QUALITY AND STABILITY OF DUCK SAUSAGES

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QUALITY AND STABILITY OF DUCK SAUSAGES

by

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LIST OF ABBREVIATIONS

AFDO	Association of food and drug officials
ANOVA	Analysis of variance
ATP	Adenosine triphosphate
a*	Redness
b*	Yellowness
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
^{o}C	Degree centigrade
Ca	Calcium
EU	Europe United
EWP	Egg white powder
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistic
FG	Fresh garlic
FG 20	20 g/kg from 1 kg duck sausage formulation added fresh garlic
FG 30	30 g/kg from 1 kg duck sausage formulation added fresh garlic
FG 50	50 g/kg from 1 kg duck sausage formulation added fresh garlic
FSIS	Food safety and inspection service
GP	Garlic powder
GP 6	6 g/kg from 1 kg duck sausage formulation added garlic powder
GP 9	9 g/kg from 1 kg duck sausage formulation added garlic powder
GP 15	15 g/kg from 1 kg duck sausage formulation added garlic powder
H_2S	Hydrogen sulfide
IFST	Institute of food science and technology
Kg	Kilogram
Lbs	Pund-mass

L*	Lightness
LSD	Least significant difference
mcg	Micrograms
mt	Million tonnes
MDDM	Mechanically deboned duck meat
P	Phosphate
PUFA	polyunsaturated fatty acids
min	Minute
mg	Milligram
ml	Milliliter
MPL	Maximum permissible levels
NaCl	Sodium chloride
NH_3	Ammonia
g	Gram
rpm	Revolution per min
SD	Standard deviation
SEWP	Sample with addition of sago flour and egg white powder
SF	Saturated fat
SPSS	Statistical package for social science
t	Tonnes
TEWP	Sample with addition of tapioca flour and egg white powder
TBHQ	Butylhydro quinone
UK	United Kingdom
US	United State
USDA	United States Department of Agriculture
v/v	Volume/volume
WHC	Water holding capacity

KUALITI DAN STABILITI SOSEJ DAGING ITIK

ABSTRAK

Kajian mengenai kualiti fiziko-kimia, tekstur, ciri-ciri sensori, dan kestabilan sosej daging itik telah dijalankan dengan berpandukan objektif berikut iaitu: 1) mengkaji kesan penggunaan tepung yang berbeza (ubi kayu, gandum, sagu dan kentang) terhadap kualiti sosej daging itik; 2 menilai kesan kombinasi tepung ubi atau tepung sagu dengan putih telur serbuk (EWP) dalam membuat sosej daging itik; dan 3) mengkaji kesan penambahan bawang putih segar dan serbuk terhadap sosej daging itik semasa penyimpanan sejukbeku. Dalam eksperimen 1, penghasilan sosej daging itik menggunakan tepung yang berbeza (ubi kayu, gandum, sagu dan kentang) menunjukkan kesan signifikan ($P > 0.05$) terhadap kandungan protein, lemak, abu dan karbohidrat. Sosej daging itik dengan penambahan tepung ubi kayu memberikan nilai kecerahan (L^*) dan kemerahan (a^*) yang lebih tinggi berbanding sampel lain. Sosej daging itik dengan penambahan tepung sagu mempunyai markah ujian lipatan, kekenyalan dan penerimaan sensori yang lebih tinggi berbanding sampel lain. Dalam eksperimen 2, penggunaan kombinasi tepung ubi kayu atau tepung sagu dan serbuk putih telur meningkatkan ($P < 0.05$) kandungan lembapan, protein dan lemak, uji lipatan, cooking yield, keupayaan memegang air (WHC), tetapi menurunkan nilai pH. Keupayaan memegang air (WHC), kecerahan (L^*) dan kemerahan (a^*), retensi lembapan dan retensi lemak bagi sosej daging itik. Tidak ada perbezaan ($P > 0.05$) pada nilai kekerasan dan kesepaduan pada semua sampel yang diperiksa tetapi

terdapat perbezaan ($P < 0.05$) berlaku pada kekenyalan, kekunyahan dan kegaman. Penerimaan keseluruhan pada uji sensori adalah lebih tinggi bagi sosej itik yang disediakan dengan menggunakan tepung sagu dan EWP berbanding sosej yang disediakan dengan tepung ubi kayu dan EWP. Dalam Eksperimen 3, penambahan bawang putih segar atau serbuk bawang putih mempengaruhi kualiti sosej daging itik selama 21 hari penyimpanan sejukbeku. Kandungan lembaban, protein dan lemak, pH, kandungan ketengikan (TBA) dan hitungan plat penuh (TPC) dan hitungan kulat penuh telah diukur. Umumnya, semua jenis sampel menunjukkan kandungan lembaban dan pH menurun, manakala peningkatan kandungan protein dan lemak sepanjang tempoh proses penyimpanan sejuk beku. Kandungan TBA dan TPC meningkat selama tempoh penyelidikan pada semua sampel, kenaikan adalah lebih rendah di dalam sampel dengan penambahan bawang putih disebabkan kerana kesan antioxidant dan antimikrob daripada bawang putih. Nilai TBA daripada sosej itik dengan penambahan serbuk bawang putih menunjukkan hasil yang lebih tinggi berbanding sampel kawalan sepanjang tempoh penyimpanan. Perlakuan bawang putih segar dan serbuk bawang putih adalah lebih berkesan dalam mencegah pertumbuhan mikrob daripada tanpa penambahan, tetapi penambahan BHT adalah sedikit lebih rendah jumlah mikrob pada sosej daging itik. Secara keseluruhan, sebanyak 50 g/kg bawang putih segar menunjukkan kesan yang paling baik untuk mengurangkan nilai TBA berbanding amaun bawang putih lain yang digunakan dalam sosej itik.

QUALITY AND STABILITY OF DUCK SAUSAGES

ABSTRACT

A study on quality physicochemical, textural, sensory attributes and stability of duck sausage has been conducted with respect to the following these objectives: 1) to study the effects of different flours (tapioca, wheat, sago and potato) on duck sausage quality; 2) to evaluate the effects of combination of tapioca flour or sago flour and egg white powder (EWP) in duck sausage making; and 3) to compare the effects of adding garlic (fresh and powder) on duck sausage quality during refrigerated storage. In Experiment 1, the production of duck sausage with different type of flours (tapioca, wheat, sago and, potato) showed significant difference ($P > 0.05$) on protein, fat, ash and carbohydrate contents. Duck sausage with tapioca flour added gave a higher lightness (L^*) and redness (a^*) values compared to other samples. Hardness of duck sausage with wheat flour added was significantly higher ($P < 0.05$) than other samples. Duck sausage with sago flour added gave higher folding test, springiness and more acceptable on sensory evaluation compared to other samples. In Experiment 2, combination use of tapioca or sago flour and EWP has significantly increased ($P < 0.05$) the moisture, protein and fat contents, folding test, cooking yield, water holding capacity (WHC), lightness (L^*) and redness (a^*) values, moisture retention and fat retention capacity in duck sausages. However, the ash and carbohydrate contents of duck sausages prepared using flours and EWP have significantly decreased as compared to their counterparts without EWP. There was no significant difference

($P > 0.05$) in hardness and cohesiveness among all the samples examined but significant differences ($P < 0.05$) occurred in springiness, chewiness and gumminess. Overall acceptability was higher for duck sausage prepared using sago flour and EWP compared to duck sausages prepared with tapioca flour and EWP. In Experiment 3, the addition of fresh garlic or garlic powder affected the quality of duck sausage during 21 d of refrigerated storage. Moisture, protein and fat contents, pH, thiobarbituric acid (TBA) content, total plate content (TPC), total yeast and mold count were measured. Generally, all sample types showed decreased moisture content and pH, while increased protein and fat contents over the course of the refrigerated storage period. TBA values and TPC increased during the experimental period for all sample types, the increases were lower in the samples with garlic added due to the antioxidant and antimicrobial effects of garlic. TBA values of duck sausage with fresh garlic or garlic powder added were higher than that of the control throughout the storage period. Fresh garlic and garlic powder were more effective in preventing microbial growth than without addition of antioxidant but addition of BHT was slightly better. Overall, the addition of 50 g of fresh garlic per kg sausage was the best at reducing the TBA value among the six levels of garlic tested in duck sausage.

CHAPTER 1
INTRODUCTION

1.1 Background and Rationale

The poultry meat industry has grown steadily paralleled with the increasing demand for poultry meat based products recently. The poultry meat based products have become desired products preferred by the consumer throughout the world in every countries and regions due to the awareness of modern people towards consuming nutritional food (Sonalya & Swan, 2004). Therefore, the industries related with the poultry meat products have always aim to fulfil the consumer demand for nutritious food with excellent pleasing, juicy taste of the meat products (Siripunyawit, 2011).

Duck meat is the one of the important sources of poultry meat besides chicken. Duck meat production and the livestock are increasing continuously for the past twenty years around the world and most of the increase happened in Asian countries. The worldwide duck meat production was about 3.95 mt in 2007 and Asia accounts for 84% of world output (Poultry Hub, 2009). This increment came from the growing duck population of local breeds and the expansion of imported breeds from foreign breeding companies as well as rapid development and wide acceptance of duck meat products amongst consumers (Lallo, 2004). Thus, it has generated interest on research and development to create and to produce more variety of value-added products based on duck meat (Huda *et al.*, 2010b).

Duck meat sausage is a new product which would expand duck meat product varieties and orients consumers towards different alternatives dish. With the changing of consumer trends, sausage has become a popular snack or side dish especially among children and gradually being served as a complete and nutritious meal itself (Siripunyawit, 2011). The improvement of duck sausage formulation and production could provide more choices to the consumers. Heinz & Hautzinger (2007) stated that it is more important for developing food variety with the combined effects of nutritious value with excellent taste.

Polysaccharide and non-meat protein ingredients are important ingredient in sausage formulation to act as a binding agent to contribute for better final products. The use of polysaccharide and non-meat protein ingredient such as tapioca starch, potato starch, cereal flours and whey protein in sausage formulations have been studied (Hughest *et al*., 1998; Hsu & Sun, 2006; Serdaroğlu, 2006; Yetim *et al*., 2006; Ruban *et al*., 2008; Ayadi *et al*., 2009; Yang *et al*., 2009). Egg white powder (EWP) is known to have high source of protein and fat, and it is produced from fresh egg with or without separating the yolk and albumen, and further dried by spray drying. The EWP is used in many food product and also meat products for different purpose such as emulsifier, texture and nutrients enhacers especially to increase protein and fat contents (Lu & Chen, 1999; Hsu & Sun, 2006). In this study, tapioca flour, wheat flour, sago flour, potato flour and EWP were incorporated into duck meat sausage formulation to study their respective effects on sausage quality in terms of physicochemical, textural, and sensory attributes.

The demand for better quality duck sausage had led to the addition of antioxidants in the sausage formulation, as antioxidants inhibit both lipid oxidation and microbial growth and therefore prolong the shelf life of the product and prevent food-borne illnesses. Synthetic antioxidants,such as butylated hydroxy toluens (BHT), currently are used in sausage formulation. However, questions about the safety of using synthetic antioxidants, which could have toxic and carcinogenic effects on health, have led to an increased interest in natural antioxidants, especially those from plants that also can be used as a preservative (Aguirrezaábal *et al*., 2000). In this study, garlic will be added into the sausage formulation to serve as natural antioxidant. Garlic is the most common spice that has been widely used to control and minimize lipid oxidation process and microbial growth in meat products (Ankri & Mirelman, 1999; Ali *et al*., 2000; Sun *et al*., 2000; Pandey, 2001; Mielnik *et al*., 2003; Sovová & Sova, 2004).

1.2 Research objectives

The objectives of this study were:

1. To determine the effects of different types of flour (tapioca, wheat, sago, and potato) on duck sausage quality (physicochemical, textural, and sensory attributes).
2. To evaluate the effects of combination of tapioca flour or sago flour with EWP on the quality of duck sausage making.
3. To compare the effects of fresh garlic and garlic powder on the quality of duck sausage during refrigerated storage.

CHAPTER 2
LITERATURE REVIEW

2.1 Production and Characteristic of Duck

2.1.1 Types of broiler duck

Ducks have served as a source of food and income for people in many parts of the world from ancient times. The breed of farmed duck used to produce meat is known as broiler duck. Duck meat was derived primarily from the breast and leg. Common duck is believed to originate from the Mallard species (*Anas platyrhynchos*) and the two major commercial farmed duck are Peking and Muscovy (Lallo, 2004; Dean & Sandhu, 2008).

2.1.1 (a) Peking duck

Peking duck (*Anas platyrhynchos domestica*, or *Anas peking*) or Long Island duck, which is originated from China is breed of domesticated duck farmed primarily for its egg and meat production. It is also the most popular commercial duck breed in the United States because about 95% of duck meat consumed in the United States is Peking duck (Lallo, 2004; Dean & Sandhu, 2008).

Peking duck is the most common choice for commercial farming due to the rate of its growth is fast and has good feed conversion. Peking duck has a large body, orange feet, beak, creamy white feathers, and can achieve weight of up to 3.2 kg by 6 weeks (Poultry Hub, 2009).

2.1.1 (b) Muscovy duck

Muscovy duck (*Cairina moschata*) is originated from Brazil, South America, and Asia. The growth of Muscovy duck is quite slow and generally takes 10 to 11 weeks to achieve market weight (Lallo, 2004; Dean & Sandhu, 2008; Poultry Hub, 2009). Muscovy duck is easily identified by its carunculated face or red, knobby in nodules along the eyes above the base of the beak and it has three varieties: the white, the coloured and the blue. Muscovy is popular due to its red gamy and attractively marbled meat, which is commonly used to make special delicacy. Muscovy duck has carcass yield between 66% and 68% (Ola, 2000). Figure 2.1 shows the appearance of Peking and Muscovy duck.

Figure 2.1 Two breeds of broiler duck in Pinang market

2.1.2 Composition of duck meat

The composition of duck meat by breed and sex are different, even the composition of each organ in species is also different (Omojola, 2007). The comparison of quality properties between Peking and Muscovy ducks meat are

presented in Table 2.1. The weight of Peking and Muscovy duck are similar but it has been found that the values of the physicochemical properties are different.

Table 2.1 Comparison of physicochemical properties between Peking and Muscovy duck meat

Physicochemical	Peking	Muscovy
Live weight (g)	2000.00	2000.00
Dressing (%)	66.67	71.18
Moisture (%)	75.62	73.55
Water Holding Capacity (%)	71.06	66.10
Shear force (kg/cm2)	2.64	3.28
Cooking loss (%)	23.67	25.00
Chilling lost (%)	2.06	1.88
*Colour	4.00	3.71
*Flavour	3.56	3.38
*Tenderness	3.67	4.67
*Juiciness	4.78	4.00
*Texture	3.44	3.22
*Overall Acceptability	5.67	5.11

Source: Omojola, (2007). *(Sensory score: 1 = Dislike very much; 2 = Dislike moderately; 3 = Dislike slightly; 4 = neither like nor dislike; 5 = Like slightly; 6 = Like moderately; 7 = Like very much).

Peking duck meat was higher in moisture content and water holding capacity (WHC). Likewise, the sensory attributes were higher than Muscovy duck. The range of sensory scores for Peking duck meat is 3.44 to 5.67 and for Muscovy duck meat, the score are 3.22 to 5.11 (Omojola, 2007). Addition that Peking duck meat is slightly more acceptable than Muscovy duck meat. But the score indicated that the panellists dislike slightly and neither like nor dislike duck meat. The Muscovy duck was heavier than Peking duck. The weight of the liver

was equal for the Muscovy and the Hinny ducks and higher in the Mule duck. For physicochemical traits, significant genetic effects were less but the Muscovy additive effect induced a lighter meat and the *L** value of muscle was a favourable heterocyst effect when measured at 1 and 9 days post mortem.

Larzul (2006) remarked direct genetic effects estimated for textural properties were most favourable to the Peking duck, which showed a more tender meat than Muscovy duck. Chatrin *et al*. (2006) mentioned that the flavour of duck meat is stronger than other poultry meats because it is higher in fat content. The high fat content in duck meat caused the oxidation process to become easy to happen and faster in rate. The breast weight of Muscovy ducks was higher and the lipid level was lower than Peking. Peking ducks exhibited the highest lipid levels and the lowest breast weights. The physicochemical of duck breast muscles from five flocks also has been studied by Larzul (2006) and Chatrin *et al*. (2006). The range of moisture (mg/100 g), protein, lipid and cholesterol contents were 76.10 - 77.70%, 19.53 - 21.81%, 0.80 - 1.32% and 71.21 - 111.82%.

Breast muscle colour of Muscovy ducks was paler, less red, and more yellow than that of other genotypes and breast muscle of Peking ducks which exhibited the lowest values for lightness (*L**), yellowness (*b**) and was judged more tender, juicy and less stringy than that of other genotypes. In contrast, scores for breast muscle of Muscovy ducks were rated the lowest for tenderness, juiciness, and flavour, and the highest for stringiness. The 0 °C chilled water temperature improves colour and does not induce cold shortening, so this temperature could be utilized to chill the whole duck carcass at duck processing plants. Furthermore, the interaction of meat type and chilling temperature on

cooking loss was significant. Leg meat shewed higher cooking loss than breast meat during chilling temperature and chilling at temperature of 20 °C resulted in higher cooking loss than other chilling temperatures (Chartrin *et al*., 2006; Ali *et al*., 2008).

According to Table 2.2, the muscles of duckmeat contained all essential amino acids, lipids and minerals. The glutamic and Aspartat acids are higher than other. Probably different physiological mechanisms in the analysed ducks resulted in the differences in chemical composition and the kind of flocks affected on profile of amino acids and fatty acids (Wołoszyn *et al*., 2006).

Table 2.2 Amino acids, lipids and mineral composition of duck meat

Nutrient	Units	Value per 100 g
Amino acids		
Isoleucine	g	0.939
Leucine	g	1.544
Lysine	g	1.564
Arginine	g	1.166
Alanine	g	1.158
Aspartic acid	g	1.790
Glutamic acid	g	2.860
Glycine	g	1.024
Lipids		
Fatty acids, total saturated	g	2.320
Fatty acids, total monounsaturated	g	1.540
Fatty acids, total polyunsaturated	g	0.750
Cholesterol	mg	77
Minerals		
Calcium, Ca	mg	11
Magnesium, Mg	mg	19
Phosphorus, P	mg	203

Table 2.2 continued

Nutrient	Units	Value per 100 g
Potassium, K	mg	271
Sodium, Na	mg	74
Zinc, Zn	mg	1.90
Selenium, Se	mcg	13.9

Source: USDA (2009a)

According to Table 2.3, duck meat with skin has the lowest moisture and protein content but has the highest fat content compared to other parts. Duck meat showed the lowest protein and lipid content including saturated fat and polyunsaturated fat when compared to the chicken meat, turkey meat or goose meat. The Ca content of duck meat was similar with others and cholesterol of duck meat was higher than chicken meat but lower than the turkey or goose meat. Bochno *et al.* (2005) reported that ducks were relatively high in carcass fatness, which results from both genetic and environmental factors as compared with other species of domestic fowls.

Table 2.3 Comparison nutrition of raw duck, chicken and, turkey meat g/ 100 g

Poultry Meat	Moisture	Protein	Lipid	Ash	CHO
Duck meat with skin	48.5	11.49	39.34	0.68	0
Duck meat only	73.77	18.28	5.95	1.06	0.94
Chicken meat with skin	65.99	18.6	15.06	0.79	0.0
Chicken meat only	75.46	21.39	3.08	0.96	0.0
Turkey meat with skin	70.4	20.42	8.02	0.88	0.0
Turkey meat only	74.16	21.77	2.86	0.97	0.24
Goose meat with skin	49.66	15.86	33.62	0.87	0.0
Goose meat only	68.3	22.75	7.13	1.1	0.0

Table 2.3 continued

Poultry Meat	SF	PUFA	Ca	P	Cholesterol
Duck meat with skin	18.69	5.08	11.0	203	76
Duck meat only	1.54	0.75	11.0	147	77
Duck meat only	1.54	0.75	11.0	147	77
Chicken meat with skin	6.24	3.23	11.0	147	75
Chicken meat only	0.9	0.75	12	173	70
Turkey meat with skin	2.9	1.98	15	178	68
Turkey meat only	0.61	0.83	14	195	65
Goose meat with skin	17.77	3.76	12	234	80
Goose meat only	1.85	0.9	13	312	84

Source: USDA (2009a). CHO= carbohydrate; SF = saturated fat; PUFA = polyunsaturated fatty acids; P = phosphate.

2.1.3 Production and consumption of duck meat

There is an increasing trend in both of live duck stocks and duck meat production during the last ten years. Figure 2.2 shows the numbers of life duck stock increase continuously since 1991 after reaching a peak in 1997, but declined in 1999, and finally continue to rise until 2008. The increasing of number of duck meat production from 1991 to 2008 was 185.06% and for number of stocks was 92.69% during eight years. Duck meat production and the number of stocks from 1991 to 2008 increased by 185.06% and 92.69%, respectively. Worldwide duck meat production was about 3.95 mt in 2007 and Asia accounted for 84% of the world output.

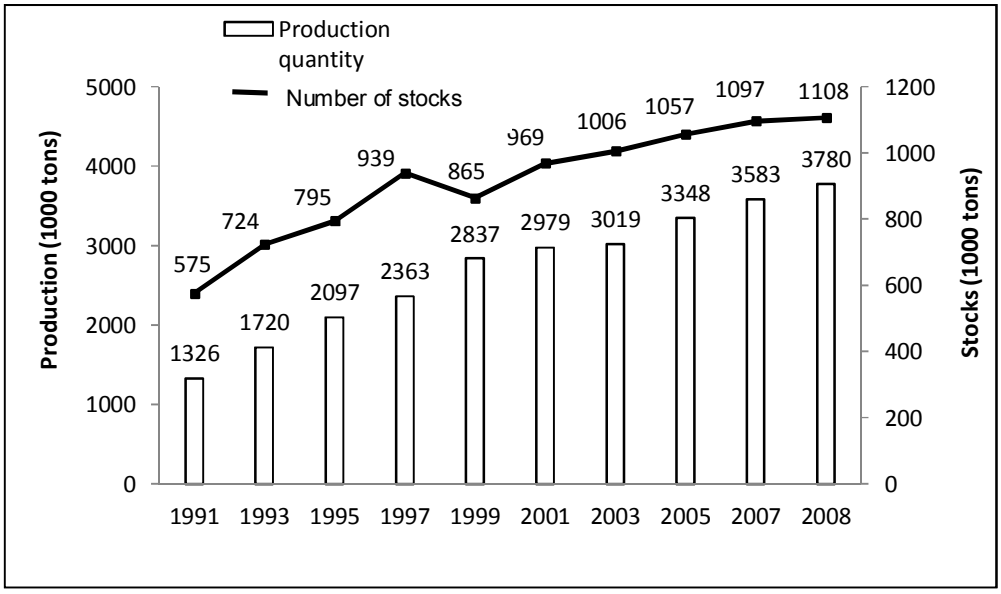

Figure 2.2 World's duck meat production and live stock (FAOSTAT, 2010).

Duck meat production has also increased continuously for the past twenty years around the world and most of this increase occurred in Asian countries. The primary goal of animal production, including broiler duck is increasingly carried out within a system of integrated agriculture to satisfy the growing demand for safe food necessary to feed the rapidly increasing human population (Poultry Hub, 2009).

Based on Table 2.4, the duck meat production has increased continuously since the last decade. Today, a growing demand has seen a positive move away from the traditional backyard or smallholder flocks to large-scale commercial systems. China still lead the population of duck in the world then followed by French and Thailand (Poultry Hub, 2009). FAO statistics put the world's duck meat production in 2008 at 3.78 mt and Asia accounts for 82.5% of world output (Bird, 2010).

Table 2.4 Duck meat production (‘000 t)

Region	2000	2004	2005	2006	2007	2008
Africa	56.5	56.6	56.6	57.4	57.5	57.1
North & Central America	80.0	106.7	112.8	113.3	113.3	112.0
USA	52.6	79.0	85.1	85.6	83.4	84.0
South America	16.3	16.7	16.7	17.4	17.5	17.6
Argentina	7.3	7.4	7.4	7.5	7.5	7.7
Brazil	7.2	7.4	7.4	7.5	7.5	7.5
Asia	2316.7	2494.3	2712.6	2744.4	2936.2	3121.9
China	1866.7	1950.3	2150.0	2175.3	2328.2	2518.2
Malaysia	64.3	102.0	107.0	108.0	110.0	111.0
Thailand	102.5	84.8	85.0	84.9	84.9	84.9
Viet Nam	69.6	88.2	88.2	86.0	84.0	84.0
Korea Rep	44.7	46.0	52.0	53.0	57.0	54.0
Indonesia	13.8	22.2	21.4	24.5	44.1	45.2
Europe	404.2	424.6	438.5	425.8	456.0	459.0
France	233.3	238.1	233.8	233.4	246.8	246.8
Germany	40.0	37.0	40.1	38.5	55.8	60.8
Hungary	43.4	48.1	53.1	44.5	51.4	51.4
Ocean	8.8	10.3	10.8	11.7	12.2	12.2
Australia	8.0	9.5	9.9	10.9	11.4	11.4
World	2882.4	3109.4	3348.2	3370.2	3590.7	3780.0

Source: Poultry Hub (2009).

Figure 2.3 shows the top ten exporters in the world since 1997 to 2007. China holds the top position of having very large increase over the last ten years as a producer and exporter of duck meat to the world), followed by Netherland. The amount of duck meat export by China is more than 14 million in 1997 and increased to more than 30 million in 2007.

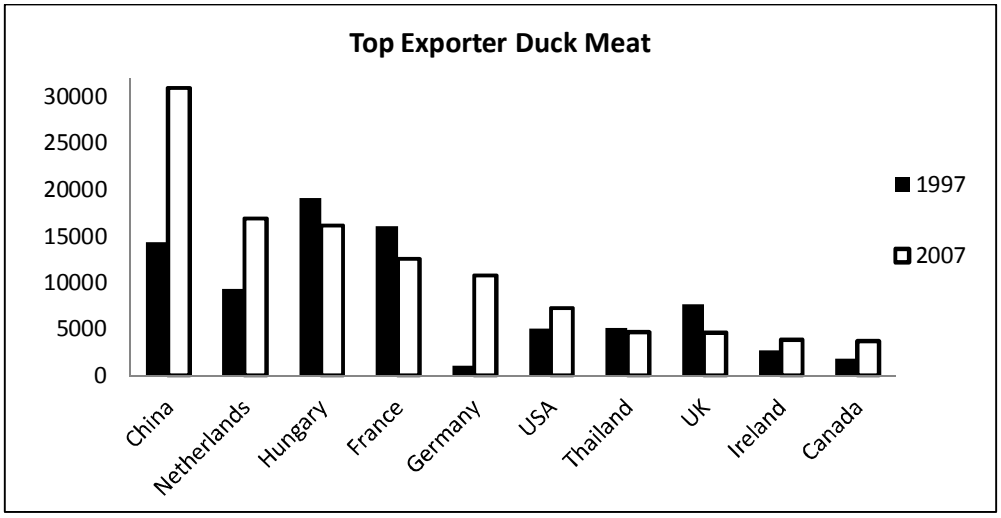

Figure 2.3 The top ten exporter duck meat in world (FAO, 2010).

Malaysia is fifth leading producer of duck meat in 2000 and the position has increased to be the third leading producer defeating Thailand and Vietnam. However, Malaysia was not included in the list of top ten-exporter of duck meat in the world. It means Malaysia produce duck meat just for local consumption. This especially differs with Thailand, which can simultaneously to be producer and exporter. Thailand is the fourth exporter with 9.6% of the market share in the top ten exporter duck meat in the world, after China, Hungary and France. Besides China and France, Thailand is the third, ahead of Vietnam, USA, South Korea, Malaysia, UK, Germany and Hungary as duck meat producer (FAO, 2010).

An interesting phenomenon has occurred in Germany where there has been about 90% increasing export of duck meat from 1997 to 2007. In general, export values of duck meat in the world have shown the total demand or consumption of duck meat in the world. Rainat, (2003) noted total duck meat production, an estimated 3.36% share of the world's 3.300 mt. Asian countries – led by Japan,

Singapore, China, Hongkong, South Korea and Malaysia, - are the biggest importers of frozen duck meat as compared to cooked duck meat, while further processed duck meat exports to Europe – Germany, the Netherlands, Switzerland, France, UK and Belgium – are definitely preferred. About 40% of duck meat imports goes to Hong Kong, Japan and South Korea are duck meat importers in Asia.

In North America, parts of Europe, Australia and in many other areas as well, roast Peking duckling is a popular item on the menus of fine restaurants. Roast, braised or barbecued Peking duckling is also popular among home gourmets. More recently, duck parts, such as breast and legs have become more available, which offer more options for diet conscious consumers (Dean & Shandu, 2008). During this review period, the duck industry grew the fastest in North and Central America, this was entirely due to developments in the US, where output jumped by almost 60% (Bird, 2010).

Europe is the second largest duck production with total of a duck meat output for UK and Europe was 2.9 mt in 2000 and was 3.8 mt in 2008. Output of ducks worldwide is estimated to be 2.7 billion, with 75% found in China alone. Annual growth was still running at 3%. The Chinese' strength are they sell cooked duck meat at a third less cost than their Thai competitors and 45% less than European producers. One of these was already exporting and the other two would come on stream this year, taking total capacity to 30,000 t, which is almost 3 times the size of the EU cooked duck meat market (World Poultry, 2010). While Europe is the second largest duck producing region, not only does output account for just 12% of the world total. France, with annual production of 249,000 t

accounting for more than 50% of the European total, expanded output by only 7% over the eight years. In Germany grew by some 53%, output in 2008 was still less than 61,000 t, while in Hungary, the third largest producer in Europe, production exceeded 51,000 t in 2008, some 18% more than in 2000 (Bird, 2010).

In Australia, 95% of the meat ducks produced is destined for domestic consumption. The Asian restaurant market for whole birds is the main market, but there is also growing demand from fine restaurants and for specialised cuts in supermarkets. Ducks destined for the whole duck market are grown to a live weight of 2.85 kg. Under commercial conditions in Australia, this takes approximately 6 to 7 weeks (Poultry Hub, 2009). Few ducks are grown in Oceania, yearly output amounting to only a little over 12,000 t, with some 94% being produced in Australia (Bird, 2010).

In South-western Nigeria, ducks has been selected for meat yield for many years. Most of the duck meat has been consumed in the region. The meat product is also served at international hotels and restaurants. It is an optional protein source and locals (Baeza *et al*., 2002) consume only 10% of the duck meat the remaining was exported to the Middle East.

2. 2 Utilization of Duck Meat

Duck meat consumption is still limited in the world and it is constrained by non-availability, non-familiarity, inability to slaughter the live duck and some traditional and religious taboos associated with the meat (Oteku *et al*., 2006). In addition that there was a significant indication showing that consumption level of

the meat will improve considerably when established duck meat shop were and processed meat products are easily available. Aini (2010) stated that in Malaysia, the main outlets for broiler ducks are Chinese restaurants and stalls selling roast ducks. The consumption of duck meat is limited; it is not common on the daily household menu. This increase in duck meat consumption is mainly due to the rapid development and wide acceptance of value added duck meat products amongst consumers. Duck meat has traditionally played an important role in Chinese food culture (Tai, 2001).

2.2.1 Traditional utilization of duck meat

When comes to raising and eating duck meat, countries differ greatly with respect to their culinary traditions and environmental conditions. In China and the countries of South and South-East Asia, accounted for 80% of the world's ducks population (Sluis, 2004). The keeping of domestic ducks for food had traced back at least 4000 years. Peking duck was first developed and became known for its excellent gastronomic qualities. Cooked duck products are popular foods in China for their flavour and nutritional value. A famous duck dish from Beijing is the Chinese Peking duck or Peking Roast Duck that has been prepared since the imperial era, and is now considered one of China's national foods. It is prepared with a kind of fruit tree and has fruity flavour. Its skin is very crispy (Dean & Sandhu, 2008; Anonimus, 2009).

The traditional Chinese meat products were originally developed in Nanjing. Nanjing is very famous for duck meat cooking skills for a very long time. Ducks have appreciated for its taste and nutritional qualities during periods

of history when food was plentiful as well as when it was in short supply, and especially in the latter case. Many traditional Chinese meat-processing methods were developed and perfected over hundreds and sometimes thousands of years. Among them were the dry-cured, roasted, and water-boiled salted ducks, all highly regarded as delicacies in China as well as in Southeast Asia for their delicate flavour and texture. Several famous duck dishes are Jingling stewed duck with bean sauce, crispy fried duck, duck with eight treasures and slated duck gizzard, etc, which has the distinctive characteristics of each (Liu *et al*., 2007; Xu *et al*., 2008; Anonimus, 2009).

In Indonesia, many traditional dish using duck meat as a raw material. Addition by Owen (1994) in the book "Indonesian Regional Food and Cookery", that there are some typical dishes of duck meat in Indonesia's province, namely: *Gulai itik Aceh* (duck cooked in the manner of Aceh province), *Gulai itik Sumatera Barat* (duck with green chillies), *Rendang itik Padang* (Duck rendang), *Bebek panggang hijau* (Marinated and grilled or roasted duck), *Masak hijau Kalimantan* (Duck in green sauce), *Bebek betutu* (Traditional long-cooked Balinese duck), and *Bebek bumbu betutu* (Breast of duck in Balinese spice).

In the United Kingdom, there is Crispy aromatic duck dish that is similar to Peking duck. It was attended since the second half of the 20th century and has become a popular dish in many Chinese restaurants in the West. It was cooked in traditional gas burners, and much of preparation is done by hand, including removing pinfeathers, de-boning, slicing and shredding (Notdelia, 2008).

In Malaysia, the Ministry of Agriculture has campaigned for eating duck meat since 2005. It was found that there is a necessity to promote intensive waterfowl production and traditional farming methods need to be changed. Duck meat was termed as an "exotic meat" due to the fact that the meat is high in protein and low in cholesterol.

2.2.2 Modern utilization of duck meat

Barbut (2002) reported that many new processed poultry products have been introduced in the market within the last couple of decades. The poultry industry has taken the initiative to develop fresh, marinated and fully cooked products. Examples of various further processed poultry products are smoked poultry, poultry roll, poultry ham, poultry bacon, sausage, frankfurter, bologna, patties, poultry nugget, fried poultry, roasted/ barbecued poultry and jellied poultry loaf. However, the processed poultry product still dominated by chicken meat products. In the Malaysian market, there are at least 10 brands of commercial chicken sausages (Huda *et al*., 2010f).

Processed duck meat is raising and present as an alternatives food to human consumption. The processed duck meat with unique flavour and taste has been produced the traditional dishes. However, it can be developed to advance the poultry based products because processed duck meat products were found to be very limited in the market. Some researchers have evaluated the physicochemical properties, textural, and sensory attributes of processed duck meat such as duck sausage by Yang *et al*. (2002), Bhattacharyya *et al*. (2005), Biswas *et al*. (2006), and duck nugget by Lukman *et al*. (2009), and duck meatball by Huda *et al*.

(2009b). In Taiwan, duck meat is an important food commodity and the consumption of duck meat has increased steadily in recent years (Chen & Lin 1997). The major processed duck meat products in Asian countries include boiled salted-duck, charcoal grilled duck, roasted duck, and smoked duck, roasting Peking duck, pressed salt duck, ginger-root duck, smoked duck steak, duck roll, tea-smoked duck, herb duck, and crispy skin duck (Tai, 2001).

Although consumers still buy the duck from the market to prepare dishes, but in the future there are trends whereby the consumers are buying processed products. Variety in cooking is an important factor to increase the consumption of duck meat. Vacuum packaging of oven-ready duck meat or frozen pre-cooked ducks is welcome by consumers. Those processed products, not only prolong the shelf life, but also added the value of ducks. Moreover, the roasting Peking duck was famous and created for the tourists visiting the Great Wall in China (Tai, 2001).

The duck meat is a potential modern processed meat like chicken processed products. Therefore, developing of duck meat production became new modern processed meat product, such as ready-to-eat, duck meat products is needed to improve duck meat consumption and thus boost up the duck industry (Putra *et al*., 2008; Huda *et al*., 2010b). Furthermore, Ramadhan *et al*. (2010) concluded that the increase in duck meat production and trends towards the greater consumption of further processed meat products present the opportunity to develop more products that use duck meat as a raw material. High quality further processed meat, particularly emulsified meat products, only made from meat with specific functional properties. The processing of duck meat into surimi-like

material is one promising strategy to improve its functional properties and allow its incorporation into many kinds of further processed meat products.

2.3 Sausage Processing Technology

2.3.1 Types of sausage

The term sausage is derived from the Latin word *"salsus"* meaning salt, or literally translated, refers to chopped or minced meat preserved by salting. Sausage is one of the oldest forms of processed foods, their origin being lost in antiquity. It has been reported that Babylonians and the Chinese produced sausages about 1500 B.C., although documented proof for this is lacking (Pearson & Gillet, 1996). For producer and consumers, sausage is an ideal meat product: it can be made by many different formulations and in many forms. All edible of carcass can be used in an efficient way, thus making it possible to utilize its entire nutritional capacity (Puolanne, 2010).

Consumers today eat sausages because of convenience, variety, economy, and nutritional value. Sausage product take little time in preparation, with some sausages being ready to serve, and others needing only to be warmed before serving. Sausages are frequently served as cold cuts or hors d'oeuvres at parties and other social gatherings. Sausages are also commonly served for breakfast, lunch, dinner or snacks (Pearson & Gillet, 1996; Puolanne, 2010). The Categories of sausage, according to the USDA (USDA, 2009b) is as follows.

2.3.1 (a) Fresh sausage

Fresh sausages are made of selected cuts of fresh meat (not cooked or cured) and must be stored in a refrigerator (or frozen) prior to eat immediately or before consume. Trimmings from premied cuts such as loin meats, hams, and shoulders are often used. Fresh sausages must be kept refrigerated thoroughly cooked before serving. In principle, fresh sausages are not cured. Fresh sausages actually comprise of the mixtures of meats, fat and spices stuffed into casings with the intention that the consumer himself cooks them prior to serving. In many countries, fresh sausages are manufactured on request in butcher shops (Savic, 1985; Puolanne, 2010).

2.3.1 (b) Uncooked smoked sausages

Sausages in this class may be cured or fresh form. They are prepared by smoke but it is not cooked prior to sale. They must be held under refrigerated conditions, no longer than seven days. These sausages should be cooked thoroughly before consumed. Examples: smoked pork sausage, kielbasa, mettwurst. (Savic, 1985; Puolanne, 2010).

2.3.1 (c) Cooked sausages

These sausages are usually made from fresh meats which are cured during processing, fully cooked, and/ or smoked. The product should be refrigerated until consumed. Since they are fully cooked, these sausages are ready to eat, although some could be served hot. The products are frankfurter (wieners), bologna,

beefwurst (beef salami), New England sausage, Vienna sausage, kielbasa, liver sausage, knackwurst (Savic, 1985; Puolanne, 2010).

2.3.1 (d) Dried and semi-dried sausages

The dried and semi-dried sausages are made from fresh meats which are cured during processing and may or may not be smoked. A carefully controlled bacterial fermentation causes these products to have lower pH (4.5 to 5.3), which aids in the preservation and produces the tangy flavour. The dried sausages are generally not cooked which include the Italian salamis and pepperoni. Dried sausages require long-dried periods (generally from 21 to 90 days, depending on product diameter), whereas semi-dry sausage are often fermented and cooked in smokehouse. Both are ready to eat. Cold storage is recommended for dried sausages, while semi-dry sausage should be refrigerated. Examples of dried and semi-dried sausages are summer sausages, Cervelat, thuringer, salamis, chorizos, frizzes, Lebanon bologna, pepperoni, mortadella, lyono, landjaeger and sopressata (Savic, 1985; Puolanne, 2010).

2.3.1 (e) Speciality meats (Luncheon meats)

Luncheon meats are made from fresh meats which are cured, fully cooked, and may or may not be smoked. Luncheon meats may be cooked in a loaf pans or casings or water-cooked in the processing plant. These products are ready to eat and should be refrigerated and might be held approximately seven days after a package is open. The products are Dutch, ham and chesses, jellied tongue, old-

fashioned, olive, pepper, pickle and pimento, Vienna sausage and, chopped ham (Savic, 1985; Puolanne, 2010).

2.3.2 Processing of sausage

The sausage processing is a continuous sequence of events in which each steps is an integral part. The processing of sausage is according to USDA, FSIS & AFDO (1999), Marianski (2009), and Puolanne, (2010) which is presented in Figure 2 4.

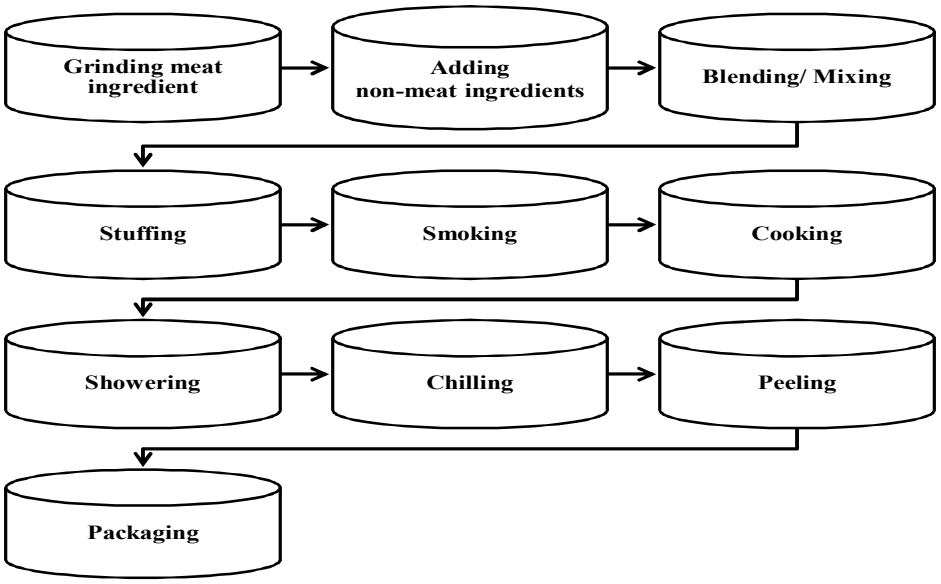

Figure 2.4 Sausage processing (USDA, FSIS & AFDO., 1999).

2.3.2 (a) Grinding

The variable size of meat chunks and shape with variable fat contents are ground to form uniform cylinders of fat and lean through mechanical grinding of grinder. This made sausage lean looking and the fat is hidden inside (Marianski, 2009).

The screw feed in a rotating blade cuts the compressed meat and aids in filling the grinder plate holes. The size of grinder plate holes determines the diameter, while the plate thickness determines the length of cylindrical partial particles of lean and fat. Proper mixing of these determines the length of cylindrical particles and it is important to obtain a uniform blend from the pre-mix technique. To avoid smearing, the meat processed should be kept at low temperature (1 – 3 ^{o}C). Ideally, meat should always be chilled between 0 ^{o}C – 2 ^{o}C for a clean cut. Refrigerator temperatures are roughly 3 ^{o}C – 4 ^{o}C. The meats can be placed in a freezer about 30 min just before grinding (Marianski, 2009).

2.3.2 (b) Mixing

The mixing step using a chopper that composed of a revolving metal bowl that contains the meat, while knife blades rotating on an axle cut though the revolving meat mass, as a means of batching the sausage mix. A chopper is basically a knife on an axle; speed of the knife, rpm of bowl and sharpness of the blades are all factors in its performance. Temperature of the chopper will raise 10 ^{o}C – 20 ^{o}C in 10 – 15 min. The chopper or emulsifier contributes about 25% - 30% of the heat used in processing. Ingredients should be mixed with cold water then poured over the minced meat. The lean meat mixed with spices first and fat or oil was added last. It takes roughly about 5 min to thoroughly mix 10 lbs of meat. The time is important because fat specks start to melt at 35 ^{o}C – 40 ^{o}C (Marianski, 2009).