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A Study of the Bio-Nutritional Evaluation of Duck-Meat

Hyun Keun Nam, Yong Ock Lee*
Gwangju Health Junior College Dept. of Food and Nutrition,
*Dept. of Food and Nutrition, *Myongji University*

오리고기의 영양생화학적 가치에 관한 연구

이 용 억
명지대학 식품영양학과
남 현 근
광주보건전문대학 식품영양과

≪요 약≫

한국에서 사육되고 있는 오리의 식용화를 검토하기 위하여 시도하였다.

시장에서 구입한 오리고기를 일반분석하여 수분 62.87%, 조단백질 19.06%, 조지방 17.05%, 회분 1.02%를 나타냈으며 오리고기 단백질을 GLC로 분석하여 거의 모든 필수아미노산이 함유되어 있음을 알 수 있었고 트리프토판이 제한 아이노산 이었다. 한편 오리고기의 지방산을 GLC로 분석하여 oleic acid가 많았고 linoleic acid도 상당량 함유되었음을 알 수 있었고 지방산의 P/S 비는 3.4를 나타냈다.

그리고 오리고기의 콜레스테롤 함량은 70.5mg%를 나타냈고 인지질도 많은 양이 함유되었으며 특히 레시틴이 많았다.

도살 후 2시간까지는 APT-phosphorus의 유리는 높은 온도에서 훨씬 빨리 되어지며, 근원단백질의 ATPase활성은 EDTA, 금속이온의 농도가 증가하면 억제를 받고 농도가 감소되면 활성은 증가되었다. 오리고기를 상이한 조건에서 조리하고 pepsin을 첨가하여 좋은 소화상태를 알 수 있었다. 이는 오리고기가 동물성 단백질이 풍부하며 소화도 잘 되므로 좋은 동물성 단백질원이 된다고 생각되어 진다.

Introduction

It is well known that proteins function as a body building block, a regulating body processes and a providing energy in human body. These proteins are widely distributed in nature, in processed food and in raw food materials. Therefore, it is very nature that we have to take enough protein from the various food stuffs. Particulary, animal protein is the most important for us in order to maintain normal body functions. Animal foods, such as meat, poultry and fish have high-quality pr-

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otein and in sufficient quantity to make them first in order of importance. But in recent years, with the unceasing rise in the price of meats, we have to search for a more economical source of protein.

In Korea, it is indicated that duck-meat and duck-blood are shown to be effective not only as a nutritional value, but also as a good diet for paralysis and hypertension. In order to cornfirm these facts, this experiment is planned to study.

Materials and Methods

Commercially available fresh ground duck-meat was purchased and analyzed for moisture, crude protein, crude fat and ash content, according to the procedures outlined in the Official Methods of Analysis of the AOAC(1979)[1].

1) Amino acid analysis

Amino acid content was determined with the chromatogram of Shimadzu gas chromatography. Samples were prepared for analysis by heating with excess constant boiling 6N-HCl at 100°C, for 20 hrs in an evacuated, sealed Pyrex tube. Following complete hydrolysis, the excess HCl was removed under reduced pressure. Tryptophan was separately analyzed following alkaline hydrolysis. It was understood that the preparation of suitable derivatives of amino acids and analysis by GLC reported by Gehrke[2)3)]. The gas chromatograph operation conditions are in Table 1.

Table 1. Gas chromatograph operation conditions

Column	Neutral & acidic amino acid	Basic amino acid
	Tabsorb(Regis Chemical co) packing	1.5% OV-17 on Chromosorb G (80/100mesh)
Column size	1.5m×4mm	1.0m×4mm
	I.D. glass	I.D. glass
Initial column temperature	7.5°C at 4°C min~200°C	140°C at 6°C/min~200°C
Injector and detector temperature	230°C	230°C
Carrier flow N_2	30m*l*/min	30m*l*/min
Air(to detector)	350m*l*/min	350m*l*/min
Hydrogen(to detector)	30m*l*/min	30m*l*/min
Chart speed	0.33in/min	0.33in/min

2) Fatty acid analysis

The fatty acid composition of duck-meat was determined by GLC. Samples of adipose tissue were prepared according to the method of Metcalfe, Schmitz and Pelka[4)] and using a Varian Aerograph Model 204 gas chromatograph. In order to extract lipid from duck-meat, ethylether was used as a solvent. Samples of lipid were prep-

ared for analysis of the constants by heating with excess ethylether solvent at 60°C, for a while, in an evacuated and nitrogen gas was influxed. The gas chromatograph operation conditions are in Table 2.

Table 2. Gas chromatograph operation condition

Instrument	Varian Aerograph Model 204
Column	20×1/8 FFAP
	Chromosorb W(100—120 mesh)
Temperature	Initial 50°C
	Final 250°C
Carrier gas	Nitrogen gas
Injeetion tem.	200°C
Detection temp.	250°C
Detector	Flame Ionization

3) Cholesterol in liver and Meats

Cholesterol content was determind on ground duck-meat and on liver. The princple method was that of Sperry[7]. Basically, this procedure involves a cold extraction of lipid material, saponification, of the extract, reextraction of the cholesterol after saponification, and finally, addition of a stable color forming reagent, in this case acetic anhydride and concentrated sulfuric acid appeared greenish blue color. A smalli amount of the extracted cholesterol in combine with this reagent produces a stable color which can be photometically measured[5)6)].

4) Blood analysis

The blood compositions such as Hematocrit, Phospholipid, Glucose and Cholesterol of duck-blood was determined by Sperry method for blood cholesterol[7)], by Somogyi-Nelson method for blood glucose[8)], by Marenzi method for phospholipid[9)], and mic rohematocrit method[10)] for hematocrit. Blood sample was collected by the cutting vein. Let blood clot and centrifuged to separate the serum and plasma.

5) Myofibril protein and ATPase activity

The longissimus dorsi muscle was removed from a newly killed duck, trimming off fat and chopped. Myofibrils were prepared by thd method of Yang[11)].

The reaction mixture composed of Myofibrils(0.25mg/m*l*), 1mM-$MgCl_2$, 1mM-EDTA, 1mM-ATP and 15mM Tris-HCl(pH 8.0) was incubated at 25°C for 5 minutes. After 5 minutes reaction runs, the reaction was stopped by the addition of TCA (final concentration of 4%). ATPase activity was expressed as micro-moles of inorganic phosphorus liberated per one minute by one milligram of protein[11)].

6) In vitro pepsin digestibility

Duck-meat protein digestibility was determined by the pepsin treated, method of Saunders et al[12)13)]. The protein was incubated at 37°C for 16 hrs in pH 2.0 with pepsin(2%). After incubation centrifuged at 2000 rpm for 30 minutes, filtered dire-

ctly through a dry Whatman NO. 1 filter paper into sample vials, and stored in the freezer at −20°C for amino acid analyses.

During the incubation, 10m*l* of incubation mixture was transfered to another tubes twice at 4 and 8 hrs passed incubate start. The taken sample was boiled at 100°C for 5 minutes, centrifuged and filtered. The filterate was used for measuring NH_2-nitrogen, which was measured by Formal method(AOAC).

Results and Discussion

Duck-meat was analyzed for moisture, crude protein, crude fat, and ash content. The results of the proximate analyses are given in Table 3. Literature values for beef and chicken are included for the sake of comparison[14].

Table 3. Proximate analysis of duck-meat

Item	Experimental Duck-meat	Beef	Chicken
Moisture	62.87	60.2	65.35
Crude fat	17.05	21.2	13.97
Crude protein	19.06	17.9	19.79
Ash	1.02	0.7	0.89

1) Amino acids

Duck-meat sample was analyzed for amino acid composition by GLC. The results of the amino acid analysis for duck-meat are shown in Table 4. Literature value for chicken included for the sake of comparison.

According to Table 4, it is understood that the duck-meat has contained all the essential

Table 4. Amino acid composition of the duck-meat

Amino acid	Duck-meat	Chicken
Arginine	1.11	6.7
Cystine+Cysteine	4.40	1.8
Histidine	5.60	2.0
Isoleucine	2.20	4.1
Leucine	4.54	6.6
Lysine	4.95	7.5
Methionine	1.15	1.8
Phenylalanine	3.01	4.0
Threonine	5.80	4.0
Tryptophan	0.95	0.8
Valine	2.75	6.7

amino acids. The limiting amino acid is tryptophan which underlined in Table 4.

2) Fatty acid

The crude fat of duck-meat was shown in the chemical constant for Acid value, Saponification number, Iodine number and Carbonyl number were 5.05, 201.55, 50.1 and 5.0 respectively. The crude fat was purified and methyl esterified for the analysis of fatty acidcomposition by GLC. The results are shown in Table 5, literature values for chicken and rabbit included[16].

Table 5. Comparison of the important fatty acid compositions of fats

Meat	Percentage of Fatty acids					
	14 : 0	16 : 0	18 : 0	18 : 1	18 : 2	18 : 3
Ouck	0.15	17.2	3.3	50.5	18.7	1.7
Chicken	0.7	24.3	10.9	37.8	21.9	0.9
Rabbit	1.2	20.1	8.4	25.8	37.3	4.6

Table 6. Comparison of P/S ratios of Fats

Meat	Satursted F.A.(S)	Oleic acid (18 : 1)	Unsaturated F.A.(P)	P/S ratio
Duck	20.65	50.5	70.9	3.4
Chicken	35.9	37.8	60.6	1.6
Rabbit	29.7	25.8	67.7	2.3

According to Table 5, 6, the content of Oleic acid(18 : 1) was much higher in duck-meat compare to the other meats. The percentage of this unsaturated fatty acid was much higher in duck-meat compare to the other meats. The percentage of this unsaturated fatty acid in terms of total fatty acids were 70.9, 60.6 and 67.7 for duck-meat, chicken and rabbit, respectively, Also the P/S ratios were 3.4, 1.6 and 2.3 for duck-meat, chicken and rabbit, respectively. Such a higher proportion of this polyunsaturated fatty acid contained in duck-meat could be harmful due to their peroxidation effect. But their higher degree of unsaturation could inhibite the synthesis of cholesterol in body. Therefore, it is possible to say that the duck-meat apparents the cholesterol lowering effect.

3) Cholesterol

Cholesterol in blood serum, in blood plasma, in meat and in liver fat was measured by Sperry, Frennen, Wyberga methods[5)6)7)]. The results are shown in Table 7.

Table 7. Cholesterol content in duck and chick

Animal	Blood serum	Blood plasma	Meat	Liver
Duck	200.2±2.2	175.5±2.7	70.5±7.5	48.7±1.3
Chicks	121.7±7.3	197.4±5.6	92.5±5.2	79.6±1.5

* Mean±S.D.

4) Blood analysis

The blood sample was analyzed for Hematocrit, Phospholipid, Glucose and Cholesterol. The cholesterol content is shown in Table 7. The results of the hematocrit, phospolipid and glucoseare shown in Table 8. According to Table 8, blood glucose of duck is higher than the chick and the content of lecithin is 39.87±4.5 for duck's blood.

Table 8. Hematocrit, Glucose and Phospholipid in duck blood

Animal	Hematocrit	Glucose	Phospholipid	Lecithin
Duck	36.1±1.5	500±2.6	119.6±5.2	39.87±4.5
Chicks	25.2±2.2	127.7±2.9	246.8±1.6	61.7 ±2.5

* Mean±S.D.

5) ATP and ATPase activity

In order to recognized the ATP-phosphorus content in duck muscle, after slaughter duck, it were stored at the temp. 20°C and 30°C vessel. By Fiske-Subbarow method[17] the results of ATP-phosphorus are shown in Fig. 1.

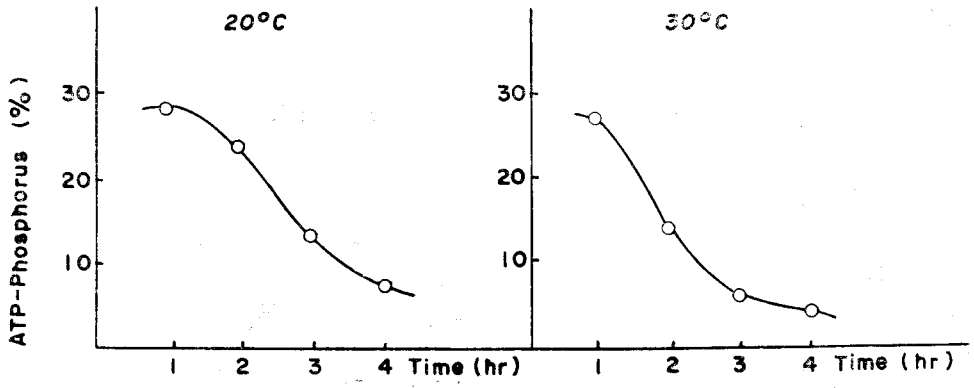

Fig. 1. Postmortem changes in ATP concentration in duck muscle at two different temperstures.

The ATPase activity of Myofibril from duck muscle was investigated. The results are shown in Fig. 2 and 3. There are two kinds of duck such as a House fed duck and a Sea fed duck.

According to Fig. 2 and 3, it is understood that the ATPase activity of Myofibrils from muscle in both House fed and Sea fed duck at the concentrations of KCl (1.0M), 1mM-EDTA(2m*l*), 1mM-Ca^{++}(1m*l*), 1mM-Mg^{++}(1m*l*) are shown the highest activity, so there was no ability to make inhibition for ATPase activity. But it showed that the ATPase activity of Myofibril from duck was inhibited at the concentration of KCl(3.0M), 1mM-EDTA(6m*l*), 1mM-Ca^{++}(3m*l*) and 1mM-

Mg^{++}(3m*l*).

6) In vitro digestibility

The duck-meat treated with pepsin was analyzed for the essential amino acids by

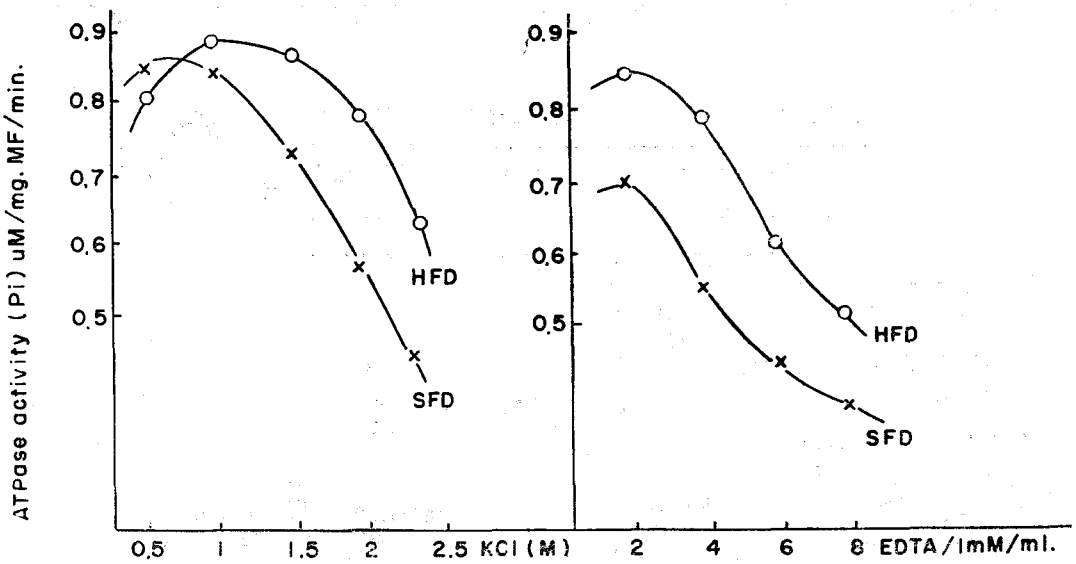

Fig. 2. Mg-Activated ATPase activiyt of myofibrils from duck.

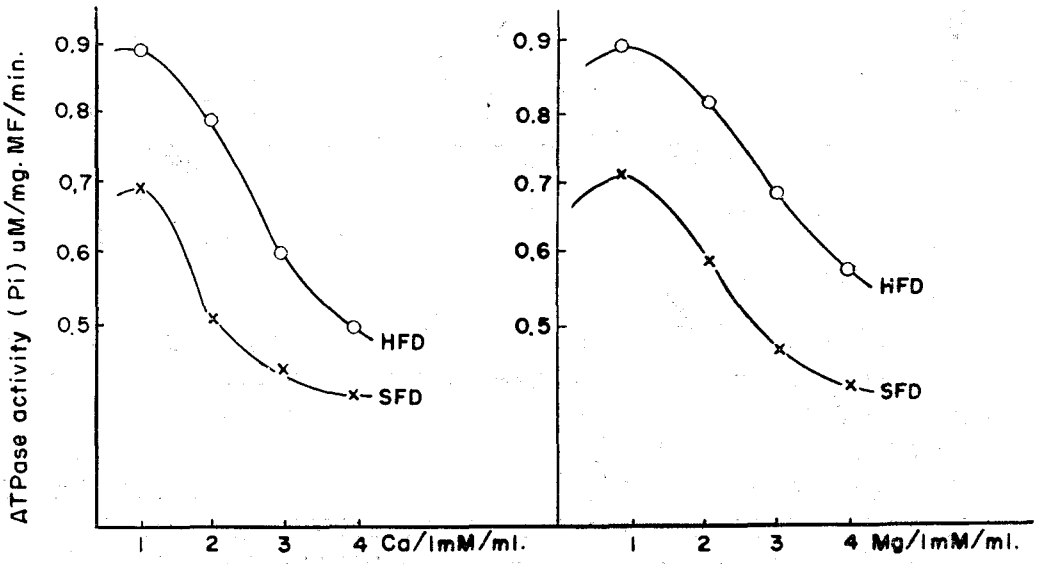

Fig. 3. Mg-Activated ATPase activity of myofibrils from duck.

Table 9. Release of the essential amino acids by an In vitro pepsin digestion of the duck-meat

Essential amino acid	Experimental contents	Untreated duck-meat
Isoleucine	1.10	2.20
Leucine	2.75	4.54
Lysine	2.17	4.95
Methionine	0.67	1.15
Phenylalanine	1.52	3.01
Threonine	0.55	5.80
Tryptophan	0.35	0.95
Valine	1.36	2.75
Histidine	1.85	5.60
Arginine	0.58	1.11

GLC. The results are shown in the following Table 9.

According to the results of pepsin treated duck-meat, after hydrolysis by pepsin, analytical values showed that the all the essential amino acids were released, the limiting amino acid was tryptophan which is underlined in Table 9.

Periodically released NH_2-nitrogen contents of duck meat during pepsin digestion according to various cooking conditions were analyzed by using Formal method (AOAC). The cooking condition is shown in Table 10, and the results of the relea sed amino nitrogen are shown in Table 11.

It is investigated that the cooking conditions affect the amino acid composition

Table 10. Cooking conditions for duck-meat

Condition	Temperature	Time(min.)	Remarks
Raw	—	—	—
Roasting	200—250°C	20	Electric cooking oven
Boiling	100°C	30	Automatic water bath

Table 11. Periodically released NH_2-Ncontents of duck meat during pepsin digestion

Condition	Digestion time(hrs)		
	4	8	16
Raw	6.59	20.15	30.75
Roasting	5.57	15.76	25.55
Boling	6.97	23.15	32.56

* Pepsin digestibility: (mg. NH_2-N/mg. Total N) × 100

and the pepsin digestibility of duck-meat protein. The pepsin digestibility was even high for the boiling meat than for the raw meat. Therefore, it can be concluded that duck-meat is a good protein food when used boiled meat by all the results obtained in this study.

Summary

Commercially available duck-meat was subjected to proximate analysis. On a wet basis, the duck-meat contained 62.87, 17.05, 19.06 and 1.02 percent of moisture, crude fat, crude protein and ash, respectively.

Almost all the essential amino acids contained in the duck-meat protein, and the tryptophan was the limiting one by amino acid analysis of GLC. An analysis of the fatty acid composition by GLC showed a relatively high concentration of oleic acid. There was also a considerable content of linoleic acid. The content of polyunsaturated fatty acids of duck-meat was 70.9% and the P/S ratio of fatty acids was 3.4.

The cholesterol content in duck-meat was determined to be approximately 70.5mg/100g ofm sample. According to blood analysis, it was understood that the content of phospholipids was relatively high, particulary in lecithin.

ATP-phosphorus, at the higher temperature, was released faster than at the lower temperature, by two hours after postmortem. The ATPase activity of Myogibril was inhibited at the relatively high concentration of added EDTA and metallic ions, but the activity was very high in the lower concentrations.

According to the cooking conditions, boiled duck-meat showed good digestion by pepsin. It was understood that the digestibility of duck meat was relatively high, so the duck-meat protein is good source of animal protein. Therefore, it is able to be recommended that duck-meat is good nitrogen source animal food.

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