

Potential Application of Duck Meat for Development of Processed Meat Products

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ABSTRACT

Recently, duck farming has been quickly growing, but processed products from duck meat are still not easy to find. Investigating duck meat qualities can provide basic information to improve duck meat utilization. The development of duck meat products on ready-to-cook and ready-to-eat market scales production is expected to increase the cycle and improve consumption of non-chicken meat-based protein. Here, the nutritional and physicochemical properties of duck meat, world duck meat production, processed duck meat including traditional duck meat products, duck meat marketing, the development of new value-added ready-to-cook and ready-to-eat products from duck meat will be discussed to explore the potential of duck as a source of waterfowl meat.

Key words: Nutritional, physicochemical, market, processed meat products, product development

INTRODUCTION

Protein and fat are two important nutrients in meat and meat products. The protein content of duck meat is relatively lower than in other poultry meats. The protein content of duck breasts and legs are 20.8 and 19.6%, respectively (Cobos *et al.*, 2000). When compared to other reports, it is concluded that the protein content of duck meat in that study is lower than the protein content in chicken (Jaturasitha *et al.*, 2008) and turkey (Maruyama *et al.*, 1996). These reports indicate that the protein content of chicken breasts and thighs is 23.6-24.8% and 20.1-21.7%, respectively, whereas the protein content in breasts and thighs of turkey meat is 25.0 and 21.0%, respectively.

The composition of duck meat as one of waterfowl meat source is different with non waterfowl meat sources such as chicken and turkey meat. The percentage of fat in duck meat is relatively higher than other common poultry meats. Fat alteration over storage time will affect the physicochemical and sensory properties (Russell *et al.*, 2004) in the form of raw meat or processed products. Furthermore, compared to chicken or turkey meat, duck meat has higher lipid levels and oxidative energy metabolism (Baeza, 2006).

The aroma of duck meat is relatively stronger than other poultry meats. In a study related to sensory characteristics of duck meat, it found that the flavor of meat is positively correlated with lipid content (Chartrin *et al.*, 2006b) and the higher fat content of duck meat may cause the

Table 1: Fatty acid characteristics in different type and meat parts of ducks

Type of ducks	Meat part	Fatty acid analysis	Value	References
Wild ducks	Breast	SFA	35.1	Cobos <i>et al.</i> (2000)
		MUFA	23.7	
		PUFA	41.2	
	Leg	SFA	31.1	
		MUFA	35.5	
		PUFA	33.4	
Muscovy ducks	Breast	SFA	34.26	Zanusso <i>et al.</i> (2003)
		MUFA	36.92	
		PUFA	22.33	
White Peking duck	Breast	SFA	26.9-40.9	Russell <i>et al.</i> (2003a)
		MUFA	36.2-49.8	
		PUFA	20.7-25.8	
	Thigh	SFA	26.9-32.8	
		MUFA	46.4-56.6	
		PUFA	16.2-25.4	
Muscovy duck	Breast	SFA	38.76-39.72	Schiaivone <i>et al.</i> (2004)
		MUFA	21.23-25.70	
		PUFA	35.61-38.98	
Muscovy, Hinny, Mule and Peking duck	Breast	SFA	32.9-38.6	Baeza (2006)
		MUFA	41.8-50.4	
		PUFA	16.7-19.6	
Muscovy, Hinny, Mule and Peking duck	Breast	SFA	32.42-39.20	Chartrin <i>et al.</i> (2006a)
		MUFA	37.20-49.26	
		PUFA	18.32-23.60	
Six ducks strains	Leg	SFA	30.38-34.99	Woloszyn <i>et al.</i> (2007)
		MUFA	30.49-39.23	
		PUFA	25.01-30.13	

stronger flavor in duck meat. Table 1 shows fatty acid characteristics in different ducks. A high fat content in duck meat causes the meat to be easily oxidized by oxygen and the meat contains a stronger odor when compared to chicken meat. Low molecular weight volatile compounds are involved in odor production. Odor sensations from thousands of low molecular weight compounds consist of aliphatic and aromatic compounds that normally contain a heteroatom (Farmer, 1994).

The pH range of duck meat is 5.4 to 6.3 (Erisir *et al.*, 2009). The pH of duck meat, however, is related to its glycogen content. A higher glycogen contents result in lower pH levels. Some physicochemical characteristics of duck meats presented at Table 2. Essential amino acids expressed as a percentage of total proteins in different duck origins has been studied. The following ranges of essential amino acid percentages were found in duck meats: 6.01-8.08% of phenylalanine and tyrosine, 3.21-6.14% of isoleucine, 7.67-8.45% of leucine, 8.60-9.57% of lysine, 3.11-3.26% of methionine and cysteine, 4.11-5.22% of threonine, 0.70-1.25% of tryptophan and 3.67-7.01% of valine (Woloszyn *et al.*, 2006).

WORLD DUCK MEAT PRODUCTION

Although, the total duck population is less than the chicken and turkey populations in worldwide, duck meat is one of most commercially expensive types of meat. The efforts to improve the quality and quantity of duck meat have been done in duck industrial system. Recently,

Table 2: Analysis of physicochemical characteristics of duck meats

Duck species	Physicochemical characteristic	Value	References
Muscovy, Hinny, Mule and Peking duck	pH	6.27-6.35	Larzul <i>et al.</i> (2006)
	L*	71.9-73.7	
	a*	1.72-2.89	
	b*	16.2-20.8	
	force max (Warner-Bratzler test)	19-43	
Muscovy, Hinny, Mule, and Peking duck	cooking loss	15.20-18.38	Chartrin <i>et al.</i> (2006b)
	shear force (N)	46.88-53.09	
	L*	34.63-39.03	
	a*	13.24-14.00	
	b*	10.13- 12.98	
Muscovy, Hinny, Mule, and Peking duck	Higher lipid content of duck meat will increase lightness, yellowness, tenderness flavor and cooking loss of meat		Baeza (2006)
Rouen, Peking, and Muscovy duck	WHC (%)	62.46-71.06	Omojola (2007)
	shear force (kg cm ⁻³)	2.15-3.91	
	cooking loss (%)	23.67-32.40	
	chilling loss (%)	1.81-2.06	

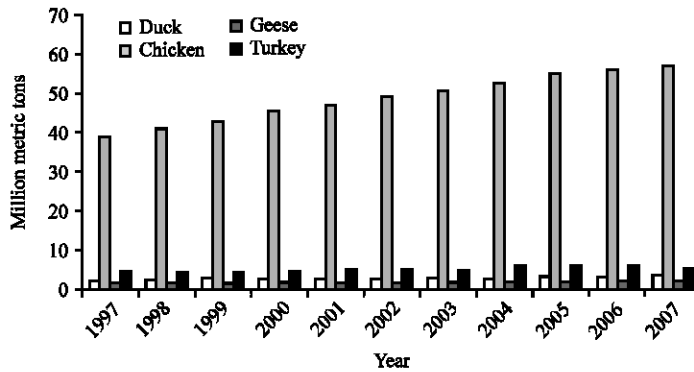


Fig. 1: Total poultry meat production in major production countries (FAOSTAT, 2009)

increased availability of duck meat and an increase in the available processed products prepared with duck meat is evidence of a movement to the large scale production of duck products (Hird *et al.*, 2005). The availability and existence of commercial feed in many places has caused an improvement in the large-scale raising of ducks; this improvement is usually found in traditionally non duck-raising areas (Chang, 2004). Sustainable and rapid developments in the broiler industry have prompted the duck industry to follow the same pattern (Anonymous, 2006). Furthermore, the production of duck meat may contribute to the improvement in the nutritional standards of the world's population.

As shown in Fig. 1, among the four large poultry meat productions in the world, the duck meat production is third, after chicken and turkey, while geese is in fourth place (FAOSTAT, 2009). However, the total production of duck is still far below the total chicken production. Globally, a continuous and rapid development is apparent in duck meat production. In Taiwan, duck production is a vital part in the poultry industry (Lien *et al.*, 1999). In China, the traditional home scale production of poultry is growing to be a regional enterprise. Finally, this industry has an

important role in improving the economic sector of rural society (Lu *et al.*, 2008). The Chinese poultry industry has been supported by a strong feed industry and veterinary services through good policy services and financial support. Peking ducks, Saqoxin ducks and Gaoyou ducks are famous breeds that were developed in China (Yang and Zheng, 2008). The European duck industry provides good facilities, such as well-ventilated, insulated, controlled-lighting and floored housing systems, to support the brooding and rearing of Peking duck parent stocks (Klein-Hessling, 2007). Furthermore, Peking ducks are the main commercial duck meat species. However, Muscovy ducks, Mule ducks and Common Teal ducks are now the next duck meat choices (Martin *et al.*, 2007).

In recent years (1998-2007), China has become the highest duck meat-producing country in the world and has dominated more than half of the world duck meat production. Since, 1998-2007, the total duck meat production of China was as follows: 1, 602, 362 MT (1998); 1,868,291 MT (1999); 1, 865, 503 MT (2000); 1, 911, 549 (2001); 1, 848, 097 MT (2002); 1,917,210 MT (2003); 1, 949, 626 MT (2004); 2, 149, 849 MT (2005); 2, 175, 260 MT (2006); and 2,325,954 MT (2007). Meanwhile, France became the second highest duck meat producing country with the following amounts of duck meat production: 219,700 MT (1998); 224,800 MT (1999); 233,300 MT (2000); 231,100 MT (2001); 253,000 MT (2002); 241,000 MT (2003); 238,600 MT (2004); 233,000 MT (2005); 233,000 MT (2006) and 233,000 MT (2007) (FAOSTAT, 2009). Furthermore, more than 400 million Peking ducks are bred every year in China, placing China as the biggest market for Peking duck breeders and Peking meat consumption. In addition, Peking duck production in Europe is dominated by Germany, UK, France and Netherlands with 23, 10, 4 and 3 million ducks, respectively (Klein-Hessling, 2007).

PROCESSED DUCK PRODUCTS

In Taiwan, duck meat consumption has increased significantly in recent years, thus resulting in this meat becoming an important food commodity in Taiwan. Boiled salted duck, charcoal grilled duck, roasted duck and smoked duck are the famous processed duck meat products in Taiwan (Chen and Lin, 1997). Generally, various kinds of traditional food prepared from duck meat have grown in number over the years in many countries. Peking roasted duck, Nanjing cooked duck, Zhangcha duck (China), Canard à l'Orange (France), Oritang (Korea) and gulai itiak lado mudo (Indonesia) are several traditional applications now found commonly. However, the traditional applications of duck meat cannot stimulate rapid growth of the development of duck meat applications in this decade.

Compared to chicken and turkey meats, the demand of duck meat is relatively low. Duck meat is usually provided in the form of frozen meat in the supermarket to avoid the loss of unsold duck meat over time (USDA, 2006). Low demand for duck meat positively correlates with the low consumption of duck meat. Many factors have contributed to the low level of duck meat consumption when compared to chicken meat, reflected in low levels of duck meat acceptance and preference by society. Acceptance, preference and consumption of the duck meat can be limited in society by some constraints, such as the unavailability of the ducks, the inability to slaughter ducks, an uncertainty of duck meat, lack of demand for ducks and weakness of market system for selling duck meat products (Oteku *et al.*, 2006). The effort to solve these problems should be focused on by researchers and government to popularize the duck meat as a food choice. A persuasive approach and good policies from the government will hopefully attract the society to use duck meat in greater quantities.

Cooked and dry cured duck products: Nanjing cooked duck and Nanjing dry-cured duck are the two famous Chinese duck products that commonly use Gaoyou ducks in their formulation (Wang *et al.*, 2009). The final product taste of Nanjing cooked ducks is enhanced due to the brining process used before boiling, which creates a delicious final taste (Liu *et al.*, 2007). In Nanjing dry-cured duck processing, several aspects, such as dry-curing, marinating, piling and drying processes, are involved during the preparation. Chinese, as well as Southeast Asians, accept this product due to its good flavor and texture formation (Xu *et al.*, 2008). Nanjing water-boiled salted duck is another type of traditional Chinese food that uses duck meat as the main component. In cooking, the low temperature used to produce the savory taste and tender texture, resulting in this product's popularity as a delicacy (Liu *et al.*, 2006).

Roasted duck: The distinctive aroma of Beijing roasted ducks is due to the active compounds resulting from different reactions during the cooking process. The degradation of fatty acids and amino acids, Maillard/Strecker reactions and other associated reactions are involved in cooking this traditional food (Chen *et al.*, 2009). The processing methods, such as steaming, roasting, smoking, charcoal grilling and liquid smoke flavoring, were found to be related to the formation of Polycyclic Aromatic Hydrocarbons (PAHs) in duck meat and different formation of PAHs in duck meat products were related to differences in processing methods. A product prepared with 3 h of smoking treatment produced the highest PAHs compared to the other duck samples analyzed (Chen and Lin, 1997).

Organ product *Foie gras*: French and Dane are the main peoples that consume liver pâté in Europe. There is a form of pâté food called foie gras, which is made from pieces of liver lobe (duck, goose, and pork) combined, and it can be found packed in terrines, jars, and tins or found in vacuum packs in markets. For pâté de foie gras production, the weight of duck livers is usually selected between 320 g and 500 g before further processed. In France, most of the foie gras is prepared using mule ducks (Sellier *et al.*, 2005). There are several classifications of foie gras products available in the market. One of them is a foie gras product that is expensive and is usually only prepared from goose or duck. There are four categories in this classification as follows: entire goose or duck foie gras, goose or duck foie gras, goose or duck lump foie gras and goose and/or duck foie gras parfait (Rodriguez *et al.*, 2003).

DUCK MEAT MARKETING

Duck meat marketing is not as big as chicken meat marketing, but the industrial aspects of duck may not be very different from the common poultry market attracting the focus of consumers. Generally, the problems faced by the duck industry are related to husbandry and other aspects related to preparation and processing; i.e., before the duck product is consumed. Moreover, an effort involving an incentive for the producer and creating affordable prices for duck products should be organized to aid the duck industry (Gajendran and Kathiravan, 2008). All of the information related to the product must be delivered to consumers as part of an effort to reach a larger market share than is currently targeted (Chang *et al.*, 2005). Capacity utilization rates, labor productivity, penetrate growing, export market and innovation are several of the economic challenges for the duck industry. However, basic factors, such as breeding and productivity, of duck farms, should also be targeted, in addition to the above-mentioned aspects (Holdings, 2001). The ability to solve these challenges will minimize the distance between the duck market and the chicken market (as the first class poultry industry) and will make duck meat more representative of waterfowl poultry.

DEVELOPMENT OF NEW VALUE-ADDED READY-TO-COOK AND READY-TO-EAT PRODUCT FROM DUCK MEAT

Commonly, ready-to-cook products require a partial processing stage in addition to a full processing stage; in this partial processing stage, the products are brought to a special temperature condition before using. On the other hand, ready-to-eat products are eaten directly after processing. Lifestyles and eating habits of busy societies have an effect on the growth of ready-to-cook and ready-to-eat products and many of these food products include meat based food products.

Asia and Europe are the two continents where the development of processing technologies for meat manufacturing has been done. However, in last decade, wider dissemination and adoption of meat processing technologies from Europe by other countries causing European technology to be more dominating world meat processing today (Heinz and Hautzinger, 2007). Currently, many types of meat products are easily found all over the world. The diversification of meat products has been developed in many forms, such as in the substitution of meats, binders and spices, with other potential components.

Many researchers have been focused on the effort to improve the quality of meat product, such as buffalo sausage (Sachindra *et al.*, 2005). Sausage is a processed meat product with elastic characteristic and it is usually composed of beef and chicken meats. Sausage is usually prepared by mixing the minced meat with a binder and spices and this formulation is then inserted into special casing. Sausage as a raw product is cooked by a steaming or smoking method.

The use of duck meat in sausage manufacturing may be a good choice, as the effort to make duck meat more popular and acceptable by consumers is increasing. The innovation of sausage prepared with duck meat as the main component will hopefully meet the protein requirements of humans. Some researchers have reported a diversification of sausage reflected in the use of duck meat. Duck sausage manufacturers try to use 10% cereal flours, such as rice, wheat, corn, millet and barley, combined with 10% beef fat. The addition of cereal flour causes a decrease in the protein and fat contents, which reduces the total expressible fluid of duck sausage batters. The lowest cooking loss was found in sausage prepared with 10% wheat flour. The addition of cereal flour and beef fat to the formulation causes a decrease in duck sausage hardness (Yang *et al.*, 2009).

An acceptability study on sausages that use broiler meat, spent hen meat and spent duck meat has been carried out and the results are shown in Table 3. Sausage produced using spent duck meat has a higher fat content when compared to the fat content of the sausage produced from broiler meat and spent hen meat. Moreover, spent duck sausage is in the range of standard nutritional values and is accepted by panelists. Sensory judgment is an important aspect for consumers. Almost all of the sensory judgments of spent duck sausages were similar to those for sausage prepared with broiler and spent hen during storage (Bhattacharyya *et al.*, 2007). This result suggests that the potency of duck sausages is relatively similar to that of chicken sausages, represented by similar sensory qualities as chicken nuggets prepared using the common formula in nugget preparation. However, this study contradicts the results of other researchers who have reported a lower sensory test judgment for duck sausage (Dewi *et al.*, 2008), different from the previous sensory test judgments. However, these differences in formulation and processing are aspects that determine the quality of meat products.

Other restructured products are found to be widely consumed all over the world, with chicken nuggets being the main product. Nuggets are usually prepared with batter and have been pre-fried. This product should be treated with final cooking, such as deep frying, before consumers

Table 3: Quality analyses of several duck based meat products

Duck-based					
No	meat products	Treatment	Specific treatment	Effect	References
1	Duck patties	Source of meat, storage time	Meat (chicken broiler, spent hen, and duck meat) and storage time (0, 3, 7,14,21 days)	Duck patties have higher fat content, no significant result in sensory evaluation	Biswas <i>et al.</i> (2006)
2	Duck sausages	Source of meat, casing and storage time	Meat (broiler, spent hen and spent duck meat), casing (natural and artificial) and storage time (0, 3, 7,14,21 days)	Duck sausages have higher fat content, natural casing are more preferable	Bhattachary <i>et al.</i> (2007)
3	Duck nuggets	Percentage of wheat flour	10%, 15%, 20%, 25% and 30%	Duck nuggets with 30% wheat flour are more preferable	Lukman <i>et al.</i> (2008)
4	Duck nuggets	Washing time of duck meat	0, 1, 2, 3 and 4 times washing	Lighter nugget with 4 times washing treatment	Lukman <i>et al.</i> (2009a)
5	Duck nuggets	Frying oil	Palm, corn, soybean, sunflower and canola oil	Lighter nuggets fried with canola oil, all cooking oil are acceptable	Lukman <i>et al.</i> (2009b)
6	Duck sausages	Different binder	Tapioca, wheat, sago and potato flour	Sausages with sago flour are more preferable	Dewi <i>et al.</i> (2008)

eat it (Albert *et al.*, 2009). Nugget development is being carried out with buffalo meat (Sahoo and Anjaneyulu, 1997; Thomas *et al.*, 2006, 2007) and goat meat (Das *et al.*, 2008).

Other ready-to-cook and ready-to-eat products that are easily found in modern markets are meatballs. Meatballs are created from grinding meat that has flour added to the meat as a binder, as well as an extender and some spices. Meatballs are made in a circular shape and are cooked in boiling water to obtain ready-to-eat meatballs or packaged and kept in refrigerators for ready-to-cook products. Meatballs are usually prepared with beef, chicken and fish as the dominant components. There are currently studies on meatballs from beef (Fernandez-Lopez *et al.*, 2005; Yizman, 2005; Serdaroglu, 2006), chicken (Tseng *et al.*, 2000) and turkey meat (Karpinska-Tymoszczyk, 2007).

Satay is another potential duck meat product. Until recent years, satay has been the most popular spiced roasted meat in Southeast Asia, especially in Indonesia and Malaysia. Satay is created from beef meat, chicken meat, or goat meat, which can be substituted with duck meat. Duck meat satay offers a variation in satay taste because the fat content of duck meat is slightly higher than the other meats, which creates a stronger aroma during the roasting process. The application of duck meat to common ready-to-cook and ready-to-eat meat products on the market scale will improve the utilization of duck meat for food and will increase duck meat production and consumption worldwide.

CONCLUSION

Duck meat has been identified to have a slightly higher fat content and lower protein than common poultry meat, such as chicken. Recently, the total production of duck meat has increased and China is the largest duck meat producer worldwide. Many variations of duck meat products in China are relevant because duck meat products are a part of the Chinese people's daily food consumption. However, other countries also produce duck meat products, although, in lower

production levels than market scale levels. The marketing of duck meat and its products needs innovation to increase market demand. The development of new products, such as ready-to-cook and ready-to-eat duck meat-based products, is required to introduce duck meat in modern daily life.

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