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# Extending The Shelf Life of Ready-To-Eat (RTE) Meat Products by Using Turmeric and Red Ginger as Film Coating of Active Packaging

Adi Sidharta Budi Dharma

Department of Food Technology, Faculty of Engineering, Bina Nusantara University, Alam Sutera, Tangerang, Indonesia

*Corresponding author (adi.dharma@binus.ac.id)

**Abstract**

The high demand for ready-to-eat (RTE) meat products is attributed to their convenience, safe, and healthy properties. The high nutritional content presence in the RTE meat product promotes the presence and growth of microbial pathogens such as Listeria monocytogenes, Escherichia coli, and Salmonella spp. It is considered to be the post-process contamination that is responsible for the shortening of a product's shelf life which leads to spoilage or foodborne diseases. The aim of this systematic review is to develop and summarize the use of red ginger and turmeric bioactive compounds as antimicrobial materials to ensure their quality and extend the shelf-life of RTE beef rendang products. Thus, the current studies of coating technology of bioactive compounds and vacuum-sealed packaging are considered to be combined strategies that develop a more robust active packaging system. In order to gain a better understanding of this research field, a literature search was performed using the electronic databases Oxford Journals, Google Scholar, SAGE Journals, ScienceDirect, and Taylor & Francis which describes 26 primary studies. The findings state that the enhanced active packaging system by using bioactive compounds was associated with a significant prolongation of various RTE meat product's shelf-life of up to 30 days of storage at room temperature. Moreover, the vacuum-sealed packaging in a retort pouch is also considered to improve the food safety environment against microbial contamination.

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## Introduction

In recent years, the consumer's demand for ready-to-eat (RTE) food has significantly increased due to its convenience and healthy properties. The RTE itself refers to the vegetable, dairy, or meat products that have been heat-processed, fully cooked, and consumable with a short preparation time required (Raybaudi-Massilia et al., 2016). Meat has been one of the favorite RTE products that can be a major source of high-value nutrients such as vitamins, minerals, protein, lipids, and bioactive compounds that are essential to maintain the body's function. A wide range of RTE meat products with different compositions, nutritional values, and sensory attributes have been manufactured for the last decade. Beef rendang the most popular traditional food from West Sumatra, Indonesia is no exception to being developed into an RTE meat product. Despite this, the main ingredients of these kinds of product are highly perishable to are exposed to spoilage or pathogenic microorganisms such as *Listeria monocytogenes, Escherichia coli*, and *Salmonella spp.* which make the commercialization of the product difficult to market widely (Horita et al., 2018; Nurmufida et al., 2017). The damage caused by the spoilage microorganism can be reduced by controlling the beef rendang product environment which is the packaging system itself. Furthermore, meat product deterioration can cause a significant economic loss in the meat industry (Domínguez et al., 2018). Therefore, an enhanced active packaging system combined with edible antimicrobial film coating is desirable to ensure the food quality, food safety, stable food shelf-life, food sensory attributes, and functionality of the food products (Song et al., 2021).

The current packaging technology to provide protection for RTE beef rendang products is only intended to encounter lipid oxidation as the main factor of food deterioration. Vacuum-sealed packaging is commonly used to reduce oxidative processes (Colima Galimpin-Johan et al., 2007; Pérez-Santaescolástica et al., 2020). However, this type of packaging is limited by the type of food and is considered to be inadequate to meet food safety and maintain its shelf life efficiently. The packaging can be improved by using active substances that are beneficial to the product inside the packages. In this case, turmeric and red ginger are used as an antimicrobial film coating material by the inner layer of the retort pouch that can reduce microbial contamination, retain the color and aroma of the meat, permit enzymatic activity that could improve tenderness, and prolong the shelf-life of the beef rendang product (Fang et al., 2017). These antimicrobial agents are expected to be slowly released into the food product during food distribution and storage. Eventually, the microbial quality of the beef rendang product can be improved and extend its shelf-life (Chen & Brody, 2013).

The antimicrobial films from turmeric and red ginger that are used for the packaging system are expected to alter and reduce the growth of microorganisms. The main objective of these substances is to act as an alternative to synthetic additives by using some anti-microbial compounds such as essential oils, flavonoids, oleoresin, phenol, curcuminoid, terpenoids, tannins, etc. The use of essential oil often causes a drawback due to its strong odor and undesirable effects on the food product. Therefore, the use of specific antimicrobial compounds from red ginger (*Zingeberon*) and turmeric (*Curcuminoid*) is extracted. It makes it more suitable since red ginger and turmeric are one of the main ingredients of beef rendang which will have a lower effect on the sensory characteristics of the products (Domínguez et al., 2018; Murtius & Hari, 2016). In several studies conducted, *Zingeberon* and *Curcuminoid* are just used to observe the antimicrobial effect of bacteria zone inhibition and can be used as raw material for medicine including food preservatives (Colima Galimpin-Johan et al., 2007; Nurmufida et al., 2017). It is reported that the use of red ginger and turmeric for film coating as part of active packaging material has not been discussed in empirical studies. Therefore, this review will further discuss the film coating formation by using spice-based antimicrobial compounds (Murtius & Hari, 2016).

This systematic review was conducted to develop and summarize the use of red ginger and turmeric bioactive compounds as antimicrobial materials to ensure their quality and extend the shelf-life of RTE beef rendang products. The use of red ginger and turmeric bioactive compound and packaging system was evaluated using qualitative approaches with study literature of benefit and its characterization. The effect of the antimicrobial agent of turmeric and red ginger on the shelf-life of beef rendang products will be evaluated using quantitative approaches of retrieved data. The result of this review is expected to provide the effective design of the RTE beef rendang product packaging system that combines packaging material and bioactive substances in order to meet food safety and help the commercialization of traditional foods across Indonesia (Pérez-Santaescolástica et al., 2020).

## Materials and Methods

### Design

The systematic reviews were intended to develop and summarize the use of red ginger and turmeric bioactive compounds as antimicrobial film coating to extend the shelf-life of RTE beef rendang products. The type of design of this review also covers a comprehensive review, which means not only using the relevant or has a similar object of review to provide a generalized understanding of the topic (Lame, 2019). The method of systematic review was conducted using an explicit method based on PRISMA 2020 reporting guidelines which provide literature mapping (Page et al., 2021).

### Eligibility Criteria

1. Type of study: Systematic literature reviews and journal articles that were published before April 2022.
2. Population: Beef Rendang and similar RTE meat products.
3. Intervention: The use of spices (turmeric and red ginger) that are intended to be the main material for antimicrobial film coating.
4. Comparison: The study that used other types of spices and RTE meat products was included.
5. Outcomes: The effect of the spices film coating on the product, the extended shelf-life of RTE meat product, and the packaging system efficiency.

### Search strategy, study selection, and search string

The early search was conducted from 1 February 2022 until 1 April 2022 by using electronic databases of Oxford Journals, Google Scholar, SAGE Journals, ScienceDirect, and Taylor & Francis Online. Studies that were written in Bahasa Indonesia or English were included and the other studies written in other languages were excluded. The type of publication used in this review is published journal articles, reviews, and book chapters while unpublished studies were excluded due to the limitation of availability and minor quantity.

The search string was developed by using all databases of advanced research that focus on the active packaging of RTE meat products by using antimicrobial film coating. The following terms were used: antimicrobial [All Fields] AND (film layer OR coating [packaging terms]) AND ready-to-eat [All Fields] AND (meat [food product] OR poultry [All Fields] OR muscle food [All Field] AND (active packaging [All Fields] OR food packaging [All Fields] AND shelf-life [All Field] AND active packaging [All Field] AND spices [All Field] AND

(turmeric [All Fields] OR red ginger [All Field]) AND vacuum-sealed [packaging terms].

Data Extraction

The studies were extracted for a series of data for the initial mapping publication characteristics including the author's last name, publication status, year of publication, the main objective or key points, study origin, sample and criteria of subject, type, and design of study characteristics, results, and important notes. The data extraction is conducted to map the overall publications in order to provide a clearer insight of heterogenous articles (Jonnalagadda et al., 2015).

Data Synthesis and Publication Bias

Due to the wide variation in the study method and experimentation, the methodological assessment and factors associated with the data frequency is not possible. The publication bias is not included in this review because of the variation of study design that does not contradict to one another (Jonnalagadda et al., 2015).

**Results and Discussion**

Literature Search and Study Characteristics

The initial literature search of articles and selection process according to the PRISMA result (Figure 1.) in 763 publications that were identified through electronic databases (Google Scholar, Oxford Journals, SAGE Journals, ScienceDirect, and Taylor & Francis) with certain keywords or terms applied as the advance search. About 62 of the duplicate publications are removed. Then 11 records were identified and added through manual searching due to the required relevant data. Furthermore, about 712 publications were screened based on the title and abstract, and 596 papers were excluded for being not suitable and not relevant to the criteria. The 116 potential papers then will be assessed for eligibility in full text, unfortunately, about 6 publications cannot be assessed in full text (closed publication). The 84 papers of them are excluded due to irrelevant methodological and material. Eventually, this systematic review includes 26 publications.

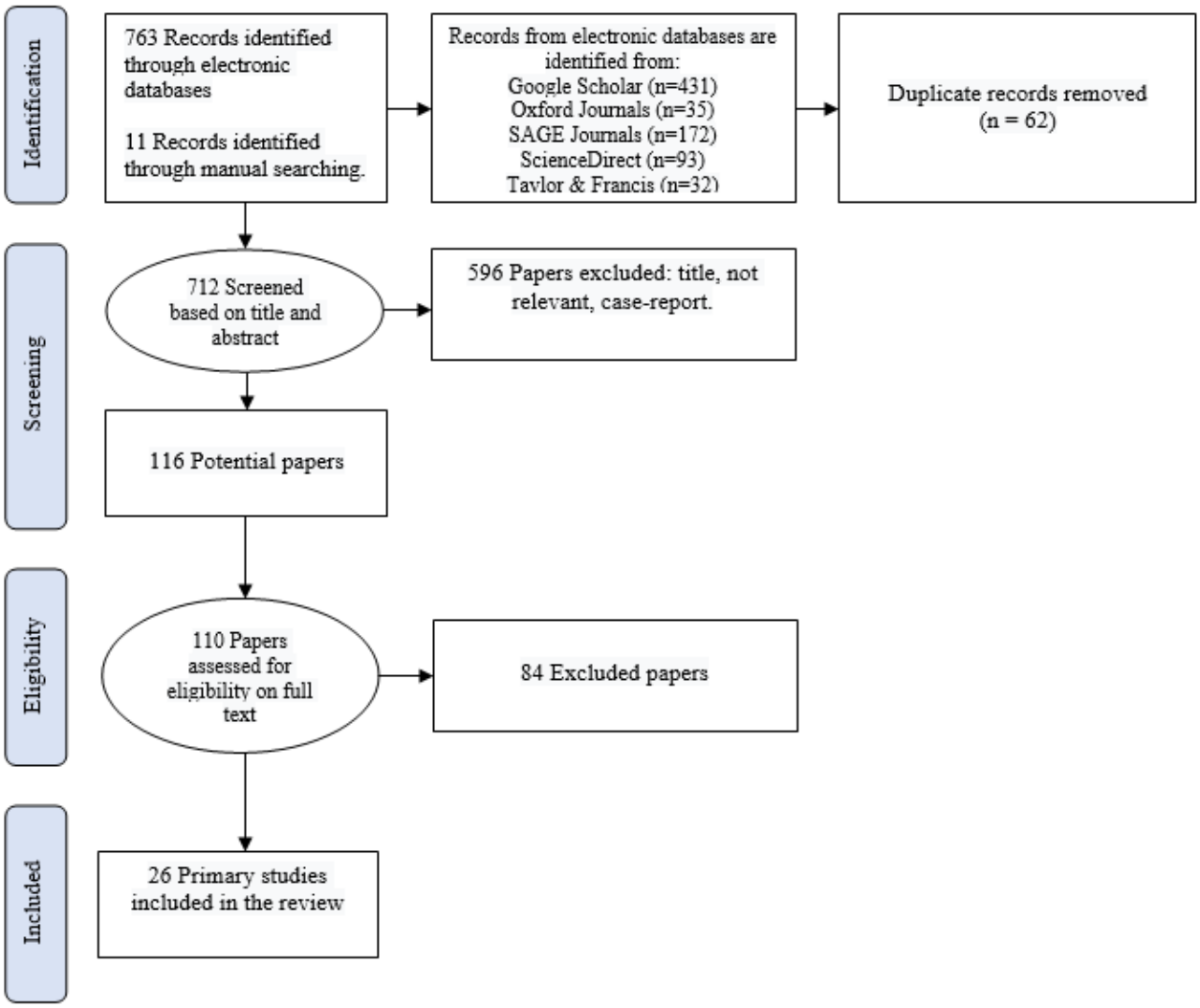


Figure 1. PRISMA Flow Diagram.

Main Outcomes

The antimicrobial effect of turmeric and ginger extract.

Table 1. Effect of antimicrobial of Ginger on Growth of Test Organisms (Kota et al., 2013).

| Spice | Dose (mg/ml) | Test Organism | | |
|---|---|---|---|---|
| | | *E. coli* | *S. aureus* | *S. typhi* |
| Ginger | 1 | + | + | + |
| | 15 | + | + | + |
| | 25 | + | + | + |
| | 50 | + | + | + |
| | 75 | + | + | + |
| | 100 | + | + | + |
| | 125 | + | - | + |
| | 150 | + | - | - |
| | 175 | - | - | - |
| | 200 | - | - | - |

Table 2. Effect of antimicrobial of Turmeric on Growth of Test Organisms (Kota et al., 2013).

| Spice | Dose (mg/ml) | Test Organism | | |
|---|---|---|---|---|
| | | *E. coli* | *S. aureus* | *S. typhi* |
| Turmeric | 1 | + | + | + |
| | 15 | + | + | + |
| | 25 | + | + | + |
| | 50 | + | + | + |
| | 75 | + | + | + |
| | 100 | + | + | + |
| | 125 | + | - | + |
| | 150 | + | - | - |
| | 175 | - | - | - |
| | 200 | - | - | - |

In order to evaluate the use of ginger and turmeric as film coating material, the data given in both Table 1. and Table 2. show the antimicrobial properties that are considered capable of inhibiting or preventing the growth of pathogenic microorganisms in a minimum concentration of 100-125mg/ml. The data only shows the concentration of ginger and turmeric itself; the effectiveness of these antimicrobial properties can still increase by only using the extracted antimicrobial compounds such as *Zingeberon* from ginger and *Curcuminoid* from turmeric. Therefore, these herbs with antimicrobial effects can be of great potential to be added to the films to slow down the RTE beef rendang product spoilage (Kota et al., 2013; Lourenço et al., 2013; Mara et al., 2014).

The film coating material selection

There are several types of polysaccharide-based edible films in meat applications shown in Table 3. The idea of edible packaging film is not meant to substitute or entirely replace the conventional packaging system, but it is intended to provide secondary packaging that improves protection from the atmosphere prevents microorganism contamination, and prolongs the shelf-life of the meat products. However, turmeric and ginger are not capable enough to provide structure as film packaging due to their characteristics. Therefore, based on Table 3 we can observe that chitosan is the most suitable material to be used due to the antioxidant, antimicrobial, inhibited discoloration, and enhanced sensory attributes of the meat product (Bharti et al., 2020).

Table 3. The polysaccharide-based edible films and coatings in meat applications.

| Raw Material | Incorporation to Matrix | Meat Product | Packaging Type | Main Effect | Reference |
|---|---|---|---|---|---|
| Cellulose | Casting | Minced camel meat | Direct Contact | Antioxidant<br>Antimicrobial<br>Increased shelf-life | (Aminzare et al., 2019; Bharti et al., 2020; Domínguez et al., 2018; Song et al., 2021) |
| Starch | Casting | Fresh beef | Direct Contact | Antioxidant<br>Antimicrobial<br>Increased shelf-life | |
| Pectin Gum | Casting | Ham and Sausage<br>Fresh Meat | Headspace | Antioxidant<br>Antimicrobial | |
| Alginate | Spraying (Coating) | Beef Steaks<br>Buffalo Meat Patties | Direct Contact | Antimicrobial<br>Inhibited discoloration<br>Decreased water losses | |
| Carrageenan | Spread (Coating) | Chicken Breast | Direct Contact | Antioxidant<br>Antimicrobial<br>Increased shelf-life | |
| Chitosan | Coating | Dry Fermented Sausage<br>Cooked Sausage<br>RTE Meat Product | Direct Contact | Antioxidant<br>Antimicrobial<br>Inhibited discoloration<br>Enhanced sensory attributes | |

Since the beef rendang was used in vacuum-sealed packaging in a retort pouch, the chitosan film characteristic is capable of enhancing the emulsifying effect, maintaining color stabilization, and clear, flexible, and also good resistant to oil and fat which makes it very suitable (Song et al., 2021).

Discussion of the RTE meat product shelf-life

This review aims to provide an overview of the use of red ginger and turmeric bioactive compounds as active packaging material to extend the shelf-life of beef rendang products. From various observed literature studies, the use of spices including turmeric and red ginger is a very promising treatment to enhance the nutritional quality and provide protection to the RTE meat product. The food packaging system of beef rendang is improved by using vacuum-sealed packaging in a retort pouch which is flexible laminated food packaging. It is expected to meet the extended shelf-life of beef rendang from 7 days of classical fresh-prepared beef rendang into 30 days of shelf-life in the retort pouch that has been through high temperature and pressure of sterilization process prior to the packaging. Furthermore, by knowing the quality parameters of beef rendang is very sensitive to acidity, heat, oxygen, microbial activity, and light. In addition to the vacuum-sealed retort pouch, the film coating of turmeric and red ginger bioactive compounds in the inner retort pouch can also prolong the shelf-life due to the oxidation-reduction and antimicrobial properties (Frediansyah et al., 2017).

## Conclusion

In this updated systematic review, the vacuum-sealed retort pouch with an antimicrobial coating of turmeric and red ginger has significantly prolonged the RTE beef rendang product shelf-life by up to 30 days of storage at room temperature. The combination of both vacuum conditions and film coating in the retort pouch has been proven to prevent oxidation and reduce microbial activity in the RTE meat product.

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## References

Aminzare M, Hashemi M, Ansarian E, Bimkar M, Azar HH, Mehrasbi MR, Daneshamooz S, Raeisi M, Jannat B, Afshari A. 2019. Using natural antioxidants in meat and meat products as preservatives: A review. Advances in Animal and Veterinary Science. 7(5): 417-426. DOI: 10.17582/journal.aavs/2019/7.5.417.426

Bharti, S. K., Pathak, V., Alam, T., Arya, A., Basak, G., Awasthi, M. G. 2020. Materiality of Edible Film Packaging in Muscle Foods: A Worthwhile Conception. Journal of Packaging Technology and Research 4(1): 117–132. DOI: 10.1007/S41783-020-00087-9

Chen, J., & Brody, A. L. 2013. Use of active packaging structures to control the microbial quality of a ready-to-eat meat product. Food Control 30(1): 306–310. DOI: 10.1016/j.foodcont.2012.07.002

Colima Galimpin-Johan, S. M., Rahman, R. A., Jamilah, B., Bin, Y., Man, C., Rusul, G., Galimpin-Johan, S. M. C. 2007. Pasteurization, development, and storage of sous vide rendang (spicy beef stew). Journal of Food Service 18: 251-263. DOI:10.1111/J.1745-4506.2007.00071.X

Domínguez, R., Barba, F., Gómez, B., Putnik, P., Kovacevik, D. B., Pateiro, M., Santos, P. M., Lorenzo, J. M. 2018. Active packaging films with natural antioxidants to be used in meat industry: A review. Food Research International: 1-34. DOI:10.1016/j.foodres.2018.06.073

Fang, Z., Zhao, Y., Warner, R. D., Johnson, S. K. 2017. Active and intelligent packaging in meat industry. Trends in Food Science and Technology 61: 60–71. DOI: 10.1016/J.TIFS.2017.01.002

Frediansyah, A., Praharasti, A. S., Kusumaningrum, A., Nurhikmat, A., Susanto, A., Khasanah, Y., Nurhayati, R. 2017. Application of static retort thermal processing technology for dried beef Rendang production: Evaluation of its post-processing on microbiological and physicochemical properties. AIP Conference Proceedings: 1788. DOI: 10.1063/1.4968362

Horita, C. N., Baptista, R. C., Caturla, M. Y. R., Lorenzo, J. M., Barba, F. J., Sant'Ana, A. S. 2018. Combining reformulation, active packaging, and non-thermal post-packaging decontamination technologies to increase the microbiological quality and safety of cooked ready-to-eat meat products. In Trends in Food Science and Technology 72: 45–61. DOI: 10.1016/j.tifs.2017.12.003

Jonnalagadda, S. R., Goyal, P., Huffman, M. D. 2015. Automating data extraction in systematic reviews: A systematic review. Systematic Reviews 4(1): 1–16. DOI: 10.1186/S13643-015-0066-7/TABLES/3

Kota, N., Tattari, S., Technical Officer, S., Nimgulkar MPharm Scholar, C., Polasa, K., Panpatil, V. V., Nimgulkar, C. 2013. In vitro evaluation of antioxidant and antimicrobial activity of spice extracts of ginger, turmeric and garlic In vitro evaluation on antioxidant and antimicrobial activity of spice extracts of ginger, turmeric and garlic. Article in Journal of Pharmacognosy and Phytochemistry 2(3): 143–148.

Lame, G. 2019. Systematic literature reviews: An introduction. Proceedings of the International Conference on Engineering Design 2019: 1633–1642. DOI: 10.1017/DSI.2019.169

Lourenço, T. C., Mendonça, E. P., Nalevaiko, P. C., Melo, R. T., Silva, P. L., Rossi, D. A. 2013. Antimicrobial effect of turmeric (*Curcuma longa*)

on chicken breast meat contamination. Brazilian Journal of Poultry Science 15(2): 79–82. DOI: 10.1590/S1516-635X2013000200002

Mara, G., Gonçalves, S., Henrique Da Silva, G., Pedro., Barros, P., Silvana., Srebernich, M., Fernanda., Tonon, R., Daniella., Fiore, S. 2014. Antimicrobial effect and enzymatic activity of extract of *Zingiber officinale Roscoe* and stability in topical preparations. Journal of Basic and Applied Pharmaceutical Sciences Rev Ciênc Farm Básica Apl 35(2): 205–210.

Murtius, W. S., & Hari, P. D. 2016. The properties of *Zingiberaceae* starch films for *Galamai* packaging. International Journal on Advanced Science, Engineering, and Information Technology 6(2): 221–225. DOI: 10.18517/ijaseit.6.2.710

Nurmufida, M., Wangrimen, G. H., Reinalta, R., Leonardi, K. 2017. Rendang: The treasure of Minangkabau. Journal of Ethnic Foods 4(4): 232–235. DOI: 10.1016/j.jef.2017.10.005

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., Moher, D. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ: 372. DOI: 10.1136/BMJ.N71

Pérez-Santaescolástica, C., Munekata, P. E. S., Feng, X., Liu, Y., Bastianello Campagnol, P. C., Lorenzo, J. M. 2020. Active edible coatings and films with Mediterranean herbs to improve food shelf-life. Critical Reviews in Food Science and Nutrition: 1-13. DOI: 10.1080/10408398.2020.1853036

Raybaudi-Massilia, R., Mosqueda-Melgar, J., Soliva-Fortuny, R., Martin-Belloso, O. 2016. Combinational edible antimicrobial films and coatings. Journal of Antimicrobial Food Packaging 52: 633-646. DOI: 10.1016/B978-0-12-800723-5.00052-8

Song, D.-H., Hoa, V. B., Kim, H. W., Khang, S. M., Cho, S.-H., Ham, J.-S., Seol, K.-H., Kim, H. W., Khang, S. M., Cho, S.-H., Ham, J.-S., Seol, K. H., Farris, S. 2021. Edible Films on Meat and Meat Products. Coating 11: 1344. DOI: 10.3390/coatings11111344