacture. Trends in Food Science & Technology.
[22] OLSEN, P.; BORIT, M. How to define traceability. Food Science and Technology, v.29, p.142– 150, 2013.

[23] ANDRADE, J. C.; DELIZA, R.; YAMADA, E. A.; GALVÃO, M. T. E. L.; FREWER, L. J.; BERAQUET, N. J. Percepção do consumidor frente aos riscos associados aos alimentos, sua segurança e rastreabilidade. Brazilian Journal of Food Technology, v. 16, n. 3, p. 184-191, jul./set. 2013.

[24] AUNG, M.M.; CHANG, Y.S. Traceability in a food supply chain: Safety and quality perspectives. Food Control, v.39, p.72-184, 2014.

[25] TARJAN, L., ŠENK, I., TEGELTIJA, S., STANKOVSKI, S., OSTOJIC, G. A readability analysis for QR code application in a traceability system. Computers and Electronics in Agriculture, v.109, p. 1–11, 2014.

[26] LIU, Y.; YANG, J.; LIU, M. Recognition of QR Code with mobile phones. School of information science and engineering. China: University of Jinan, 2008.

[27] CATA, T.; PATEL, P. S; SAKAGUCHI, T. QR CODE: A New Opportunity for Effective Mobile Marketing. Journal of Mobile Technologies, Knowledge and Society. v. 2013, p. 1-7, 2013.

[28] MAZZUCO, H. Ações sustentáveis na produção de ovos. Revista Brasileira de Zootecnia. v.37, p. 230 – 238, 2008.

[29] PINTO, A.T.; SILVA, E.N. Ensaios de penetração de Salmonella Enteritidis em ovos de galinha com diferentes qualidades de casca, submetidos ou não a lavagem industrial e duas temperaturas de armazenamento. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, v.61, n. 5, p.1196 – 1202, 2009.

[30] AMARAL, G. F.; GUIMARÃES, D. D.; NASCIMENTO, J. C. O. F.; CUSTODIO, S. Avicultura de postura: estrutura da cadeia produtiva, panorama do setor no Brasil e no mundo e o apoio do BNDES. BNDES Setorial, Rio de Janeiro, n. 43, p. 167-207, 2016.

[31] FARIA, J. M. Dinâmica estrutural do setor produtivo de ovos: uma análise a partir das empresas líderes brasileiras. Rio Grande do Sul: UFRGS, 2013. 113 p. Dissertação (Mestrado) - Programa de Pós-Graduação em Agronegócios, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013.

[32] MAGALHÃES, A. ISO 22005:2007 – Rastreabilidade na cadeia alimentar. Segurança e qualidade alimentar, n. 3, 2007.

[33] ABNT - ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR ISO 2005. Rastreabilidade na cadeia produtiva de alimentos e rações — Princípios gerais e requisitos básicos para planejamento e implementação do sistema. Rio de Janeiro, p. 14. 2008.