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Review Article

Pork DNA Contamination in Pharmaceutical Products: A Review

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ABSTRACT

Objectives: A country with a muslim majority population, halal in food product as well as no food product including pharmaceutical product has been main concerned. Several materials which used on pharmaceutical product such as gelatin, collagen and fat content synthesized or extracted from mammalia such as bovine, fish, and also porcine. Product sourced from pork and its derivatives was prohibited for muslim . This review presents about methods to detect pork content in pharmaceutical products and information about pharmaceutical products that are positively contaminated with pork ingredients and their derivatives related to halal status for muslims.

Data Sources Study Selection: The method used in this research was study of literature. Literatures used in this paper were based on publication of the last ten years (2010-2020). Data sources of this review article taken from various online journal search sites such as digital library, Google, Google Scholar, PubMed, Science Direct, and E-Resources.

Conclusion: Conclusion: A result of this review were found 36 capsule samples, 7 gelatin of soft candy gelatin, 4 cosmetic product, amniotic fluid, placenta, oleic acid, stearate acid/stearic alcohol, lanolin alcohol and propylene glycol are positive contain pork DNA. The analytical method used to detect the content of pork and its derivatives in pharmaceutical products such as PCR, HPLC, Nano UPLCESI-Q-TOFMS, FTIR, Liquid Chromatography–Tandem Mass Spectroscopy, Liquid Scintillation Counting, PEME, ELISA, and SDS-PAGE Both Conventional and Combined.

Keywords: Pork DNA, Pharmaceutical products, Cosmetic product, Detection method.

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INTRODUCTION

Halalan-toyyiban is a concept in Islamic law. Halal products are products whose basic ingredients are not at risk of being bad for health. Recently, Halal term was not only for food product, but also for non food product[1]. In Islam perspective, halal was focus in allow or not allow product to consumption, because by consuming non halal product could affect to our health and behavior[1,2]. Halal has become a global concern, especially for muslim that aware of food, beverages, insurance, leather products, pharmaceuticals and cosmetics[3,4]. Islam advocates for consumption of halal products including cosmetics[5,6,7].

A country with a muslim majority population such as Indonesia, halal food has become the main concern, it is food or non-food product such as cosmetic, and pharmaceutical products. Identification of halal product is very important due to in islam not allowed to consume product (food or non-food) sources porcine[8,9,10]. Food, medicine and cosmetic product must be certified halal[11]. According to BPOM[12] material sourced from pork must include information that the material come from pork and include a special sign containing pork, and/ or in the manufacturing process it has contact with pork-sourced ingredients.

Gelatin is an ingredient that is widely used in pharmaceutical products (capsule shells and cosmetic) and food[13,14]. However, commercial gelatin is sources from skin and bone of mammals (mainly porcine)[15]. Beside gelatin, lard (LD) or pig fat content numerous applications in pharmaceutical products, food and cosmetic as thickening agent (increase viscosity). Food and Drug Administration (FDA) has determined LD as a safe ingredient for use in food and cosmetic products[16]. However, cosmetic products contaminated with lard are prohibited to use by followers of certain religions, one of which is Islam[17]. Collagen (protein synthesized from meat

or mammalian connective tissue) which is added to cosmetic formulations[18] also still doubt the halal due to commercial collagen generally sources from bovine and porcine bone[19,20,21,22]. Several cosmetic of animal origin such as lecithin, glycerol, and fatty acid also still doubt the halal[23,24].

The importance of pharmaceutical products (medicines and cosmetics) from non-halal ingredients (pig and its derivatives) must be known by using a valid detection method. This review looks at both Pharmaceutical product that is positively contaminated with pork ingredients and the method can be used to detection of pig contents for halal status which is very important for muslim .

METHODS

The method that use by the authors in this review is by conducting literature studies both domestically and abroad. The literature is taken from various online journal search sites such as digital library, Google, Google Scholar, PubMed, Science Direct, and E-Resources with keyword "porcine gelatin", "pig fat", "pork DNA", and "halal detection" it is combine with keyword "detection method", "pharmaceutical products", "detection of gelatin source capsules", "detection of fat sources in medicinal products", "detection of pig DNA content in cosmetic products", and "detection of pig DNA in pharmaceutical raw materials", but the authors still ensure that the quality of the journal meets academic standards. The literature taken is related to pharmaceutical products (medicines and cosmetics) which are susceptible to contamination by pork products or pig DNA, be it finished products, active ingredients or additives.

In this review paper the author refers from Manikas & Hansen[25], it is five inclusion and exclusion criteria in selecting literature, such as: 1. The literature should address pork DNA in of pharmaceutical products as an area of research, 2. Be research papers, i.e. being published in a scientific per reviewed venue, 3. Be written in english, 4. The literatures used have publication span of the last ten years (2010-2020), except it is very important literature, and 5. The literature used should not have a broad abstract perspective, and too short a discussion. Although the discussion is global, it should still focus on the contamination of pig DNA in pharmaceutical products.

Study on the halal source of pharmaceutical product ingredients must be carried out, it is very importance information especially for muslim majority population country. Nikzad[26], have found 12 capsule product contains pork DNA by used Duplex PCR and Widyadat[27], the result by used RT-PCR have found pork DNA contents on day cream raw materials, beauty soap and bread brush. By this study was found several method analysis that can be used to detection of pork DNA contents on pharmaceutical products and cosmetic. Also about information of pharmaceutical products that positive contaminated with pork DNA.

RESULTS AND DISCUSSION

1. Pharmaceutical product and raw materials for pharmaceutical products contaminated with pork DNA

Country	Samples	Method	Result	Author(s)
Iran	12 hard capsule shells and 12 soft capsule shells from a capsule preparation containing the drug	Duplex PCR and Simplex PCR Other methods: HPLC and RT-PCR	From 24 samples of hard capsules and soft capsules, 12 samples contained pig DNA in both PCR methods, such as: Omeprazole, Lansoprazole, Paracetamol, Pancreatic, Duloxetine, Multivitamin Mineral, Adult Cold, Liver Oil, and Fish Oil	26, 28, 29, 30, 14, 31
Malaysia	82 hard capsule shells and 31 soft capsule samples in the form of OTC obtained from local products in the Selangor region, Malaysia	Multiplex PCR Amplification for Southern Hybridization Analysis	From 113 samples of hard and soft capsules, 42 samples were obtained containing pig DNA such as: Hard capsule: Fibric Acid derivative; antiinflammatory herbs; Sulpiride; Doxymycin; Ginseng; Mefenamic Acid; Bitter ground Seed; Vitamin D3; Slimming Purposes; Ursodeoxycholic Acid; Nutrients, and antioxidants; as well as medicines. Soft capsules: Calcium, Magnesium, and Zinc; Omega-3; Vitamin E-200; Steroids; Fish Oil; Vitamin E; and Garlic.	13
	20 capsule brands (hard capsules and soft capsules)	PCR-Southern Hybridization on Chip and PCR Conventional	In the Conventional PCR method, no samples containing pig DNA were found. However, by using PCR-Southern Hybridization on Chip method were found 6 positive capsule brands containing porcine DNA (3 hard capsules and 3 soft capsules)	32

	Gelatin DNA from Marshmallows (17 samples from Turkey), Gummy Drop (11 samples from Turkey and 11 samples from Germany), Jelly (3 samples from Turkey), and Turkish Delight (1 sample from Turkey)	RT-PCR Another method: NanoUPLCESI-QTOFMS	Marshmallow imported from Turkey found 1 sample containing pork DNA and the Gummy Drops found 2 samples from Germany positive for pork DNA. Meanwhile, Jelly and Turkish Delight products were all negative samples containing pork DNA	33, 34
	Gelatin DNA from Gummy Sweets (10 samples), Dietary Supplements (5 samples), Candy and Pastilles (10 samples), edible Gelatin Powders (2 samples), Jellies, and Puddings (3 samples), and Yogurt (5 samples), Gummy Vitamins	TaqMan Probe Based Multiplex Quantitative PCR Assay Another method: Multiplex Endpoint PCR, RT-PCR Evagreen, Combination of Fourier Transform Infrared Spectroscopy (FTIR) and Principal Component Analysis (PCA), PCR-RFLP	From 35 test samples, it was found that 5 positive samples contained pork gelatin such as Yupi Gummy Pizza from Indonesia, Darry's Strawberry Gummy, Lot 100 Happy Mix Gummy, Sour + Cocoaland, and Jelly Bean from Malaysia that were positive for pork DNA	35, 36, 37, 38, 39
Malaysia, Bnaglades, and Singapura	20 hard capsules and 10 soft capsules obtained from several pharmacies in Malaysia, Bangladesh and Singapore	Multiplex PCR-RFLP and HPLC	From 30 capsules, 3 capsules were found containing pork DNA, namely Fimoxyl, Flubex, and Multivitamins. 27 other samples not contain pork DNA	40
	Elizavecca Green Piggy Collagen Jella Pack Pig Mask Cream, Collagen Product (100 mL), Brightening Cream SPF15 with authorized Halal logo (100 mL), Collagen Hand Cream (100 mL), Whitening Face Cream (100 mL), and Collagen Plus Vit E Day and Night cream (100 mL)	PCR Another method: TaqMan Probe Real Time Polymerase Chain Reaction	Elizavecca Green Piggy Collagen Jella Pack Pig Mask Cream, Collagen Product (100 mL) and Collagen Hand Cream (100 mL) positive contain pork DNA	41, 42
Indonesia	100 mg of slimming capsule shells obtained from the Yogyakarta Kranggan market	PCR and HPLC	Pork DNA contamination was found 16.67% using PPA 8 primer, and 90% using pork primer	43, 44
	Capsules, bread brush, day cream, and beauty soap	Real Time-Polymerase Chain Reaction (RT PCR) and HPLC	Content of pork DNA was found in ingredient for made day creams, beauty soaps and bread brushes with contamination from 3.15% -124.83% by using RT-PCR.	27
Global Reseach	Cosmetic Ingredient	Liquid Chromatography-Tandem Mass Spectroscopy, Liquid scintillation counting, Spectroscopy (IR/FTIR), PEME, ELISA, SDS-PAGE, Sandwich ELISA	Amniotic fluid, Gelatin, Placenta, Collagen, Oleic Acid, Steric Acid/Stearic Alcohol, Lanolin Alcohol, Glycerin/Glycerol, and Propylene Glycol	23, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55

2. Identification of pork DNA in capsule shell gelatin and soft candy

Gelatin is one of basic ingredients in pharmaceutical, cosmetic, biomedical, and food. Gelatin was used as a thickening agent in made hard and soft capsule shells[56,57]. Gelatin was made from partially denatured collagen extracted from skin, bone, and connective tissue from animals (bovine and porcine).[58]. However, in fact most of the capsule shells that used for pharmaceutical packaging has made from pork tissue because it is cheaper, stronger, more stable, and has a short manufacturing time[13].

The medicine coated with gelatin is an innovative pharmaceutical product that makes it easier for patients to swallow capsules without worry about irritation. In addition, capsules could protect medicine from temperature and light effect[31]. Previous studies have reported that capsule-based pharmaceutical products are easily carried out by adulteration[59,26,31,60]. Gelatin

adulteration was used by companies to obtain gelatin which is in good texture and low production costs[40]. Where as in terms of labeling, the inclusion of the gelatin source used must be made honest and clear[59]. Based on this, a method is needed to determine the halal source of gelatin.

DNA is a molecule that is stable, heat resistant and detectable even in fragments. DNA-based detection can be used to determine the presence of impurities in a product and to determine the source of the gelatin product material[61]. Molecular-based technique using mitochondrial DNA (mtDNA) is an effective technique because it produces many copies and adequate polymorphisms[62,63]. Detection of the type and amount of DNA could be done using a polymerase chain reaction (PCR) based method. This method has the advantage of a high level of sensitivity and specificity as well as a fast process. However, the quality of DNA was of great concern when using this method, because DNA damaged by heating greatly affects the results[65,66].

DNA-based techniques are commonly used in quantitative and qualitative tests of samples containing DNA. This technique has a high sensitivity (up to 0.1%), more specific results and less risk of contamination[35,67]. Cai[66] reported that testing with two species-specific quantitative-PCR (qPCR) method showed specific results in quantitative and qualitative tests on the presence of porcine and bovine DNA in the mixture in capsule shell gelatin. This method could detect contamination in the gelatin mixture (bovine+porcine) up to 1.0%. Mutalib[31] conducted a halal test of 20 capsule brands used the PCR-Southern Hybridization on Chip Hybridization method and Conventional PCR. From this test, it was found that with PCR-Southern Hybridization on Chip method, 6 capsules containing DNA were detected. However undetectable in Conventional PCR methods.

Sultana[40] have developed Novel PCR-RFLP Multiplex test to examine the types of animal DNA contained in gelatin capsules in 20 hard capsule products and 20 soft capsule products obtained from several pharmacies in Malaysia, Bangladesh and Singapore. From the results of the study, it was found that 3 positive capsules contained pork DNA, namely Fimoxyl, Flubex and Multivitamins even though there was a halal logo on the capsules. Another 27 products tested positive for bovine DNA. Capsules containing gelatin show a clear band on the agarose gel, The DNA of each product that has been extracted is tested for halalness by being digested in the RFLP system and it is found that the similarity of the base sequence is 99-100% with Susscrofa. In addition, Conventional Duplex PCR method (semi-quantitative) can also be used to detect porcine DNA fragments (more than 100 bp) from the shells of hard and soft gelatin capsules (including capsules containing medicines) with a sensitivity level of 0.1% using the duplex PCR method 35 cycles[26,68]. Based on the results of research reported by Nikzad[26], by conducting tests on hard and soft capsule shells on pharmaceutical products from various brands/companies. Samples were tested using simplex PCR, Duplex PCR and Real-Time PCR, and DNA kits were also used to detect pork DNA. Based on the study were found two trademarks that contaminated with porcine gelatin, among them Omeprazole, Duloxetine (positive with 9.6 µL of DNA extract/20 µL of PCR reagent).

The halalness of pharmaceutical products such as capsules could be determined by the Multiplex PCR amplification for Southern Hybridization Analysis method. The combination of both methods was used OLIPRO Biochip Porcine Gene showed a highly specific and sensitive. A total of 113 samples with extracts were used in testing the halalness of capsules for gelatin-based pharmaceutical products using this technique. It was found that 42 positive samples contained porcine DNA (with the extract used of 10 µl from 50 ng DNA templates)[13]. Mutalib[31] also conducted halal tests on 20 capsule brands in Malaysia and found that there were 6 positive capsule brands containing pork DNA using the PCR southern hybridization method and no positive samples were found using conventional PCR methods and no positive samples were found using the conventional PCR method. Aviani[43] conducted a study on 100 mg of slimming medicine capsule shells that isolated by the Boom modification method and then DNA contamination was measured by PCR method. The resulting DNA has high purity. It is indicated by the amount of DNA obtained from positive control of 42.1 69.0 ng / µl. Based on research conducted by Aviani, it was found that the contamination of pig DNA in the capsule shell reached 90%.

Besides the PCR method, there was another method, namely the FTIR (Fourier Transform Infrared) Spectroscopy method. Hashim[49] reported that FTIR Spectroscopy method was able to differentiate gelatin derived from porcine and gelatin from bovine. Based on that studies, it was also known that FTIR Spectroscopy could be used for gelatin classification.

Testing of the halal source of gelatin in a product can also be carried out using a combination of chromatography and chemometric methods. Nemati[69] reported that 14 porcine gelatins and five beef gelatins with PCA Amino Acid Profile obtained from (RP) HPLC-Fluorescence Analysis of gelatin acid hydrolysis. There were 20 peaks detected by HPLC analysis, there was one peak indicating the presence of bovine gelatin. Widyaninggar70 have developed a method by used chemometric analysis of the HPLC-Fluorescence detection profile of amino acids in distinguishing between bovine and porcine content in gelatin from capsule shells. Amino acids in gelatin capsule shell obtained by hydrolysis HCL. The amino acid levels obtained were dependent on the gelatin source and the PCA score plot PC1 and PC2, that were 64.4% (porcine gelatin) and 15.7% (bovine gelatin). Based on these results, it was concluded that PCA amino acid profile of HPLC could be used to detect the halalness of gelatin.

Besides capsule samples, the halal source of gelatin which is one of ingredient in production of pharmaceuticals and cosmetics could also be analyzed on soft candy preparations, as in a study conducted by Dermihan[33] by

Real Time-PCR method, with a target of cytochrome b using a special porcine primer, the SureFood® PREP Animal system was used in the extraction and purification of DNA from gelatin and RT-PCR used the SureFood® Animal ID Pork Sens device. The minimum detection limit was 1.0% b/b. The samples included chewing gum, marshmallows and turkish food, which are believed to contain gelatin. From fourteen samples, it was found that Marshmallow samples imported from Turkey were positive for pork DNA and in the gummy drops, 2 samples from Germany were found to be positive for pork DNA. Meanwhile, jelly and turkish delight products were all negative samples containing pork DNA. Sultana[35] also performed detection of animal sources of gelatin-based products by using TaqMan probe based Multiplex Quantitative PCR Assay method to differentiate gelatin species from bovine, porcine, and fish in samples with a limit of 0.005 ng/µL and authenticity level of 99-100. From 35 test samples, it was found that 5 positive samples contained pork gelatin, such as Yupi gummy pizza from Indonesia, Darry's Strawberry Gummy, Lot 100 Happy mixgummy, Sour+Cocoaland, and Jelly Bean from Malaysia that were positive for pork DNA.

3. Halal identification of sources cosmetics ingredients

Generally, cosmetics was produced from derived ingredients from animals or plants. Halal cosmetics are products that do not contain haram animals, alcohol, animal fats, as well as dangerous chemicals and other ingredients that are haram in nature[71,72] . Some cosmetic ingredients whose sources are expected from pigs including amniotic fluid, gelatin, placenta, collagen, oleic acid, stearic acid/alcohol stearate, lanolin alcohol, glycerin/glycerol, propylene glycol, fats and fatty acids [73,74,23,75]. Lard (LD) is a porcine derived substance taken from adipose tissue. In cosmetic products, LD were used as an ingredient for the formulation of skin care and make-up products such as eyebrow pencils, eyeliner and lipstick. it is functions as an emulsifying, moisturizing, occlusive, viscosity-enhancing agent[75].

In Islamic law, muslim should to consume halal and healthy products, including about ingredients sources and production process of cosmetics[76]. The analytical steps for testing the halalness of cosmetics include preparation of lard component in cosmetics, extraction of lard from cosmetic samples using the Soxhlet, Bligh, and Dyer or Folch extraction methods, FTIR spectrum acquisition, development calibration, model validation, model evaluation, and finally analysis of lard in samples [77].

Lipstick is a cosmetic product that is widely used, especially for women. For women, using lipstick on their lips increased self-confidence. Waskitho[78] reported that it has proven the presence of lard or it is derivatives in lipstick formulations using the FTIR Spectroscopy method that combined with multivariate analysis of principal component analysis and least squares. The extraction method used in this study was bligh and dryer because it was considered better than other extraction methods. In a previous study using FTIR Spectroscopy has been done in the testing of purity coconut oil is used as an emulsifying agent in the manufacture of cosmetic creams and in a mixture of coconut oil and lard[79]. FTIR spectroscopy method was carried out to detect contamination of pork and its derivatives in food and non food. Infrared spectroscopy is a standard method of chemistry that provides vibrational images of atomic compounds[80,81]. In previous research, FTIR Spectroscopy was used to detect non-halal ingredients (lard) in food ingredients such as chocolate and cakes. In non-food products such as cosmetics, this method was used to detect contaminants in virgin coconut as an emulsifier system in cream formulations[79] . This method was chosen because of fast, simple sample preparation and also sensitive.

Based on research results of Lukitaningsih[82] reported that they had succeeded in calculating and classifying the lard content in cosmetic lotions using the PLS and PCA methods in the frequency region between 1,200–1,000 cm-1. Samples of fat that contained in the lotion was extracted using emulsifying hydrolysis with concentrated HCl. Furthermore, the extract obtained was determined using FTIR spectroscopy. Rohman[83] also reported that the lard content in the olive oil mixture in cosmetic cream, could be detected using the same method.

The success of analysis using the molecular spectroscopy method is the development of chemometric software on complex and overlapping spectra used for data processing[89]. FTIR Spectroscopy method has drawbacks in terms of detection of lard commercial nano technology cosmetic products because FTIR Spectroscopy can only be used for certain formulations[89].

Beauty products such as cosmetic creams are also susceptible to porcine contamination. This is indicated by Ghani42 were able to prove and detect the presence of lard in cosmetic creams using the TaqMan Real-Time PCR. Based on research conducted by Widayat27 on samples of caspul, bread brush, day cream, and beauty soap on the market with concentrations of 2.2 - 3.4 ng/µL. Analysis was carried out in two stages, first, extraction to obtain a DNA solution for analysis and next analysis, using RT-PCR at a temperature of 600 with 40 repetition and pork DNA content was found in samples of day cream, beauty soap, and bread brush of 3,15-124,83 %. Kim[84] used RT-PCR to detect the presence of pork DNA in cosmetics (liquid masks, powder masks, and cosmetic creams), In this study it was stated that the extraction of porcine DNA in cosmetics was determined by the type of cosmetics, and the RT-PCR method was suitable for analyzing cosmetic samples. The use of RT-PCR method has also been widely used in previous studiessuch as research conducted by to detected and calculated content of porcine and bovine in gelatin mixture[67], detected pork DNA in gelatin contained in processed foods[59], detected alcohol and pork content in pharmaceutical excipients and medicinal products[83], DNA-based analy sis with Real Time PCR[86], identified adulteration of meatballs with pork. This RT-PCR method has the advantage of being more sensitive, specific[88,89,90,91], and can analyze large

numbers of samples in a fast time[92]. Erwanto[93] and Erwanto[94] also examined pork DNA in meatballs using Polymerase Chain Reaction-Restric-tion Fragment Length Polymorphism (PCR-RFLP) method.

Several methods for detecting the presence of pork ingredients in a product have been extensively studied such as detection technique is broadly categorized as high Performance Liquid Chromatography (HPLC)[17,70], Flighttime-Fly-MS Liquid Chromatography Ultra-Performance[95] , Liquid Chromatography Ultra-Electrospray Performance of Quadrupole Ionization MS Flight time[34], HPLC/MS/Orbitrap linear ion traps[96] or Biochemical Engineering, Conventional Duplex Polymerase Chain Reaction (PCR)[26] , PCR Restriction Multiplex Fragment Length Polymorphism[40], By using an Electric Nose, the results will be seen in the form of a VaporPrintTM[97], Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis[98], as well as a chemometric methods[99] .

The research conducted to detect non-halal content in cosmetic products has not been as much as in food or medicinal products. From the literature, it was found that most of the detection was carried out on ingredient originating from pork, such as lard and its derivatives. However, a few discussed of other non-halal ingredients such as placenta, lanolin, albumin, etc. This is due to the lack of awareness and knowledge of the muslim community regarding the criteria for halal cosmetics[100].

CONCLUTIONS

Halal products have become an important concern for muslim consumers, not only for food products but also for non-food products such as medicines and cosmetics. Pharmaceutical and cosmetic products are not free from contamination of non-halal ingredients in them. Sereval capsule products, food products containing gelatin, cosmetic products, and ingredient for medicines and cosmetics were found contain with pork DNA such as 12 capsules of Omeprazole, Lansoprazol, Paracetamol, Pancreatin, Dulocetine, Multivitamins, Minerals, Adult Cold, Liver Oil, Fish Oil, 42 hard capsules of Fibric Acid derivatives, anti-inflammatory herbs, Sulpiride, Doxymycin, Gingseng, Mefanamic Acid, Bitterground Seed, Vitamin D3, Slimming purposes, Ursodeoxycholic acid, Nutrients and Antioxidants, and medicines, soft capsules of Calcium, Magnesium, and Zinc, Omega-3, Vitamin E-200; Steroids, Fish Oil; Vitamin E; and Garlic, Fimoxyl, Flubex, and Multivitamin capsules, slimming capsules obtained from the Yogyakarta kranggan market, 6 positive capsule brands containing pork DNA (3 hard capsules and 3 soft capsules), 1 sample marshmallow imported from Turkey, 2 samples of Gummy Drops from Germany, Yupi Gummy Pizza from Indonesia, Darry's Strawberry Gummy, Lot 100 Happy Mixgummy, Sour+Cocoaland, and Jelly Bean from Malaysia, Elizavecca Green Piggy Collagen Jella pack pig mask cream collagen product (100 mL), and Collagen Hand Cream (100 mL), the content of pork DNA is found in the ingredients for making day creams, beauty soaps and bread brushes with a contamination 3.15%-124.83%, Amniotic Fluid, Placenta, Oleic Acid, Stearic Acid/Stearic Alcohol, Lanolin Alcohol, Glycerin/Glycerol, and Propylene Glycol.

The analytical method that can be used to detect pig contamination in pharmaceutical products among them Conventional PCR methods, TaqMan Probe Real-Time Polymerase Chain Reaction, Real Time-Polymerase Chain Reaction (RT PCR), RT-PCR, TaqMan Probe Based Multiplex Quantitative PCR Assay, RT-PCR Evagreen, Simplex PCR, Duplex PCR, Multiplex PCR amplification for Southernhyridization Analysis, Multiplex PCR-RFLP, PCR-Southern Hybridization on Chip and Conventional PCR, Multiplex Endpoint PCR, HPLC, Nano UPLCESI-Q-TOFMS, Combined Fourier Transform Infrared Spectroscopy (FTIR) and Principal Component Analysis (PCA), Spectroscopy (IR/ FTIR), Liquid chromatography–tandem mass spectroscopy, Liquid Scintillation Counting, PEME, ELISA, SDS-PAGE, and Sandwich ELISA.

REFERENCES

1. Hashim P, & Mat Hashim D. A Review of Cosmetic and Personal Care Products: Halal Perspective and Detection of Ingredient. *Pertanika J. Sci. Technol*, 2013; *21*(2):281-292.
2. Hassan N, Ahmad T, & Zain N.M. Chemical and Chemometric Methods for Halal Authentication of Gelatin: An Overview. *J. Food Sci*, 2018; *83*(23): 2903–2911.
3. Hunter M. The Emerging Halal Cosmetic and Personal Care Market. *Personal Care*, 2012; 37–41.
4. Ismail Z, & Ehsan A.H. Halal Nutraceutical Market: Issues and Challenges. *Segi Review*, 2010; *3*(2):96–117.
5. Aziz A.N, Ibrahim I, & Abdul Raof N. The Need for Legal Intervention Within The Halal Pharmaceutical Industry. *Procedia-Social and Behavioral Science*, 2012; 121:124–132.
6. Hanzaee K.H, & Ramezani M.R. Intention to Halal Products in The World Markets. *Interdisciplinary Journal of Research in Business*, 2011; *1*(5): 1-7.
7. Mursyidi A. The Role of Chemical Analysis in The Halal Authentication of Food and Pharmaceutical Products. Journal of Food and Pharmaceutical Sciences, 2013, 1(1): 1-4.
8. Ballin N. Z. Authentication of Meat and Meat Products. *Meat Sci*, 2010; *86*(3):577–87.
9. Raraswati M.A, Triyana K, & Rohman A. Differentiation of Bovine and Porcine Gelatins in Soft Candy Based on Amino Acid Profiles and Chemometrics. *J Food Pharm Sci*, 2013; *2*(1):1–6.
10. Huang C.Y, Kuo J.M, Wu S.J, & Tsai H.T. Isolation and Characterization of Fish Scale Collagen from Tilapia (*Oreochromis* sp.) by A Novel Extrusion-Hydro-Extraction Process. *Food Chemistry*. 2016; *190*:997–1006.
11. Hosen, & Nadirsyah. Hilal and Halal: How to Manage Islamic Pluralism in Indonesia?. *Asian Journal of Comparative Law*, 2012; *7*(1):11-12.
12. Badan Pengawasan Obat dan Makanan Republik Indonesia. Pencantuman Informasi Asal Bahan Tertentu Kandungan Alkohol, dan Batas Kedaluwarsa pada Penandaan/Label Obat, Obat Tradisional, Suplemen Makanan, dan Pangan. Peraturan Kepala Badan Pengawas Obat dan Makanan Republik Indonesia Nomor HK. 03.1.23.06.10.5166. Jakarta: Badan Pengawasan Obat dan Makanan Republik Indonesia; 2010.p.4-5.
13. Sahilah Mohd A.M, Fadly L, Norrakiah A.S, Aminah A, Wan Aida W.M, Ma'aruf Mohd. A.G, & Khan A. Halal Market Surveillance of Soft and Hard Gel Capsules in Pharmaceutical Products Using PCR and Southern-Hybridization on The Biochip Analysis. *Int Food Res J*, 2012; *19*(1):371–5.
14. Azira T, Che Man Y.B, Raja Mohd Hafidz R.N, Aina M.A, Amin I. Use of Principal Component Analysis for Differentiation of Gelatine Sources Based on Polypeptide Molecular Weights. *Food Chemistry*, 2014; *151*:286–292.
15. Shabani H, Mehdizadeh M, Mousavi S.M, Dezfouli E.A, Solgi T, Khodaverdi M, Rabiei M, Rastegar H, & Alebouyeh M. Halal

Authenticity of Gelatin Using Species-Specific PCR. *Food Chemistry*, 2015; *184*:203–206.
16. Food and Drug Administration 2006. Alphabetical List of SCOGS Substances. Retrieved from www.cfsan.fda.gov/*dms/ opascogc 23 July 2020.
17. Rohman A, Che Man Y.B. Analysis of Pig Derivatives for Halal Authentication Studies. *Food Rev Int*, 2012; *28*(1):97–112.
18. Yang H, & Shu Z. The Extraction of Collagen from Pig Skin. Journal of Chemical and Pharmaceutical Research, 2014; 6(2):683-687.
19. Liu Q, Kong B, Xiong Y.L, & Xia X. Antioxidant Activity and Functional Properties of porcine Plasma Protein Hydrolysate As Influenced By The Degree Of Hydrolysis. *Food Chemistry*, 2010; *118*(2):403–410.
20. Pati F, Adhikari B, & Dhara S. Isolation and Characterization of Fish Scale Collagen of Higher Thermal Stability. *Bioresource Technology*, 2010; *101*(10):3737–3742.
21. Zhan J, Duan R, Ye C, & Konno K. Isolation and Characterization of Collagens from Scale of Silver Carp (*Hypophthalmichys molitrix*). *Journal of Food Biochemistry*, 2010; *34*:1343–1354.
22. Hoyer B, Bernhardt A, Lode A, Heinemann S, Sewing J, Klinger M, Notbohm H, & Gelinsky M. Jelly Fish Collagen Scaffolds for Cartilage Tissue Engineering. Acta Biomaterialia, 2014; 10(2):883–892..
23. Sugibayashi K, Yusuf E, Todo H, Dahlizar S, Sakdiset P, Arce F.J.R, & See G.L. Review Halal Cosmetics: A Review on Ingredients, Production, and Testing Methods. *Cosmetics*, 2019; *6*(37):1-17.
24. Mohammad A.W, Suhimi N.M, Abdul Aziz A.G.K, & Jahim J.M. Process for Production of Hydrolysed Collagen from Agriculture Resources: Potential for Further Development. *Journal of Applied Sciences*, 2014; *14*(12):1319-1323.
25. Manikas K, & Hansen K.M. Software Ecosystems-A Systematic Literature Review. Journal of Systems and Software, 2013; 86(5):1294–1306.
26. Nikzad J, Shahhosseini S, Tabarzad M, Varcheh N.N, & Thosabi M. Simultaneous Detection of Bovine and Porcine DNA in Pharmaceutical Gelatin Capsules by Duplex PCR Assay for Halal Authentication. *DARU Journal of Pharmaceutical Sciences*, 2017; *25*(3):1-11.
27. Widayat W.T, Winarni Agustini M, Suzery A, Ni'matullah Al-Baarri S, Rahmi Putri, & Kurdianto K. Real Time-Polymerase Chain Reaction (RT-PCR) sebagai Alat Deteksi DNA Babi dalam Beberapa Produk Non-Pangan. *Indonesia Journal of Halal*, 2019; *2*(1):26-33.
28. Azilawati M, Hashim D, Jamilah B, & Amin I. RP-HPLC Method Using 6-Aminoquinolyl-N Hydroxysuccinimidyl Carbamate Incorporated with Normalization Technique in Principal Component Analysis to Differentiate The Bovine, Porcine And Fish Gelatins. *Food Chem*, 2015; *172*:368–376.
29. Pratiwi D, Fitriani N.E, Sudjadi, & Rohman A. Application of Real Time Polymerase Chain Reaction for Analysis of Porcine DNA in Gelatine-Containing Capsule Shell for Halal Authentication. International Food Research Journal, 2018; 25(4):1515-1519.
30. Sudjadi Wardani H.S, Sepminarti T, & Rohman A. Analysis of Porcine Gelatin DNA in A Commercial Capsule Shell Using RealTime Polymerase Chain Reaction for Halal Authentication. Int J Food Prop, 2016; 19(9):2127–34.
31. Maryam St, Sismindari Raharjo T.J, Sudjadi, & Rohman A. Analysis of Porcine Contamination in Dendeng Using Mitochondrial D-loop 686 and Cyt B Gene Primers by Real Time Polymerase Chain Reaction. *International Journal of Food Properties*, 2015; *19*:187-195.
32. Mutalib S.A, Muin N.M, Abdullah A, Hassan O, Mustapha W.A.W, Sani N.A, & Maskat M.Y. Sensitivity of Polymerase Chain Reaction (PCR)-Southern Hybridization and Conventional PCR Analysis for Halal Authentication of Gelatin Capsules. *LWT-Food Science and Technology*, 2015; *63*(1):714–719.
33. Dermihan Y, Ulca P, & Zenyuva H.Z. Detection of Porcine DNA in Gelatine and Gelatine-Containing Processed Food Products-Halal/Kosher Authentication. Meat Science, 2012; 90(3):686-689.
34. Yilmaz M.T, Kesmen Z, Baykal B, Sagdic O, Kulen O, Kacar O, & Baykal A.T. A Novel Method to Differentiate Bovine and Porcine Gelatins in Food Products: Nano UPLC-ESI-Q-TOF-MS E Based Data Independent Acquisition Technique to Detect Marker Peptides in Gelatin. *Food Chem*, 2013; *141*(3):2450–2458.
35. Sultana S, Motalib Hossain M.A, Azlan A, Johan M.R, Chowdhury Z.Z, & Eaqub Ali M. TaqMan Probe Based Multiplex Quantitative PCR Assay for Determination of Bovine, Porcine and Fish DNA in Gelatin Admixture Food Products and Dietary Supplements. *Food Chemistry*, 2010; *325*:1-8.
36. Ali M.E, Razzak M.A, Hamid S.B.A, Rahman M.M, Al Amin M, & Rashid N.R.A. Multiplex PCR Assay for The Detection of Five Meat Species Forbidden in Islamic Foods. *Food Chem*, 2015; *177*:214–224.
37. Sepminarti T, Wardhani H.S, Sudjadi, & Rohman A. Real-Time Polymerase Chain Reaction for Halal Authentication of Gelatin in Soft Candy. *Asian Journal of Biochemistry*, 2016; *11*(1):34-43.
38. Zilhadia K.F, Betha O.S, & Supandi. Differentiation of Bovine and Porcine Gelatin Extracted from Vitamin C Gummy by Combination Method of Fourier Transform Infrared (FTIR) and Principal Component Analysis (PCA). Pharmaceutical Sciences and Research (PSR), 2018; 5(2):90–96.
39. Fadhlurrahman, Wardani A.K, & Widyastuti E. Deteksi Gelatin Babi pada Soft Candy Menggunakan Metode PCR-RFLP Sebagai Salah Satu Pembuktian Kehalalan Pangan. *Jurnal Teknologi Pangan*, 2015; *16*(2):81-88.
40. Sultana S, Hossain M.A.M, Naquiah N.N.A, & Ali Md.E. Novel Multiplex PCR-RFLP Assay Discriminates Bovine, Porcine and Fish Gelatin Substitution in Asain Pharmaceuticals Capsule Shells. *Food Additives & Contaminants*, 2018; *Part A*:1-12.
41. Zabidi A.R, Fauzi, F.N, Abd Razak F.N, Rosli D, Jamil M.Z.M., Wan Ibrahim W.K, & Yahaya N. Screening Porcine DNA in Collagen Cream Cosmetic Products. *Food Research*, 2019; *4*(1):151 – 156.
42. Gani S.S.A, Mustafa S, Desa M.N.M, Mokhtar N.F.K, Hanapi U.K, Zakaria Z, Yahaya N, Sulaiman W.M.A, & Wan. Detection of Porcine Adulteration in Cosmetic Cream Formulation via TaqMan Probe Real-Time Polymerase Chain Reaction. *International Journal of Engineering & Technology*, 2018; *7*(4.14):112-115.
43. Aviani N. Deteksi Cemaran Babi Pada Sediaan Kapsul Suplemen Kecantikan Di Kota Yogyakarta Dengan Metode PCR (Polymerase Chain Reaction). 2017; Http://ejournal.uajy.ac.id/12577.
44. Che Man Y.B, Mustafa S, Mokhtar N.F.K, Nordin R, & Sazili A.Q. Porcine-Specific Polymerase Chain Reaction Assay Based on Mitochondrial D-Loop Gene for Identification of Pork in Raw Meat. *International Journal of Food Properties*, 2012; *15*(1):134-144.
45. Kim T, Kim S, Kang W.Y, Baek H, Jeon H.Y, Kim B.Y, Kim C.G, & Kim D. Porcine Amniotic Fluid As Possible Anti Wrinkle Cosmetic Agent. Korean J. Chem. Eng, 2011; 28(9):1839–1843.
46. Seretis A, & Tsiakaras P. Hydrogenolysis of Glycerol to Propylene Glycol by In Situ Produced Hydrogen from Aqueous Phase Reforming of Glycerol Over SiO2–Al2O3 Supported Nickel Catalyst. Fuel Process. Technol, 2016; 142:135–146.
47. Choi Y.L, Park E.J, Kim E, Na D.H, & Shin Y. Dermal Stability and In Vitro Skin Permeation of Collagen Pentapeptides (KTTS and Palmitoyl-KTTS). *Biomol. Ther*, 2014; *22*(4):321–327.
48. Intarakumhaeng R,Wanasathop A, Li K. Effects of Solvents on Skin Absorption of Non Volatile Lipophilic and Polar Solutes Under finite Dose Conditions. *Int. J. Pharm*, 2018; *536*(1):405–413.
49. Hashim D.M, Che Man Y.B, Norakhasa R, & Shuhaimi M. Potential Use of Fourier Transform Infrared Spectroscopy for Differentiation of Bovine and Porcine Gelatins. *Food* Chemistry, 2010; *118*(3):856-860.
50. Hermanto S, & Fatimah W. Differentiation of Bovine and Porcine Gelatin Based on Spectroscopic and Electrophoretic Analysis. *J. Food Pharma Sci*, 2013; *1*(3):68–73.
51. Rezazadeh M, Yamini Y, Seidi S, & Aghaei A. Pulsed Electromembrane Extraction for Analysis of Derivatized Amino Acids: A Powerful Technique for Determination of Animal Source of Gelatin Samples. *Talanta*, 2015; *136*(1):190–197.
52. Tukiran N.A, Ismail A, Mustafa S. & Hamid M. Determination of Porcine Gelatin in Edible Bird's Nest by Competitive Indirect ELISA Based on Anti-Peptide Polyclonal Antibody. *Food Control*, 2016; *59* :561–566.
53. Amin M.A, Ismail A, Nhari R, Hafidz R.M. & Che Man Y. Identification Polypeptide Biomarkers of Porcine Skin Gelatin by Twodimensional Electrophoresis. *Food Res. Int. J*, 2013; *20*(3):1395–1399.

54. Malik A, Sutantyo M.L, Hapsari I, Sinurat A.V, Purwati E.M, Jufri M, & Suryadi H. Simultaneous Identification and Verification of Gelatin Type in Capsule Shells by Electrophoresis and Polymerase Chain Reaction. *J. Pharma Investig*, 2016; *46*(5):1–11.
55. Nhari R.M.H.R, Ismail A, Man C, & Yaakob B. Analytical methods for gelatin differentiation from bovine and porcine origins and food products. J. food Sci, 2012; 77(1):42–46.
56. Nur Hanani Z.A, Roos Y.H, & Kerry J.P. Use of Beef, Pork and Fish Gelatin Sources in The Manufacture of Films and Assessment of Their Composition and Mechanical Properties. *Food Hydrocolloid*, 2012; *29*(1):144-151.
57. Zilhadia Yahdiana H, Irwandi J, & Effionora A. Characterization and Functional Properties of Gelatin Extracted from Goat Skin. International Food Research Journal, 2018; 25(1): 275-281..
58. Liu D, Nikoo M, Boran G, Zhou P, & Regenstein J.M. Collagen and Gelatin. *Annu Rev Food Sci Technol*, 2015; *6*(1):527–57.
59. Amqizal H.I.A, Al-Kahtani H.A, Ismail E.A, Hayat K, & Jaswir I. Identification and Verification of Porcine DNA in Commercial Gelatin and Gelatin Containing Processed Foods. *Food Control*, 2017; *78*(1):297-303.
60. Lee J.H, Kim M.R, Jo C.H, Jung Y.K, Kwon K, & Kang T.S. Specific PCR Assays to Determine Bovine, Porcine, Fish and Plant Origin of Gelatin Capsules of Dietary Supplements. *Food Chem*, 2016; *211*: 253-259.
61. Husieh M.K, Shih P.Y, Wei C.F, Vickroy T.W, Chou C.C. Detection of Undeclared Animal by-Products in Commercial Canine Canned Foods: Comparative Analyses by ELISA and PCR-RFLP Coupled with Slab Gel Electrophoresis or Capillary Gel Electrophoresis. *J Sci Food Agric*, 2016; *96*(5):1659–1665.
62. Mane B.G, Mendiratta S.K, & Tiwari A.K. Beef Specific Polymerase Chain Reaction Assay for Authentication of Meat and Meat Products. *Food Control*, 2012; *28*(2):246-249.
63. Ali M.A, Al Amin M, Hamid S.B.A, Hossain M.M, & Mustafa S. Lab-on-A-Chip-Based PCR-RFLP Assay for The Confirmed Detection of Short-Length Feline DNA in Food. *Food Addit Contam*, 2015; *Part A*(32):1373-1383.
64. Mohamad N.A, Mustafa S, El Sheikha A.F, Khairil Mokhtar N.F, Ismail A, & Ali M.E. Modification of Gelatin-DNA Interaction for Optimised DNA Extraction from Gelatin and Gelatin Capsule. *J Sci Food Agric*, 2016; *96*(7):2344–51.
65. Yusuf Z.K. Polymerase Chain Reaction (PCR). *Jurnal Saintek*, 2010; 5(6):1-6.
66. Cai H, Gu X, Scanlan M.S, Ramatlapeng D.H, & Lively C.R. Real-time PCR Assays for Detection and Quantitation of Porcine and Bovine DNA in Gelatin Mixtures and Gelatin Capsules. *Journal of Food Composition and Analysis*, 2012; *25*(1):83–87.
67. Zulfahmi Z. Deteksi Kontaminan Babi Pada Produk Makanan Menggunakan Teknologi DNA Molekuler, Kutubkhanah. *J. Penelit. Sos. Keagamaan*, 2015; *18*(1):1-6.
68. Raharjo T.J, Cahyaningtyas W, Surajiman I, & Pranowo D. Validation of PCR-RFLP Testing Method to Detect Porcine Contamination in Chicken Nugget. Indonesian Journal of Chemistry, 2013; 12(3):302–307.
69. Nemati M, Oveisi M.R, Abdollahi H, & Sabzevari O. Differentiation of Bovine and Porcine Gelatins Using Principal Component Analysis. *Journal of Pharmaceutical and Biomedical Analysis*, 2014; *34*(3):485–492.
70. Widyaninggar A, Triyana K, & Rohman A. Differentiation Between Porcine and Bovine Gelatin in Capsule Shells Based on Amino Acid Profiles and Principal Component Analysis. Indonesian Journal of Pharmacy, 2012; 23(2):104–109.
71. Kaur K, Osman S, & Maziha S. Predicting Working Women Purchasing Behaviour of Malaysian Halal Cosmetic Products by Using Theory of Planned Behaviour. International Academic Research Journal of Business and Management, 2014; 3(1):1-7.
72. Aoun I, & Tournois L. Building Holistic Brands: An Exploratory Study of Halal Cosmetics. *Journal Of Islamic Marketing*, 2015; *6*(1):109-132.
73. Shafii Z, & Wan Siti Khadijah W.M.N. Halal Traceability Framework for Halal Food Production. World Appl. Sci. J, 2011; 17(Towards the Traceability of Halal and Thoyyiban Application):01-05.
74. Yorgancioglu A, & Bayramoglu E.E. Production of Cosmetic Purpose Collagen Containing Antimicrobial Emulsion with Certain Essential Oils. *Industrial Crops and Products*, 2013; *44*:378-382.
75. Rodríguez M.I.A, Barroso L.G.R, & Sánchez M.L. Collagen: A review On Its Sources and Potential Cosmetic Applications. *J. Cosmet. Dermatol*, 2017; *17*(1):20–26.
76. Briliana V, & Mursito N. Exploring Antecedents and Consequences of Indonesian Muslim youths Attitude Towards Halal Cosmetic Products: A Case Study in Jakarta. *Asia Pac. Manag. Rev*, 2017; *22*(4):176–184.
77. Rohman A, & Salamah N. The Employment of Spectroscopic Techniques Coupled with Chemometrics for Authentication Analysis of Halal Pharmaceuticals. *Journal of Applied Pharmaceutical Science*, 2018; *8*(10):63-68.
78. Waskitho D, Lukitalingsih, E, Sudjadi, & Rohman A. Analysis of Lard in Lipstick Formulation Using FTIR Spectroscopy and Multivariate Calibration: A Comparison of Three Extraction Methods. *Journal of Oleo Science*. 2016; *65*(10):815-824.
79. Rohman Abdul, & Che Man Y.B. Analysis of Lard in Cream Cosmetics Formulations Using FTIR Spectroscopy and Chemometrics. *Middle-East Journal of Scientific Research*, 2011; *7*(5):726-732.
80. Dole M.N, Patel P.A, Sawant S.D, & Shedpure P.S. Advance Applications of Fourier Transform Infrared Spectroscopy. *International Journal of Pharmaceutical Sciences Review and Research*, 2011; *7*(2):159-166.
81. Kurniati E, Rohman A, & Triyana K. Analysis of Lard in Meatball Broth Using Fourier Transform Infrared Spectroscopy and Chemometrics. Meat Science, 2014; 96(1):94–98.
82. Lukitaningsih E, Sa'adah M, Purwanto, Rohman A. Quantitative Analysis of Lard in Cosmetic Lotion Formulationusing FTIR Spectroscopy and Partial Least Square Calibration. *Journal of theAmerican Oil Chemists Society*, 2012; *89*(8):1537-1543.
83. Rohman A, Gupitasari I, Purwanto, Triyana K. Quantification of Lard in the Mixture with Olive Oil in Cream Cosmetics Based on FTIR Spectra and Chemometrics for Halal Authentication. *Jurnal Teknologi (Sciences and Engineering)*, 2014; *69*(1):113-119.
84. Kim Y.S, Yu H.K, Lee B.Z, & Hong K.W. Effect of DNA Extraction Methods on The Detection of Porcine Ingredients in Halal Cosmetics Using Real-Time PCR. *Applied Biological Chemistry*, 2018; *61*(3):549-555.
85. Husni P, Putriana N.A, Wicaksono I.A. Metode Deteksi Kandungan Babi dan Alkohol dalam Eksipien Farmasi dan Produk Obat untuk Menjamin Kehalalan Sediaan Obat. *Majalah Farmasetika*, 2017; *2*(1):1-7.
86. Zilhadia, Izzah A.N, & Betha O.S. Perbandingan Metode SYBR Green dan Hydrolysis Probe dalam Analisis DNA Gelatin Sapi dan Babi Menggunakan Real Time PCR. *Jurnal Sains Farmasi & Klinis*, 2017; *4*(2):16-23.
87. Rahmawati, Sisimindari, Raharjo T.J, Sudjadi, & Rohman A. Analysis of Pork Contamination in Abon using Mitochondrial D-Loop 22 primer Using Real-Time Polymerase Chain Reaction Method. *International Food Research Journal*, 2016; *23*(1): 370-374.
88. Balia R.L, Suryaningsih L, & Putranto W.S. Pengujian Pemalsuan Bakso dengan Daging Babi Melalui Pendekatan Ensimatis dan Molekuler pada UKM di Kawasan Pendidikan Jatinangor Kabupaten Sumedang. *Dharmakarya : Jurnal Aplikasi Ipteks untuk Masyarakat*, 2014; *3*(2):70-72.
89. Rohman A, Himawati A, Triyana K, Sismindari, & Fatimah S. Identification of Pork in Beef Meatballs Using Fourier Transform Infrared Spectrophotometry and Real-time Polymerase Chain Reaction. International Journal of Food Properties, 2017; 20(3):654-661.
90. Wahyuni S, Maryam S, & Aminah. Validasi Metode Analisis Cemaran DNA Babi pada Bakso Sapi Menggunakan Primer Mitokondria D-Loop22 dengan Metode Polymerase Chain Reaction (PCR). *Jurnal Farmasi Galenika (Galenika Journal of Pharmacy)*, 2019; *5* (1):65-72.
91. Raharjo T.J, Alfiraza E.N, Enjelina E, & Pranowo D. Validation of A Non-Specific Dye Real-Time PCR Assay for Porcine Adulteration in Meatball Using ND5 Primer. Indones. J. Chem, 2017; 17(2):167–174.
92. Nooratiny, Sahilah A.M, Alfie A.R.A, & Farouk M.Y.M. DNA Extraction from Ghee and Beef Species Identification Using Polymerase Chain Reaction (PCR) Assay. International Food Research Journal, 2013; 20(5):2959-2961.
93. Erwanto Y, Sugiyono, Rohman A, Abidin M.Z, & Ariyani D. Identifikasi Daging Babi Menggunakan Metode PCR-RFLP Gen

Cytochrome B dan PCR Primer Spesifik Gen Amelogenin. Jurnal Agritech, 2012; 32(4):370-377.

94. Erwanto Y, Sugiyono, Rohman A, Abidin M.Z, & Muslim E.Y.P. Identification of Pork Contaminant in Meat-balls of Indonesia Local Market Using Polymerase Chain Reaction-Restric-tion Fragment Length Polymorphism (PCR-RFLP). *Journal of Asian Australas. J. Anim, Sci*, 2014; *27*(10):1487-1492.
95. Cheng X.L, Wei F, Xiao X.Y, Zhao Y.Y, Shi Y, Liu W, Zhang P, Ma S.C, Tian S.S, Lin, R.C. Identification of Five Gelatins by Ultra Performance Liquid Chromatography/Time-Of-Flight Mass Spectrometry (UPLC/Q-TOF-MS) Using Principal Component Analysis. *J. Pharm. Biomed. Anal*, 2012; *62*:191–195.
96. Sha X.M, Zhang L.J, Tu Z.C, Zhang L.Z, Hu Z.Z, Li Z, Li X, Huang T, Wang H, Zhang L. The Identification of Three Mammalian Gelatins by Liquid Chromatography-High Resolution Mass Spectrometry. *LWT Food Sci. Technol*, 2018; *89*:74–86.
97. Nurjuliana M, Che Man, & Mat Hashim. Rapid Identification of Pork for Halal Authentication Using The Electronic Nose and Gas Chromatography Mass Spectrometer with Headspace Analyzer. *Meat Science*, 2011; 88(4):638-644.
98. Azira N,T, Amin I, Che Man Y.B. Differentiation of Bovine and Porcine Gelatins in Processed Products Via Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) and Principal Component Analysis (PCA) Techniques. *Int. Food Res. J*, 2012; *19*(3):1175–1180.
99. Bosque-Sendra J.M, Rodríguez L.C, Samblás C.R, & De la Mata A.P. Combining Chromatography and Chemometrics for The Characterization and Authentication of Fats and Oils from Triacylglycerol Compositional Data-A Review. *Analytica Chimica Acta*, 2012; *724*:1-11.
100. Hajipour B, Gharache M, Hamidizade M.R, Mohammadian F. Raising Halal Cosmetic Awareness Among The Respective Consumers. International Journal of Academic Research in Business and Social Sciences, 2015; 5(7):338-349.