

Physicochemical Analysis and Mineral Composition of Duck Meat (Peking, Muscovy and Local Java)

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Abstract--- Quality characteristics of three types of duck meat (peking, muscovy and local java spesies) were evaluated. Peking duck has the highest moisture content which is 77.01% and the lowest value of fat, protein and total ash. Muscovy and Local java have about the same protein and fat contents which is 17.85% and 4.82%. Muscovy produces a more active and stable emulsion. The emulsion activity is 6.25% and the emulsion stability is 72.58%. Peking contains highest amount of calcium (1.77 mg/g), phosphorus (2.28 mg/g) and zinc (0.023 mg/g). Magnesium (0.37 mg/g) and potassium (3.56 mg/g) are the highest in Muscovy. Local Java duck has highest amount of copper (0.005 mg/g), iron (0.0656 mg/g) and sodium (0.69 mg/g). and pH value which is 6.20. For colour determination, Muscovy is the darkest and reddest. The value of L^* is 39.4975 and a^* is 12.2858. Peking has the highest value of b^* which is 17.7571 compared to Muscovy and Local Java.

Keywords--- Physicochemical, mineral composition, duck meat, protein source

I. INTRODUCTION

POULTRY is among the most popular food products worldwide and consumer demand is at least partly due to the desirable flavour of poultry products (Barker and Bruce, 1995). Consumption of poultry meat and poultry meat products is currently growing and increased production of cut-up and processed meat has provided considerable quantities of parts suitable for mechanical deboning. With the growing demand for poultry meat, the duck industry has commenced to follow the same pattern of the broiler industry. This could be seen in the establishment of more specialized business venture with modern poultry slaughterhouse, processing for better packaging and presentation to consumers. The totally population of duck in Malaysia at 2006 is 8.138.777 and for the duck broiler is 6.710.493 (Department of Veterinary Services, 2007).

There are various types of ducks found in Malaysia, such as Muscovy duck, Local Java duck, Peking duck and mixed duck of male Muscovy with female Peking, which is called Mule duck (Yeong *et al.*, 1993). Duck meat normally obtained from the parts of chest and thigh. The meat from thigh usually is darker in colour and more fat content compared to chest meat. The colour of duck meat is darker compared to chicken and turkey meat. Duck has one layer of fat under skin between skin and its' flesh (Anon, 2007).

Meat is muscle tissue and animal organ may be consumed like beef, goat, sheep, pig, poultry and others. Meat is also a muscle cleave to animal bone and framework. Meat constitute three major components namely muscle tissue, adipose and connective tissue (Anon, 2007).

Meat is an important food substance to balanced nutrition. In addition to the high protein content, the meat also contains an amino acid to a complete and balanced, meat consumption advantage in food is that it more have been digested easily. Apart from that, meat also contains a few mineral and vitamins (Anon, 2007).

Quality of meat is usually associated with scattered fat content in the overall of animal muscle. This fat is more recognizable known as marbling. The marbling is also associated with the animal age. Increasingly young the animal, much better animal meat quality achieved (Nickerson *et al.*, 1992). Nevertheless, this marbling will increase when animal age increase. Then, in animal young age, the meat is softer compared old animal meat.

In generally, meat contains large volume of water, protein and fat. Meat protein is the most actomyosin. Proteins in the tendon tissue binding meat muscle tissues. The compositions of meat after slaughter contain 21% fat, 18% protein, 1.0% ash and 66% In meat there were some types of proteins which form that meat structure. Protein shrinkage is important. These protein including myosin, actin, tropomyosin and another protein. If this protein is extracted cells inside meat, either with salt solution or by using mechanical agitation (hashing), it could form a type of sticky substance could function as binder (Nickerson *et al.*, 1992).

If minced meat is heated, the proteins of this shrinkage will gather and binding the pieces of meat together. Then, this way may produce based on meat such as sausage, balls, burger, nugget and others. Types of meat than a carcass is affected by the carcass part, especially the weight of meat, major tissue distribution (muscle, fat and bone), distribution tissues in carcass, muscle thickness, chemical composition and meat qualities (Caballero *et al.*, 2003). The largest part in carcass was muscle. Carcass contains soft tissue and hard tissue. Some part of bone and a few cartilage parts classified as hard tissue, while muscle, fat and connective tissue classified as soft tissue.

This study to determine physicochemical analysis and mineral composition of duck meat (peking, muscovy and local java spesies) as reference raw materials to development of restructured meat food product from poultry.

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II. MATERIALS AND METHODS

A. Duck meat

Two month old Peking duck broilers were collected from Kampung Matang Mahang, Ayer Hitam, Kedah. Six month old Muscovy duck and Local Java duck broilers were collected from Kampung Pulau Pisang, Kubang Pasu, Kedah. The ducks were slaughtered and cleaned at an abattoir. The carcasses were sent to Fika Sdn Bhd to be mechanically deboned and minced, vacuum packed and kept under freezing conditions ($-22 \pm 2^\circ\text{C}$) before transporting it to laboratory.

B. Proximate analysis

1. Moisture (AOAC Method: 945.38)

Moisture pan were pre-dried at 100°C for 1 hour in the oven (Oven Memmert UL40), then cooled in a dessicator and weighed. In each pre-dried pan, 10g of sample was weighed and distributed uniformly. Samples were dried to a constant weight at 105°C (4 hours) in the oven (Oven Memmert UL40). Samples were removed after drying and cooled in a dessicator (15-30 minutes). The samples were weighed after cooling. Calculations:

$$\text{Moisture content (wet basis) (\%)} = \frac{a-b}{a} \times 100$$

Where a = weight of wet sample

b = weight of dried sample

C. Protein (AOAC Method: 979.09)

1. Digestion

Three mg of sample was weighed together with a piece of filter paper using microbalance and being transferred into micro-Kjeldahl tube. A blank was also prepared. Five mg of cupric sulfate and 2 ml of sulfuric acid, H_2SO_4 were added and the solution was digested in the Block Digestion Systechne WB 31856 until it become clear. The digestion process was then continued for 1 hour. The digest was then cooled. A few drops of water was then added and left until it was completely cooled.

D. Distillation and Neutralization

The digest was transferred into the distillation flask by using minimum amount of water. Ten ml of 50% NaOH solution was added into the digest and then distilled into 10 mL boric acid solution in the collecting flask. The tip of the condenser must be extended below the surface of boric acid solution. After 5-10 minutes of distillation, the process was stopped. Red litmus paper was used for confirmation of the pH value of the distillate coming out of the condenser. There be should no change in the colour of red litmus paper should be dismantled the condenser and the tip rinsed with distilled water.

E. Titration

The distillate (green solution) was titrated with 0.02 M HCl to determine the end-point (when the indicator turns to purple) in triplicate. A blank titration was also carried out. Nitrogen content was estimated through nitration with hydrochloric acid.

Calculations:

$$\% \text{ (w/w) nitrogen} = \frac{(\text{mL HCl for sample} - \text{mL HCl for blank}) \times \text{molarity} \times 14 \times 100}{\text{mg sample}}$$

$$\% \text{ crude protein (wet basis)} = \% \text{ nitrogen} \times \text{conversion factor (6.25)}$$

Molarity of HCl used in titration = 0.02 M

F. Fat (AOAC Method: 945.38)

Five to ten gram of the dry sample was weighed accurately into the fat-free extraction thimble and fat-free cotton wool was lightly plugged into the thimble's upper hole. Then, it was placed into the Soxhlet extractor. Petroleum ether was added into the extractor until it was siphoned into a weighed round flask. This was repeated about 1-2 times. The condenser was set-up and left to reflux for about 4 hours. (The extraction process was completed when no oil droplets were detected in the solvent. Dropper was used to drop the solvent onto paper). After that, the solvent from the flask was distilled until it became almost dry. The extracted oils were carefully prevented from charring. It was then placed inside the fume cupboard (overnight) to air dry. Follow by oven drying at 105°C for 1 hour. Then it was cooled inside desiccators and the flask together with its extracted oil was weighed. The amount of fat was calculated as the percentage of the dry sample weight.

Calculations:

$$\% \text{ Fat (dry basis)} = \frac{a-b}{c} \times 100$$

a = Weight (g) of flask with sample after extraction

b = Weight (g) of flask

c = Weight (g) of dry sample

$$\% \text{ Fat (wet basis)} = \% \text{ Fat (dry basis)} \times \frac{100\% - \text{Moisture (wet basis)}}{100}$$

G. Ash (AOAC Method: 923.03)

The porcelain crucible with lids were pre-ignited at 550°C in the muffle furnace (Type 6000 Furnace) overnight cooled in a dessicator and weighed accurately. Approximately 5 g samples were weighed into each crucible, heated on Bunsen burner until the samples were thoroughly charred. The crucibles were placed in the muffle until the sample turned white in colour. If traces of carbon were still evident, a little distilled water was added and returned to the muffle furnace and was ashed again. By using tongs, the crucibles were removed from the muffle and cooled in a dessicator. Each crucible and the sample were reweighed accurately.

Calculations:

$$\% \text{ ash content (wet basis) w/w} = \frac{\text{weight of sample after ashing}}{\text{weight of sample before ashing}} \times 100$$

H. Mineral analysis

1. Sodium, potassium, ferum, zinc, magnesium, calcium and copper (AOAC Method: 999.10)

Mineral sodium (Na), magnesium (Mg), iron (Fe), calcium (Ca), zinc (Zn), copper (Cu) and potassium (K) analysis were determined by using an Perkin Elmer atomic absorption spectroscopy AAS (Beaconsfield, UK) equipped with

deuterium hollow cathode lamp background correction system.

One gram sample was weighed in a vessel and approximately 6 ml of concentrated nitric acid, HNO₃ and 1 ml of 30% (v/v) hydrogen peroxide, H₂O₂ were added to it. The vessel was closed and the sample was digested in the Microwave Digestor (Milestone Ethos 900) for 15 minutes. The vessel was then removed from the digester and cooled to room temperature. The sample solution was then transferred into a volumetric flask and made up to 50 ml with deionized water. For calcium determination, 5 ml of lanthanum oxide solution, La₂O₃ was added to the digest before made up with deionized water. A series of standard solution for all that minerals were prepared at certain suitable concentration (ppm). For example, the concentrations solution of iron standard prepared were 0.0, 1.0, 3.0, 4.0 and 5.0 ppm.

A linear standard curve (absorbance vs. concentration) of standard solution was plotted. Concentration of mineral can be determined through the values of absorbance of tested sample.

I. Phosphorus (Pearson, 1979)

Determination of Phosphorus (P) was determined by the Vanado-Molybdate method of UV-Vis, using Shimadzu UV-Vis Spectrophotometer (UV-160A). Firstly, vanadate-molybdate composite reagent was prepared by dissolving 20 g ammonium molybdate in 400 ml warm water (50°C) and cooled. 1.0 g of ammonium vanadate was dissolved in 300 ml boiling distilled water, cooled and added with 140 ml of concentrated nitric acid gradually with stirring. The molybdate solution was then added gradually to the acid vanadate solution, stirred and diluted to 1 liter with deionized water.

A standard phosphate solution was made by preparing a stock solution containing 3.83 g potassium dihydrogen phosphate (KH₂PO₄) per liter and diluted from 25 ml to 250 ml (1ml = 0.2mg P₂O₅). In the preparation of a standard graph, a series of 100 ml volumetric flask were filled with 0, 2.5, 5.0, 10.0, 20.0, 30.0, 40.0 and 50.0 ml of standard phosphate solution. A few drops of ammonium solution (0.88) were added and make just acid with nitric acid (1:2). 25 ml of vanadate-molybdate reagent was added, diluted to the mark with distilled water and allowed to stand for 1 minute. The absorbance is measured using UV-Vis at 470 nm. To prepare the sample for this experiment, 50 ml of sample (containing 0.5-1.0 mg P₂O₅) is vanadate-molybdate reagent is added, diluted to the mark and allowed to stand for 10 minutes before measuring the absorbance.

J. pH

The pH values of samples were measured with a 10 g of sample which was homogenized with 40 ml deionized water. The pH meter used was pH Meter Mettler Toledo Delta 320. pH values for each sample were determined in triplicate (Ronald *et al.*, 2006).

K. Emulsion characteristics

1. Emulsion activity

Both emulsion activity and emulsion activity were taken as the indices of emulsifying properties. The following procedure was adopted from Yasumatsu *et al.* (1972) with a slight modification. The emulsifying activity was measured with the

meat extract which was prepared by extracting 15 g of ground meat with 20 ml of 7% sodium chloride solution. 80 ml of 7% sodium chloride solution was added into 20 ml of the extract. Then 100 ml of corn oil (Mazola Corn Oil) was added into it. The mixture was emulsified with Global Multifunctional Blender GB311L for 1 minute. The emulsion obtained was divided evenly into three 50 ml centrifugal tubes and centrifuged at 3500 rpm for 5 minutes. The emulsifying activity was calculated as:

$$\text{Emulsion activity (\%)} = \frac{\text{Height of emulsified layer}}{\text{Height of whole layer in centrifuge tube}} \times 100\%$$

Emulsion stability

To measure the emulsion stability, the emulsion prepared by the procedure for emulsion activity measurement was heated for 30 minutes at 80°C, cooled with tap water for 15 minutes, and centrifuged at 3500 rpm for 5 minutes. Emulsion stability was expressed as:

$$\text{Emulsion stability (\%)} = \frac{\text{Height of remaining emulsified layer}}{\text{Height of emulsified layer in centrifuge tube}} \times 100\%$$

L. Colour

Colour differences between each sample was measured using colourimeter Minolta Spectrophotometer model CM-3500d (Osaka, Japan) with Spectramagic Version 2.11, 1998 (Minolta) software. The colourimeter was calibrated by using the zero calibration box (CM-A120), followed by white calibration plate (CM-A128). Target mask (CM-126) of Petri dish was used where samples in the Petri dish was placed on the optical centre and covered with a black container. Three measurements of L*, a*, and b* values were taken for each formulation to obtain consistent results and mean values. The method of colour measurement used is *Commission Internationale de l'Eclairage* (CIE) L*, a*, b* colour space. In this method, the colour space is considered spherical. According to Nielsen (1998), L indicated lightness (perfect black = 0; pure white = 100, (+) a values indicated redness, (-) a values indicated greenness, (+) b value indicates yellowness and (-) b indicates blueness.

M. Statistical analysis

Data obtained from all the analysis were analyzed by using one-way analysis of variance (ANOVA) and followed by DUNCAN Multiple range test of statistical package for social science version 15.0 (SPSS Inc., Chicago, Illinois, U.S.A). Statistical significance was indicated at 95% confidence level.

III. RESULTS AND DISCUSSION

A. Proximate analysis

The data obtained by proximate analyses of duck meat are presented in Table I. Statistical analysis showed that are no significant differences ($P < 0.05$) between Muscovy and Local Java for moisture. However, there are significant differences between Peking and both of the ducks. Peking showed the highest moisture content. However there are no significant differences between ducks for fat, protein and total ash. Muscovy and local Java showed the highest fat content and

protein content. For total ash content, Local Java contains the most total ash.

TABLE I
PROXIMATE ANALYSIS OF DUCK MEAT (WET WEIGHT BASIS)

Sample	Peking	Muscovy	Local Java
Moisture (%)	77.01 ^b ±0.59	74.71 ^a ±1.09	74.44 ^a ±0.55
Fat (%)	4.11 ^a ±0.84	4.82 ^a ±1.64	4.82 ^a ±0.54
Protein (%)	17.29 ^a ±2.59	17.85 ^a ±1.17	17.85 ^a ±1.04
Ash (%)	0.99 ^a ±0.08	1.01 ^a ±0.21	1.18 ^a ±0.17

^{a,b}Means with different letters in each row are significantly different ($P<0.05$), $n=6$.

Muscovy has much lower fatness compared with Peking (Wawro *et al.*, 2004). Based on table, the Muscovy has higher fat than Peking. Local Java has lower fat value compared to Peking duck (Wu *et al.*, 1991). But the data obtained doesn't represent this. Literature data (Esminger *et al.*, 1993) showed that the proximate compositions of raw flesh meat from domestic ducks are 68.8% for moisture, 21.4% for protein and 8.2% fat.

Sales and Hayes (1996) reported that the percentage of ostrich meat for moisture content is 76.27%, protein is 21.12%, intramuscular fat is 0.65%, and ash is 1.07%. Chicken in the other hand contains 75.46% of moisture, 21.39% of protein, 3.08% of intramuscular fat and 0.96% of ash. Comparing these two animals with the duck, Peking showed higher moisture content and Local Java showed a higher ash content. However, ostrich and chicken contain more protein.

B. Mineral analysis

1. Sodium, potassium, ferum, zinc, magnesium, calcium, copper and phosphorus

Mineral compositions of Peking, Muscovy and Local Java are presented in Table II. No significant differences are observed with respect to the iron and phosphorus content but there are significant differences ($P<0.05$) between ducks for copper, magnesium, and potassium. For sodium and zinc content, Peking and Local Java don't show a significant difference but both differ significantly with Muscovy.

TABLE II
MINERAL ANALYSIS OF DUCK MEAT

Sample	Peking	Muscovy	Local Java
Calcium (mg/g)	1.77 ^b ±0.20	1.31 ^a ±0.15	1.61 ^b ±0.25
Copper (mg/g)	0.0039 ^{ab} ±0.0014	0.0027 ^a ±0.001	0.0050 ^b ±0.0028
Iron (mg/g)	0.05 ^a ±0.02	0.05 ^a ±0.001	0.07 ^a ±0.01
Magnesium (mg/g)	0.37 ^{ab} ±0.01	0.37 ^b ±0.03	0.35 ^a ±0.01
Phosphorus (mg/g)	2.28 ^a ±0.08	2.06 ^a ±0.40	2.11 ^a ±0.33
Potassium (mg/g)	3.18 ^{ab} ±0.55	3.56 ^b ±0.27	3.08 ^a ±0.15
Sodium (mg/g)	0.67 ^b ±0.10	0.50 ^a ±0.08	0.69 ^b ±0.14
Zinc (mg/g)	0.023 ^b ±0.002	0.019 ^a ±0.002	0.021 ^b ±0.001

^{a,b}Means with different letters in each row are significantly ($P<0.05$) different, $n=6$.

Peking showed higher calcium, phosphorus and zinc contents compared to Muscovy and Local Java. Magnesium and potassium contents are higher in Muscovy than the other two. Local Java contains higher cuprum, iron and sodium compared to the others. Literature data (Esminger *et al.*, 1993) showed that raw duck meat (flesh only) has 0.12 mg/g

calcium, 2.03 mg/g phosphorus, 0.74 mg/g sodium, 2.85 mg/g potassium.

Mineral analysis revealed that duck meat is good source of calcium. Sales and Hayes (1996) reported that ostrich meat has 0.08 mg/g calcium and chicken meat has 0.12 mg/g calcium. Compared to chicken and ostrich meat, the ducks have higher calcium content. Pearson and Gillert (1999) stated that calcium is the most abundant mineral element in the animal body and described it as an important constituent of the skeleton and teeth, in which about 99% of the total body calcium is found. Calcium is essential for the activity of a number of enzyme systems, including those necessary for the transmission of nerve impulses. This clearly explains why the calcium content was low in flesh.

Meat is a major source of iron. Iron is considered to be the most important minor mineral in meat, especially for the adult woman (Sales and Hayes, 1996). Iron in meat has a high bioavailability, the main reservoir being as a component of the haem protein myoglobin. Iron deficiency is the most common nutritional deficiency in the world. More than 90% of the iron in the body is combined with proteins, most important being haemoglobin (Aganga *et al.*, 2003). Between ducks, Local Java contains the highest amount of iron. Iron amount in ostrich and chicken meat are 0.023 mg/g and 0.009 mg/g (Sales and Hayes, 1996). If the comparison between duck, ostrich and chicken, the duck possesses more iron.

Magnesium is closely associated with calcium and phosphorus and about 70% of the total magnesium is found in skeleton. That's why the content is lower in flesh. Magnesium is an enzyme activator. It is an essential activator of phosphate transferase, activates pyruvate carboxylase, pyruvate oxidase and the reactions of the tricarboxylic acid cycle. Thus, it can be seen that magnesium is a key element in cellular biochemistry and function (Aganga *et al.*, 2003). Sales and Hayes (1996) reported that magnesium content in ostrich and chicken meat are 0.22 mg/g and 0.25 mg/g. It can be said that duck have higher magnesium content than ostrich and chicken.

Aganga *et al.* (2003) also reported that meat is a good source of phosphorus than calcium. Meat is better source of phosphorus because 20% is present in tissue other than bone, compared to only 1% for calcium. Phosphate in one several forms are added to meat products during processing to increase water-holding capacity, bind in restructured products and improve tenderness, colour and oxidative properties. There are 2.13 mg/g phosphorus in ostrich meat and 1.73 mg/g in chicken meat (Sales and Hayes, 1996). Peking has higher phosphorus content compared to chicken and ostrich meat.

Potassium is found in many foods, especially meat, milk, fruits and vegetables. Potassium works with sodium to maintain the body's water balance. Potassium is an essential mineral macronutrient in human nutrition. It is the major cation (positive ion) inside animal cells, and it is thus important in maintaining fluid and electrolyte balance in the body. Research has indicated that diets high in potassium can reduce the risk of hypertension. In ostrich meat, there is 2.69 mg/g potassium and 2.29 mg/g potassium is found in chicken meat. So this shows that duck has higher content of potassium.

Sales and Hayes (1996) reported that ostrich meat has 0.43 mg/g sodium whereas chicken meat has 0.77 mg/g sodium. Compared with duck and ostrich, chicken has the highest

sodium content. The low sodium content of ostrich meat has an advantage for people who have to consume low sodium content.

Zinc content in ducks is about the same in ostrich and chicken meat possesses similar content of iron with the quails. Sales and Hayes (1996) reported that ostrich meat has 0.02 mg/g zinc and chicken meat has 0.015 mg/g zinc. Zinc has been found in every tissue in the animal's body. The element tends to accumulate in the rather than the liver, which is the main storage organ of the other trace elements. High concentration has been found in the skin, hair and wool of animals.

The duck has higher copper content compared to the ostrich, chicken and quail. There are 0.001 mg/g copper in ostrich meat and 0.005 mg/g copper in chicken meat (Sales and Hayes, 1996).

C. pH

Figure 1. showed that pH differ significantly ($P < 0.05$) between species. Local Java has the highest pH value. The pH of muscle during life is about 7.2 after death; the muscle acidifies to value of 6 or less through the accumulation of lactic acid (Richardson and Mead, 1999). pH plays an important role during emulsification and is strictly related to the physicochemical and functional properties of an emulsion (Zorba and Kurt, 2006). The high pH meat is often characterized as being dark, firm and dry and the lighter meat as being pale, soft and exudative. In addition, muscle pH affected the water binding nature of the proteins and therefore directly affects the physical structure of the meat and its light reflecting properties (Richardson and Mead, 1999).

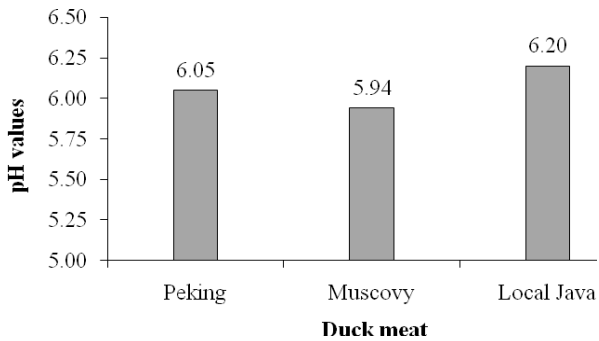


Fig. 1 pH value of duck meat

D. Emulsion Characteristics

Table III. showed that there are no significant differences ($P < 0.05$) between Local Java and Peking for emulsion activity and emulsion stability. However, both ducks differ significantly with Muscovy for both emulsion properties. Muscovy meat produces a better emulsion properties compared to the others.

A classical emulsion consists of two immiscible liquid phases, one of which is dispersed in the form of a colloidal suspension. Meat proteins serve as the emulsifying agent in meat emulsion. To form a stable meat emulsion, these proteins must surround the finely chopped fat particles. In emulsified meat products, the technological properties of proteins play an important role.

TABLE III
EMULSION CHARACTERISTICS OF DUCK MEAT

Sample	Peking	Muscovy	Local Java
Emulsion Activity	3.75 ^a ±0.83	6.25 ^b ±2.10	2.08 ^a ±0.83
Emulsion Stability	50.83 ^a ±1.67	72.58 ^b ±7.44	52.19 ^a ±4.38

^{a,b}Means with different letters in each row are significantly different ($P < 0.05$). n=6.

Among the meat proteins, miofibrillar proteins have high functionality in emulsification (Zorba, 1995). Their increasing solubility and interactions affect oil binding and water holding ability, stability, viscosity, density and other characteristics of emulsions. Zorba (1995) also reported that properties and proportional levels of protein fractions affected emulsion properties. Myosin in particular plays a significant role in emulsification. Its functional properties are controlled by its species of origin as well as some physicochemical factors (Imm *et al.*, 1997). Different species have different protein characteristics and these differences can be due to interaction effects (Rawdkuen *et al.*, 2004).

Bard reviewed some factors influencing the extractability of salt soluble proteins from muscle tissue and concluded; (a) temperatures in the range of -5°C to 2°C gave maximum protein extraction, (b) increasing extraction time increased protein extraction, up to an extraction time of 15 hr (c) pre-rigor meat is more extractable than post-rigor meat and (d) a sodium chloride concentration of 10% extracted the most protein.

pH plays an important role during emulsification and is strictly related to the physicochemical and functional properties of an emulsion (Zorba *et al.*, 2006). As the pH moves away from the isoelectric point, the net charge on the proteins during emulsification (Schut, 1976). Zorba (1995) reported that when the pH moves to the isoelectric point, the solubility of proteins decreased. pH played a more important role than that of protein concentration on emulsification stability values.

One of the most important features in the production of meat emulsions is to achieve water and fat binding through heat processing. The main property of meat that determines the stability of a meat emulsion is its ability to form a fine protein matrix with tiny pores and capillaries which entrap water and fats. This property is of tremendous importance in the product during and after heat treatment. The amount and the quality of meat protein are crucial to the formation of a stable heat-set protein matrix.

A strong protein matrix and its continuity can hold oil droplets leading to increased emulsion stability (Smith, 1988). Protein-protein interactions strengthen the protein matrix and so prevent it being broken. Heat treatment also affects protein properties allowing protein-protein interactions. It has been reported that the addition of some proteins, such as collagen, could improve water holding capacity and textural characteristics of meat products (Meullenet *et al.*, 1994). Doerscher *et al.* (2003) reported that the matrix formed with myofibrillar proteins with pork collagen gels had greater ability to entrap water than myofibrillar alone. Schilling *et al.* (2003) reported that collagen acts synergistically with the myofibrillar structure in meat to bind water. Elizalde *et al.* (1988) found that the stability of emulsions relate to the hydrophilic and lipophilic characteristics of proteins.

An important functional characteristic of proteins is gel forming ability. Myofibrillar proteins play an important role in gel formation after heat treatment. Gel formation contributes to the desirable texture and fat-water stabilization in emulsified meat products. Also, during gel formation, some components can be retained inside the protein matrix (Ker *et al.*, 1992).

E. Colour

L^* indicates lightness (perfect black = 0; pure white = 100), (+) a^* values indicates redness, (-) a values indicates greenness, (+) b^* value indicates yellowness and (-) b indicates blueness.

TABLE IV
COLOUR PARAMETERS OF DUCK MEAT

Sample	Peking	Muscovy	Local Java
L^*	48.42 ^b ±2.61	39.50 ^a ±2.01	39.92 ^a ±2.76
a^*	9.52 ^a ±1.54	12.29 ^b ±1.37	12.02 ^b ±1.51
b^*	17.76 ^b ±0.53	16.49 ^a ±0.41	16.58 ^a ±0.43

^{a,b}Means with different letters in each row are significantly different ($P < 0.05$). n=6.

Honikel (1998) reported that the content of pigment (myoglobin) is intrinsic to the muscle, being dependent on primary production factors such as species breed, age of animal and nutritional status. Myoglobin varies according to species, being the lowest in chicken and highest in beef. The preslaughter period, the slaughter process and subsequent processing also affect colour by influencing the rate and extent of pH and temperature decline during storage, distribution and display, the processes of oxygenation and oxidation of myoglobin influence colour (Honikel, 1998).

Physical appearance of meat products is the principle characteristics upon which consumers base their initial purchase. In considering the specific features comprising physical appearance, researchers agree that meat colour is one of the most important. Adams and Huffman (1972) reported that consumers relate the colour of lean to its freshness.

IV. CONCLUSION

Based on results showed significantly different of proximate analysis, pH, colour, emulsion properties and mineral composition of peking, muscovy and local java duck meat. Peking duck meat showed excellent values for proximate, mineral, pH, colour, and characteristics of emulsion that have been used as raw materials duck meat restructured product.

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