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RESEARCH ARTICLE

A review : Conversion of chicken viscera into protein hydrolysate for palatant production

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Abstract

Flavor and aroma cannot be separated in food industries. The manipulation of the ingredients to increase the taste has started since early civilization. Common example of the earliest application of ingredients to increase the savory taste of the food is soy sauce production. The process of digging out the aroma and flavor includes frying, stewing, grilling as well as fermenting. Nowadays, much complex savory system in food can be achieved through several processes such as Maillard reaction and protein hydrolysate production. The food produced will not only be tasty but healthy. This concept was first focusing on human food production. However, the increasing number of pet owner for about 10% annually since 2008 as reported by US Pet Owner Society demands the same concept to be implemented in pet food industries. Since most pet owners considered their pets as part of their family, the pet food source from 4D (dead, dying, disable and diseased) animals are unacceptable. Therefore, the pet food industries are competing with human food industries to get the clean source of meat for food as well for flavor production. An alternative to overcome this is by utilizing the viscera of the slaughtered chicken for palatant or flavor production. Aside from meat, bones and feathers, viscera are also abundantly being considered as waste and were not fully utilized. They are rich in protein. The protein can be recovered using suitable process and later turned into a value-added product such as flavor. There is a study available for converting the protein waste into protein hydrolysate via chemical and physical technique. However, only few reports are available for the conversion process via indigenous microbes and enzymes. It is believed that the indigenous microbes and enzymes (protease, peptinase) can be utilized for protein hydrolysate production which will later can be utilized as palatant. The palatant produced should have Sulphur-based aroma compound such as 2-methyl-3-furanthiol and 2-furfuryl-thiol which serve as precursors for chicken aroma.

***Keywords*:** Chicken viscera, hydrolysate, palatant, pet food, flavor

INTRODUCTION

Protein waste or sometimes known as poultry by-products has not been utilized properly in Malaysia. Large amount of poultry by-products are just considered as waste and they were just being thrown away from the poultry farms, markets, food processing industries and homes. Examples of the poultry by-products are animal viscera, bones, skins and head. One of the largest contributors for high protein waste in Malaysia is from chicken slaughterhouse. This is because chicken are easy to be grown and the demand for chicken meat itself is high. Not to mention that the price of chicken in the market are affordable. As the meat of the chicken are utilized to fulfil the human needs, the by-products were just thrown away. Improper disposal of these waste actually can lead to several pollutions to the environments as well as being harmful to our health. Despite of that, those protein wastes have high potential to be utilized as source for pet food, and feedstock.

At the same time, the demand to have a very good quality of pet food are increasing as well as the number of pet owner especially cat owners. Cats are the common companion animals in the world other than dogs. Some of the pet owners already acknowledged their companion animals as their family members. For that reason, they are willing to spend thousands just to ensure their companion are healthy just like them. In Malaysia, cats are the most common companion animals. They are strict carnivore and they require food with high content of protein to sustain their health. This can be the main reason to utilize the poultry by-products to fulfil this demand.

In another scenario, halal market currently has received tremendous attention globally as more people including non-muslim believe that halal method in Islam ensures the quality and safety of the food in terms of cleanliness as well as producing healthier food which has high nutritive value. In pet food production, there have been some issues regarding the chicken flavor of the pet food. They started to raise question on how the chickens were slaughtered, the 'halal' ingredients of the pet food and those related to Islamic constitution. This issues might seems to be a problem only for a muslims, however, non-muslims also started to concern about halal ingredients because they began to understands the benefits of the halal. Note to be added, the scope of halal is really wide and it can implies in many conditions and to non-muslims too.

What is chicken viscera?

According to Ministry of Agriculture of Indonesia, viscera are define as chicken's liver (after the gallstone is removed), heart, colon and other organs located in chest and stomach abdominal which are edible after passing the cleaning and washing procedure.

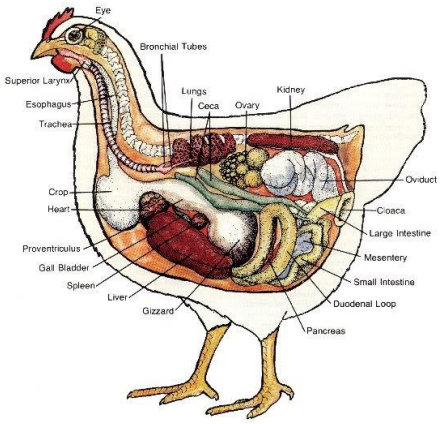


Figure 1 General parts of chicken. Source: Anotomy and Physiology of Poultry (Perham, 2010).

Figure 1 shows that chicken anatomy can be divided into four parts namely dorsal (the upper surface of the chicken – lungs, ceca, ovary and kidney), ventral (parts of the lower and abdominal surface – crop, heart, proventriculus, gall bladder, spleen, liver and gizzard), cranial (front or head area – superior larynx, esophagus and trachea) and caudal (tail or rear area – oviduct, cioaca, large intestine, mesentery, small intestine, duodenal loop and pancreas). Based on the picture in figure 1, ventral part where the liver, spleen, gall bladder, gizzard, pancreas, duodenal loop and small intestine are located is known as chicken viscera. These internal sections made up from proteins and they have high potential to be recovered and utilised for value added product. However, due to economic factor, most of the viscera have been discarded. Only recently the chicken viscera is being used as fish meal, pet food and live feed stock.

The business of the chicken poultry are enormous. Statistics from poultry industry watchers showed that United States, China and Brazil maintain their lead as the biggest producers of poultry meat. Each is expected to produce up to 19,852, 18,102 and 12,200 thousand metric tons of poultry meat, respectively, in 2011 (USDA, 2011). However, China and Brazil top the list in the production of chicken meat, each having a forecast of 13,000 and 11,750 thousand metric tons, respectively, in 2011 (USDA, 2011). In 2013 in Malaysia, there were issues such as unregistered slaughter house, chronic flies infestations, chicken shortage and uncontrolled increased of the price. Despite of all of the issues, the consumptions keep increasing, forcing the supply to meet the demands (Table 1). The number is also projected to reach 1.5 million metric tonnes by 2017-2018. 90% of the productions are from Peninsular Malaysia while the other 10% are from east Malaysia.

Table 1 Poultry Meat Supply and Distributions in Malaysia from 2012 until 2014.
Source: USDA FAS Gain Report MY4005

Malaysia's Poultry Meat Supply and Distributions in Metric Tons (MT)			
	2012	**2013**	**2014**
Productions	1374500	1408862	1437039
Imports	52595	53600	54000
Exports	32497	31400	32000
Domestic Consumption	1394598	1431062	1459039

With this large production, thousands of tons of organic by-products in the form of viscera, feet, head, bones, blood and feathers are generated (Zhu et al., 2010). The viscera constitute about 30% of these wastes while feather could be up to 10% (Jamdar and Harikumar, 2005; Grazziotin et al., 2007). As the list mentioned, The Commission of the European Communities Regulation (EC) No. 1096/2009 has defines animal by-products as, whole body of an animal, parts from the body of an animal or products derived from animals which are not meant for human consumption (European Commission, 2009). In the definition, the by-products were grouped into three categories according to the ability of the by product to transmit pathogens. As in Table 2, poultry by-product from category 1, 2 or combination of both category have high potential on transmitting pathogens. The only way to handle those by-product is by incineration; which the result of the incineration can be applied as thermal and electrical energy or biogass production. By-product that falls under category 3 are part of slaughtered animal that is fit or unfit for human consumption such as bones, skins and wools have low risk of transmitting pathogens. These by-products contain high protein content thus, besides on utilizing it for biogas or compost, EU legislation suggested that all components that falls under category 3 can be recovered for value added product in pet food and feedstock. With this, it is clear that the intention of the act establishment is to ensure high level of health and environment safety. The Bovine Spongiform Encephalopathy (BSE) epidemic in 1990's is the benchmark for the safety. Since then, poultry by products has been strictly reviewed as it is the best intermediates in propagating and transmitting such epidemic.

In the previous time, the common method of treating the poultry by-products is by rendering process as reported by A. Lasekan et. al. (2012) and Salminen and Rintala (2002). Rendering is a heating process with temperature of 133°C at 3 bar pressure for 20 minutes. This process can separate fat and protein as reported by Salminen and Rintala (2002). The fat later can be utilized as raw material for cooking oil, soap, detergents and cosmetic production. Shareefdeen et. al. (2005) later reported that the protein residue can be further dried, grounded, and utilized as meat and bone meal, and meat meal for livestock. Jamdar and Harikumar (2005), Lasekan et. al. (2012), Nchienzia, Morawicki and Gadang (2010) later on reported that poultry waste by-products are definitely rich in protein and the proteins can be recover to form protein hydrolysate by using chemical or enzymatic method. The protein hydrolysate produced have great potential to be further utilized as additional protein in food, palatant, or any protein-based product.

What is palatant in pet food?

Carbohydrate, fatty acid, proteins, peptides, vitamins and minerals are some of the macro and micro nutrients that made up a complex ingredient system of palatants. Originally, palatants were known as digests, which refer to protein that is simplified enzymatically and applied to dry foods to provide sensory impacts of meat. The function of palatant is to enhance sensory experience of the pet owner and the pet itself, masking the unpleasant taste as well as improving the pets' eating desire while ensuring pets receive the vital nutrients. For the palatant to function effectively, it has to be appeal to all sensory capacities of the animals in terms of chemical (olfaction, taste, and chemical irritation), auditory, visual and tactile. This can be achieved if and only if the palatants can blend well in the product applied. Only then the pet food is enhanced, masked, stabilized and energize overall sensory impact of the pets (AFB International, 2012).

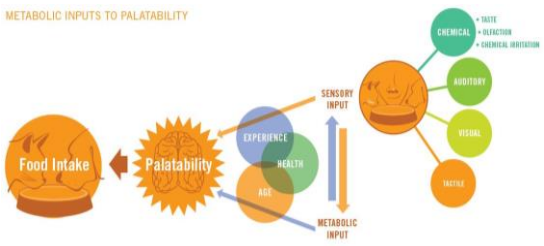


Figure 2 General concept of palatability.
Source: Understanding the Drivers for Palatability:
From Basic Science to Complex Product Systems (AFB International 2012)

Table 2 Poultry by-product classification by European Union.
Source: European Union Legislation document (European Union, Regulation (EC) No. 1096/2009).

Category	Examples	Potential use / Method of handling
Category 1	• All body parts suspected or confirmed infected with transmissible spongiform encephalopathy (TSE). • Pets, Zoo, Circus, Experimental, Wild Animals. • Mixtures of category 1 with category 2 and/or category 3 material.	• Incinerate in approved incineration plant. • Processed in an approved plant with specific method, later incinerate. • Can be used as thermal and electrical energy
Category 2	• Manure and digestive tract content. • Animals other than category 1 that have not been slaughtered for human consumption. • Mixtures of category 2 and category 3 material.	• Incinerate in approved incineration plant. • Processed in an approved plant with specific method, later disposed as waste • Make a compost if derived from fish. • Can be used as biogas or compost
Category 3	• Part of slaughtered animal that fit or unfit for human consumption and not intended for human consumption. • Bones, feathers, hooves, hides, horns, skins, wool. • Fish or other sea animals except sea mammals.	• Incinerate in approved incineration plant. • Used as raw material in pet food or feedstock plant. • Can be used as biogas or compost

Palatants which are also commonly known as flavour in human food industry is a perception that requires multiple orosensory modalities. The preference or perception of the animals are different between one and another. This perception normally influenced by experience, age and health factor. Due to this factor, the perception for the taste of sweet, salty, sour, bitter and umami might be difference (AFB International, 2012). The challenge foes to food technologist to fulfil the desire of the animals because different composition of palatants (protein, amino acid, fatty acid, vitamin, etc.) could exhibit one or more of the taste. Researcher at AFB has found that amount of certain taste active (active amino acid), fat-containing chemicals, and certain levels and type of esters from yeast (from palatant-containing yeast) yields positive correlations to the palatants performance. Off notes are often occur when alkenals (products of lipid oxidation) present at certain levels (Wheatly R.A, 2000). Figure 2 simply summarises these domino's effect which started from optimising the ratio of the palatant with other ingredients in pet food productions where later on give an impact to the multiple orosensory modalities of the pets according to their age, experience and health; and lastly will determine the amount of the food intake by them. The amount of the food intake is the result of the favoritism of the pets towards specific food.

As the main component of the palatant is protein, the source can be vary from meat or vegetables depend on performance target, cost and brand claims (AFB International, 2011). However, for cat food, protein derived from vegetables which is known as hydrolysed vegetable protein (HVP) are not being utilized. Cats do not have the ability to convert linoleic acid into arachidonic acid due to the lack of liver delta 6 desaturase enzyme and both nutrients must be supplied in the foods they eat. This means that they cannot obtain fatty acids from plant sources, including plant oils and grains because only linoleic acid is present in plant foods. Sometimes, palatants are made to fulfil certain claims such as grain-free, natural and non-GMO products to attract the pet owners. Commonly, protein utilized for palatant production is meat-based, and it can be obtained from various part such as skin, muscle tissue, bones and viscera. The common way for transforming the source into desired protein size or amino acid, is by hydrolysing them to produce protein hydrolysate.

How chicken viscera can be converted into palatant?

Harikumar et. al, (2010) has reported that poultry by-products contain high amount of exo and endo peptidase which can be cut into small pieces. General concept of protein hydrolysis as shown in the figure 3. In this figure, it shows that water have the capability to break down protein into amino acid and chains that contain carboxylate group. With the presence of carbohydrate and heat, browning process can be occurred. The browning process is also known as Maillard reaction. This simple cooking process will produce volatiles and non-volatiles compound that contribute to the rise of the aroma and flavor. However, the time taken to break the protein using only water are long. It is required to have physical, chemical, enzymatic or combination of any of the mentioned treatment to break the protein chains faster.

The mixture of the various length of protein is known as protein hydrolysate. Hydrolysate also refers to all products of protein hydrolysis (peptides, amino acids, and minerals) present in the protein and acid or alkali used to adjust the pH. The products (peptides or amino acids) contain variable side chains. However it depends on the type of enzymes or treatment used. Different side chains of peptides or amino acid may exert specific physiological roles in animal, microbial, insect and plants (Pasupuleti, 2006; Pasupuleti et al., 2010). As for pet food production, these side chain might cause allergic, or even producing desired flavour to enhance the palatability.

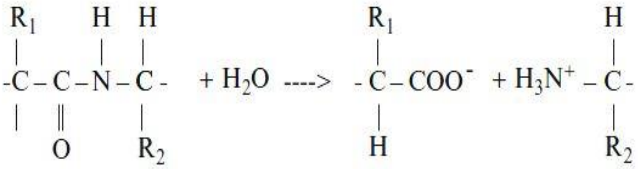


Figure 3 General concept of protein hydrolysis.
Source: Protein Hydrolysate Book (Adler-Nissen, 1986).

The history of hydrolysis already started back in 1880, where the first hydrolysate from meat was used for microbial cell growth. (Nagelli, 1880). Next was in the year 1900 where McConkey Media were introduced. 14 years later, Difco Lab introduce Bacto-Peptone for bacterial growth. During this age, protein hydrolysate were used solely as nitrogen source. Entering the biotechnology era, the use of hydrolysate were widen by applying it in biotechnology field such as medicine, agriculture, production of recombinant protein, bioremediation and pet food production as palatant.

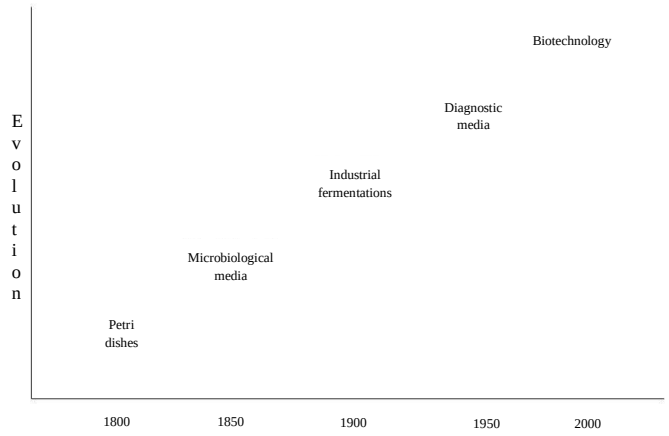


Figure 4 Chronology of Protein Hydrolysate application. Source: Protein Hydrolysate book (Adler-Nissen, 1986).

Despite its ancient application history, nowadays hydrolysate normally used for the nutritional management of people as well as for pets that cannot digest intact proteins. For example, production of baby food formulas for infants with hypersensitivity to food allergens. Infants are fond to allergic reaction where about 0.5% and 10% of normal full-term infants will develop some kind of food allergy (Nagodawithana, 1995). Usually the source of allergic will be from bovine milk as it is the most used protein source for infants (Kleinman et al. 1991). Allergies can be considered as critical health problem as the effects can be as little as mild rashes to very serious as life threatening as anaphylactic shock. Previously, the only method to counter allergies is by avoiding the allergens. Avoiding allergen for about 2 years will cause the loss of sensitivity to that allergen in approximately one-third of older children and adults allergic to foods (Sampson and Scanlon 1989; Pastorello et al. 1989). In another reports, 85% of food-sensitive infants lose their sensitivity to those foods by the age of 3. However this does not implies to all allergen as there are some cases that the allergen will be prolonged or remain for a lifetime (Cordle 1994).

This issue also be a concern to all pet owners. However, no details studies been conducted so far on that issues. Most of the time, pet owners will consider animal allergies are the same like human. Taking responsibilities of producing non-allergic food, pet food industry formulate their ingredients to have different source of protein as well incorporating hydrolysate with low molecular weight which can be achieve via acid, alkali or enzymatic treatment. Generally, proteins smaller than 10,000 Da are weakly allergenic (immunogenic), and peptides less than 2,000 Da are generally not immunogenic without modification (Nagodawithana, 1995). By having this knowledge, pet food that are allergen-free are possible to be made.

To obtain such size in hydrolysate for palatant in pet food production, three possible ways are available; acidic, alkali and enzymatic. Acid hydrolysis of protein were first recorded in the year 1820 by Bracannot (Hill, 1965). This oldest method were widely used until now because it is simple and fast. It can break down proteins to single amino acid and further to smaller peptides. Undergo this method also provides significant amount of salt in the hydrolysate which can prevent microbial growth. Due to this reason, it is mostly used in food and pet food industries for flavour enhancer after partially or completely removing the salt (Nagodawithana, 1995; 1998; 2010). Common acid used is hydrochloric acid and sulphuric acid. Conditions to be taken as consideration when dealing with this method is the type and concentration of the acid used, temperature, pressure and time of hydrolysis. This technique have some layback. Some of the essential amino acid (tryptophan, methionine, cysteine, and cysteine) are destroyed while glutamine, and asparagine are converted to glutamic acid and aspartic acid respectively (Bucci and Unlu, 2000).

Alkaline hydrolysis has not been reported to been used in biotechnology application. However it is used in commercial scale in food industry. Applying this method will keep tryptophan but destroying serine and threonine. The method starts with solubilized the protein with heating first and later add alkaline agents such as Ca, NaOH and KOH with a maintained temperature (range 80°F-130°F). After getting the targeted degree of hydrolysis, the hydrolysate are either evaporate, pasteurized or spray dried.

Acid and alkaline treatment often producing hydrolysate with uncontrollable length of peptide. This can be encountered by using enzymatic treatment. Enzyme have specific site that can cut and give specific length of protein. Usually enzymes used in hydrolysis comes from animals (pancretin, trypsin, pepsin, protease), plant (papain, bromelain), and fermentation product (protease from fungi or bacteria). Having enzyme as tool to break down the protein, the steps can be single step (single enzyme) or sequential step (multiple enzyme). The choice of enzyme should be according to the end product targeted and protein source (Adler-Nissen, 1986).

Flavour in chicken meat

It has been established many times that one of the main properties employed for the evaluation of product quality is flavor, that is, an adequate flavor composition considerably enhances the marketability of products. A desirable flavor is due to the complex mixture of various volatile and nonvolatile constituents mixed in proper proportions. The chemical structures of these molecules show high diversity and even flavor compounds with highly similar chemical structures may have an entirely different sensorial effect (Cserha´ti and Forga´cs, 2003). Most flavor molecules are hydrocarbons, alcohols, aldehydes, ketones, or esters. The backbone of these compounds generally consists of a linear or branched alkane or alkene chain. Saturated and unsaturated ring structures and terpenoids also occur among the basic structures of flavor compounds. Most of these molecules are relatively small; they are volatile or semivolatile and especially suitable for gas chromatographic (GC) analysis (Cserha´ti and Forga´cs, 2003). A large amount of volatile and nonvolatile flavor compounds has been found in foodstuffs containing meat, fish, and oil as the main ingredient

General chemistry of chicken meat flavour

Flavour comprises mainly of taste and aroma and is involved in consumers' meat-buying behavior and preferences. Chicken meat flavour is supposed to be affected by a number of ante- and post-mortem factors, including breed, diet, post-mortem ageing, method of cooking, etc. Additionally, chicken meat is more susceptible to quality deterioration mainly due to lipid oxidation with resulting off-flavors (Jayasena et al., 2013).

Chicken meat flavour is thermally derived and the Maillard reaction, thermal degradation of lipids, and interaction between these 2 reactions are mainly responsible for the generation of flavour and aroma compounds. The reaction of cysteine and sugar can lead to characteristic meat flavour specially for chicken and pork. Mortram 1998 has classified major volatile compounds produced during cooking of chicken meat as shown in table 3. Those volatile compounds are further classified into two distinctive group; derived from lipid precursors and water soluble precursors. Generally the main precursor for chicken flavor are from group of alkanals, alkyl furans, methylfuranthiol and alkyl disulfides just to name a few. Volatile compounds including 2-methyl-3-furanthiol, 2-furfurylthiol, methionol, 2,4,5-trimethyl-thiazole, nonanol, 2-trans-nonenal, and other compounds have been identified as important for the flavour of chicken. However 2-methyl-3-furanthiol is considered as the most vital chemical compound for chicken flavour development (Jayasena et al., 2013). The main reason for flavour deterioration and formation of undesirable "warmed over flavour" in chicken meat products are supposed to be the lack of α-tocopherol in chicken meat (Jayasena et al., 2013).

Appearance, aroma, taste, and texture of meat can generally persuade a consumer's decision to purchase meat. Flavor comprises mainly of taste and aroma and involves in consumers' meat-purchasing behavior and preferences even before the meat is eaten (Shahidi, 1989; Sitz et al., 2005). It is well known that raw meat has only a blood-like taste with little or no aroma. Aromatic notes and most of the characteristic flavours responsible for the development of

meat flavour are primarily contributed by the volatile compounds originated through heat induced complex reactions between non-volatile components of lean and fatty tissues during cooking (Mottram, 1998).

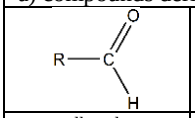
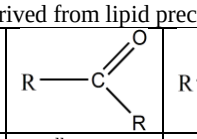
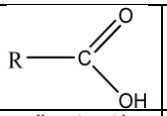
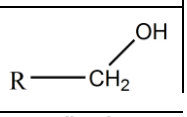
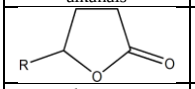
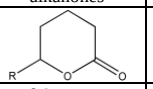
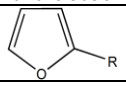
The cheapest commercially produced meat in a global context is chicken. It is supposed to have an increase in consumption by 34% by 2018 (Jung et al., 2011). Chicken meat which is whitish is consider more superior to red meat due to several reasons, including its health benefits, as it contains less fat and cholesterol, easy to handle portions and less religious barriers (Liu et al., 2012).

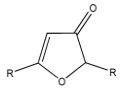
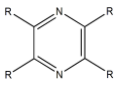
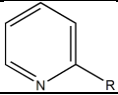
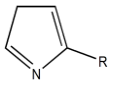
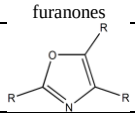
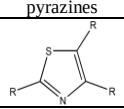
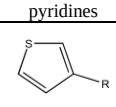
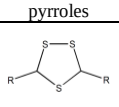
Bloody, metallic, and salty taste is generally a unique characteristic of fresh uncooked meat. Its aroma resembles blood serum (Wasserman, 1972; Joo and Kim, 2011). However, significant changes take place in the flavour of meat during cooking. The main reactions involved during cooking that are responsible for flavour developemnt are Maillard reaction, thermal degradation of lipids and Maillard-lipid interactions (Brunton et al., 2002).

Flavour gets developed during cooking through complex reactions between components found in raw meat combining with heat. More than 1,000 chemicals have so far been identified in the volatiles of different muscle foods (Shahidi et al., 1994). Majority of the volatile compounds identified in cooked poultry meat, have been recognized in chicken (Brunton et al., 2002). However many of these have little influence on flavour of meat and relatively few make a key contribution to the odour and flavour of cooked meat (Aliani and Farmer, 2005).

With respect to chicken meat, many of their key flavor and odor compounds together with the mechanisms for the formation have been identified (Aliani and Farmer, 2005). According to Shi and Ho (1994), 16 primary odor components have been identified in chicken broth, of which 14 are structurally identified. They further demonstrated that 2-methyl-3-furanthiol, generated from the Maillard reaction and lipid oxidation, as the most vital chemical compound responsible for the meaty flavour of chicken broth. In addition, other volatile compounds originated from above two reactions include 2-furfurylthiol, methionol, 2,4,5-trimethylthiazole, nonanol, 2-trans-nonenal, 2-formyl-5-methylthiophene, p-cresol, 2-trans-4-trans-nonadienal, 2-trans-4-trans-decadienal, 2-undecenal, β-ionone, γ-decalactone and γ-dodecalactone. These compounds are obviously the major sources of chicken flavour (Shi and Ho, 1994; Varavinit et al., 2000).

Table 3: Major classes of volatile compounds produced during the cooking of chicken meat (Mottram, 1998).

a) compounds derived from lipid precursors			
			
alkanals	alkanones	alkanoic acid	alkanols
			
γ-lactones	δ-lactones	alkylfurans	

b) compound derived from water soluble precursors			
			
furanones	pyrazines	pyridines	pyrroles
			
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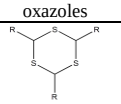	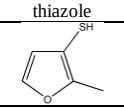	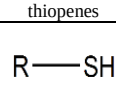	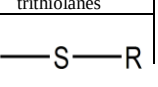
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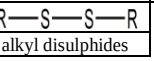			
alkyl disulphides			

Halal Pet Food – The Connection

Halal means permissible according to Islamic Sharia's Constitution. The scope under halal concept are very large which includes daily activities, daily interactions with different gender and even in food processing. In food processing, halal concept covers almost the same as the Good Manufacturing Product (GMP) method, cleanliness of the production and Hazard Analysis and Critical Control Point (HACCP) just to name a few. As of this concern, eventually it attract pet food manufacturer to implement the halal concept into their productions.

Halal method seems to be a must especially for the production of the meat-based pet food for cats in Malaysia because pet owners in Malaysia involve large number of Muslims. Muslims are much more concerns on halal issues however, nowadays, non-Muslims are also looking for halal production. This happens because they found out that most of the pet food industries sometimes using source of dead animal from accidents, died from disease and many unknown source in which the safety of the food are questioned. Unlike in halal method, the animals must be healthy before slaughtering takes place. The animals are slaughtered and conducted properly for food purpose and the cleanliness of the meat are guaranteed. The other reason for the pet food industries to shift their market to halal market is due to highly positive acceptance of people on the halal market.

As per the latest research by the World Halal Forum, quoted in TIME Magazine (May 2009), the total size of global Halal food market is worth about US$ 632 billion in 2009 and if the non-Muslim consumers are included, the total figure will be much higher. Halal industry experts believe the size of total global Halal market including all Halal food, non food products and services ranges from a minimum of US$ 1.2 trillion to US$ 2 trillion per annum. In the West, USA, Brazil, Canada, Australia, New Zealand & France are the biggest Halal suppliers. In the East, Thailand is the biggest exporters of Halal certified products after which Philippines, Malaysia, Indonesia, Singapore and India are the leading Halal products suppliers to the world.

Asians countries are among the world leading suppliers and also importers of Halal products. They compete with each other in producing Halal products. However, they also do significant trading among themselves. For example, Indonesia is the biggest buyer of Malaysian Halal food, proves that Halal food market in Malaysia has high potential in the future. Halal certified products are recognized as hygienic and of good quality, hence these are also in high demand amongst non-Muslims. Multinationals around the world are already part of the Halal trade and major hypermarkets in Europe and Asia sell Halal products. Halal Certified logo gives an international brand identity that is recognized and accepted throughout the world.

As the Halal food market demand increases, the Halal pet food has now also gain increasing demand in the local market. A variety of cultures are interested in buying Halal food. Therefore the Halal food market is expanding dramatically to fill the needs of diverse culture. The pets' owners nowadays are much more particular in choosing their pets' food. There are researches that claimed feeding slaughterhouse wastes to animals increases their risk of getting cancer and other degenerative diseases. As a result, natural and organic pet food manufacturers have been increasing in number in the last few years. The awareness of the importance of Halal pet food to the pets' owner has also contributed to the increasing demand of Halal pet food especially for cat food since Muslim cannot keep dog as pet.

CONCLUSION

Chicken viscera have high potential to be developed as flavor or protein source in pet food industry. Utilization of chicken viscera in the industry can improve food security of the nation as people will no longer competing on getting meats for meal. In the environment perspective, pollution such as smell, flies, and water-based disease that were derived from poultry waste can be avoided. Opportunity in halal industry can be expanded by exploring this kind of field. At the moment, authors and the team are detecting the flavors developed from chicken viscera to ensure and convinced the industry that

chicken viscera can be an alternative source which is way cheaper for chicken flavor and protein source in the cat food.

REFERENCES

Adler-Nissen J. A (ed). (1986). *Enzymatic Hydrolysis of Food Proteins*. London: Elsevier.

Aliani, M., & Farmer, L. J. (2005). Precursors of chicken flavor I. Determination of some flavor precursors in chicken muscle. *Journal of Agricultural and Food Chemistry*, 53(15), 6067-6072.

Aliani, M., & Farmer, L. J. (2005). Precursors of chicken flavor II. Identification of key flavor precursors using sensory methods. *Journal of Agricultural and Food Chemistry*, 53(16), 6455-6462.

American Veterinary Medical Association (AVMA). 2012. U. S Pet ownership and demographic sourcebook. AVMA. Schaumburg IL.

Amir H. M. S., Razauden, Z., Harisun, Y., Ida, I. M & Mona, Z. 2014. Halal cat food for the world market. *International Journal on Advanced Science, Engineering and Information Technology*, 4(4), 26-29.

Belitz, I. H. D., & Grosch, I. W. (2004). *Aroma Compounds*. In Belitz, H.-D., Grosch, Werner, Schieberle, Peter (Eds.) *Food Chemistry* (pp. 342-408). Springer Berlin Heidelberg.

Berg, A. H., Combs, T. P., & Scherer, P. E. (2002). ACRP30/adiponectin: An adipokine regulating glucose and lipid metabolism. *Trends in Endocrinology & Metabolism*, 13(2), 84-89.

Cordle, C. T. (1994). Control of food allergies using protein Hydrolysates. *Food Technology*, 10, 72–76.

Cserháti, T., & Forgács, E. (2003). Cyclodextrins in chromatography (Vol. 9). United Kingdom: *Royal Society of Chemistry*.

Damle, M., Harikumar, P., & Jamdar, S. (2010). Chicken intestine: A source of aminopeptidases. *Science Asia*, *36*, 137-141.

European Union, Regulation (EC) No. 1096/2009 of the European Parliament and of the Council of 21 October 2009. Laying Down Health Rules as Regards Animal By-Products and Derived Products not Intended for Human Consumption and Repealing Regulation (EC) No. 1774/2002. Animal By-Products Regulation.

Hill R.L (1965). Hydrolysis of proteins. Advances in Protein Chemistry, 20, 37–107.

AFB International. (2016, April 17). Electronic references. Retrieved from http://afbinternational.com/en/downloads/understanding-the-drivers-for-palatability-from-basic-science-to-complex-pr.

AFB International. (2016, April 17). Electronic references. Retrieved from http://afbinternational.com/en/downloads/principles-of-pet-food-palatability.

Jamdar, S. N., & Harikumar, P. (2005). Autolytic degradation of chicken intestinal proteins. *Bioresource Technology*, *96*(11), 1276-1284.

Jamdar, S. N., & Harikumar, P. (2008). A rapid autolytic method for the preparation of protein hydrolysate from poultry viscera. *Bioresource technology*, *99*(15), 6934-6940.

Jayasena, D. D., & Jo, C. (2013). Essential oils as potential antimicrobial agents in meat and meat products: A review. *Trends in Food Science & Technology*, *34*(2), 96-108.

Lasekan, A., Bakar, F. A., & Hashim, D. (2013). Potential of chicken by-products as sources of useful biological resources. *Waste management*, 33(3), 552-565.

Laing, D. G., & Jinks, A. (1996). Flavour perception mechanisms. *Trends in Food Science & Technology*, *7*(12), 387-389.

Mottram, D. S. (1998). Flavour formation in meat and meat products: a review. *Food chemistry*, *62*(4), 415-424.

Nagodawithana, T. W. (1995) *Maillard and other Flavor-Producing Reactions*. In Nagodawithana, T. W. (ed*) Savory Flavors*. Esteekay (pp 103–163). Milwaukee, WI.

Nagodawithana, T. W. (1998). *Production of Flavors*. In: Nagodawithana, T. W., Reed, G. (eds) *Nutritional Requirements Of Commercially Important Microorganisms* (pp 298–325). Esteekay Associates, Milwaukee, WI.

Nagodawithana, T. W., Nelles, L., Trivedi, N. B. (2010). Protein hydrolysates as hypoallergenic, flavors and palatants for companion animals. In Pasupuleti V. K,. Demain, A. (eds) *Protein Hydrolysates in Biotechnology*. Springer, The Netherlands.

Oladipupo, B., Stough, J., Guthrie, N. (2011). Application of combined electronic nose and tongue technology in petfood flavor development and quality control. *14th International Symposium on Olfaction and Electronic Nose Proceeding, 1362*. 2-5 May 2011. New York City, USA, 75-76.

Pastorello, E. A., Stocchi, I., Pravetonni, V., Bigi, A., Schilke, M. I. (1989). In Cuvaria C, Zanussi C (eds.) Role of the elimination diet in adults with food allergy. *Journal of Allergy and Clinical Immunology*, 475–483.

Pasupuleti, Vijai, K., and Arnold, L. Demain, eds. (2010). *Protein Hydrolysates in Biotechnology*. Springer Science & Business Media.

Perham (2010, November 15). Anatomy and Physiology of Poultry. Retrieved from https://www.uspoultry.org/educationprograms/PandEP_Curriculum/Documents/PDFs/Lesson11/PoultryAnatomyandPhysiologyPres.pdf

AFB International. (2016, April 17). Electronic references. Retrieved from http://afbinternational.com/en/downloads/principles-of-pet-food-palatability.

Rowe, C., & Skelhorn, J. (2005). Colour biases are a question of taste. *Animal Behaviour*, *69*(3), 587-594.

Sampson, H. A., Scanlon, S. M. (1989) Natural history of food hypersensitivity in children with atopic dermatitis. J Pediatr 11, 23–27.

Sitz, B. M., Calkins, C. R., Feuz, D. M., Umberger, W. J., & Eskridge, K. M. (2005). Consumer sensory acceptance and value of domestic, Canadian, and Australian grass-fed beef steaks. *Journal of Animal Science*, *83*(12), 2863-2868.

Shahidi, F. (Ed.). (2012). *Flavor of Meat and Meat Products*. Springer Science & Business Media.

Understanding the Drivers for Palatability: From Basic Science to Complex Product Systems. (n.d.). Retrieved April 27, 2016, from http://afbinternational.com/en/downloads/understanding-the-drivers-for-palatability-from-basic-science-to-complex-pr

Varavinit, S., Shobsngob, S., Bhidyachakorawat, M., & Suphantharika, M. (2000). Production of meat-like flavor. *Science Asia*, *26*, 219-224.

Wasserman, R. H., Corradino, R. A., Fullmer, C. S., & Taylor, A. N. (1975). Some aspects of vitamin D action; calcium absorption and the vitamin D-dependent calcium-binding protein. *Vitamins & Hormones*, *32*, 299-324.

Wheatley, R.A., Some recent trends in the analytical chemistry of lipid peroxidation. Trends Anal Chem, 2000. 19(10): p. 617-628.

Zellner, D. A., Hoer, K., & Feldman, J. (2012). Names will hurt you: Effect of label on liking and preference. *Proceedings of Fechner Day*, *28*(1), 152-155.