International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN : 0974-4290
Vol.6, No.7, pp 3896-3902, Sept-Oct 2014

Physicochemical Properties, Fatty Acids Profile and Cholesterol Content of Indigenous Manado Chicken, Broiler and Spent Hen Meat

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Abstract: The study of meat quality of three different chicken species namely indigenous Manado chicken, spent hen and broiler was conducted. Carcasses of three different species were purchased in local market in Manado, North Sulawesi and mixture of breast and thigh fillets were used as samples for determination of physicochemical properties, fatty acids profile and cholesterol content. Broiler breast and thigh fillets mixture contained higher amount of moisture, fat and cholesterol compared to breast and thigh fillets mixture of either spent hen or indigenous Manado chicken, but lower protein content was observed in mixture of breast and thigh fllets of broiler. Saturated Fatty Acids (SFA) content in broiler meat were lower ($P<0.05$)compared to the one in spent hen and indigenous Manado chicken, while Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA), omega 3, 6 were also observed higher amount ($P<0.05$) compared to breast and thigh fillets of either indigenous Manado chicken or spent hen. However omega 9 content of broiler mixture of breast and thigh fillet were slightly lower ($P>0.05$) than spent hen meat , while omega 9 content of indigenous Manado chicken mixture breast and thigh fillets was the lowest amount ($P<0.05$) compared to other types of chicken meat.
Keywords: Mixture of breast and thigh fillets, physicochemical charactristic, Fatty acids profile, Cholestrol content.

Introduction

Meat and meat products are a very important source of fat, protein, amino acids, minerals and vitamins especially in the diet of developing countries[1]. Cattle, buffalo, goat, sheep, rabbit and chicken are commercially produced for meat consumption in Indonesia. Chicken meat is most preferable because of lower in price, easy to process, fast growing hence short raising time. This type of meat are obtained from slaughtering indigenous chicken, broiler and spent hen.

According to Chuaynukool, *et al.* the meat properties of indigenous chicken are very similar to the one from spent hen, but quite different from broiler meat[2]. Wattanachant *et al.,* and Jaturashitha *et al.*, also noted

that meat of indigenous chicken has a different texture and taste compared to broiler meat, and in Thailand an increase of consumers demand on indigenous chicken meat due to its unique characteristics[3-4]. Indonesian concumers are also prefer indigenous chicken meat as it is believed that this type of meat have a lower fat content, less moisture content and more dry as this breed are actively scratch their feed. Indigenous chicken are slow growth rate and this affected the meat properties where it has a tough texture and more tasty after cooked compared to broiler meat.

Broiler is one of the commercial chicken which are domisticated because of fast growing rate followed by fast fat deposit and cholesterol in its meat. This type of meat have a high nutritive value, good taste and aroma, soft texture and relatively cheap hence almost all consumers like this type of meat. Spent hen are finish egg laying cycle chicken and its meat have a similar nutritive value as commercial broiler, and as a good source of protein (Lee *et al*., [5]) and also could be enriched with omega3 and low cholesterol content in breast part which already proved it's beneficial for consumers health as reported by Ajuyah *et al.* [6].

The difference of meat fat content are possibly due to animal breed, external and internal factors, climate, farming and feeding system[7]. Most of consumers prefer chicken meat with low fat content as consumption of fat contained high proportion of saturated fatty acids could cause blood cholesterol and triglyceride content increased leading to aterosclerosis which end up with coronary disease [8] .

The physicochemical characteristics of indegenous chicken, spent hen and broiler meat especially in Thailand have been intensively studied as reported by Abeni and Bergoglio[9-14,4]. However there are still no scientific publication on indigenous chicken, spent hen and broiler meat produced in Manado, North Sulawesi. The objectives of this present study are therefore to investigate the physicochemical characteristics, cholesterol content and fatty acids profile of those type of meat.

Material and Methods

Breast and thigh fillet preparation. Indigenous chicken, Spent Hen and broiler carcass of 1.5 – 2.0 kg were purchased from traditional market in Manado, North Sulawesi, and breast and thigh fillet from these carcasses were collected then packed in polyethylene pouches and stored at 4^0 C before laboratory analysis.

Laboratory analysis.

Moisture, fat and protein contents were determined using the methods as described in AOAC[15], and fatty acids profile was determined using Gas Chromatography according to the method as described by Park [16].

Sample for GC analysis were prepared following the method as described by Park [16]. 2 g of chicken meat was homogenised using 4 ml and 100 ml homegenate were placed in a test tube and 100 ml of mixture of methylene chloride and 1 ml of NaOH 0.5 N in methanol were added. After flushed with nitrogen gas, the test tube was closed with a lid before heating in water bath at 90^0 C for 10 minutes. After cooling the test tube, 1 ml BF3 14% in methanol were added and flushed with nitrogen gas before heat treatment continued at the same temperature for another 10 minutes.

The test tube was then cooled up to room temperature before 1 ml aquadest and 200 – 500 µl hexane were added and then vortexed for 1 minute to extract the fatty acid methyl ester, centrifuged and the upper layer was ready for fatty acids profile using GC. The condition of GC apparatus used were as follow: the temperature was between 140^0C – 230^0C and gradually increased 8^0C, while the detector temperature was 230^0C and the capiller columnn used was CBP 10 –semipolar 50 m length, gas carier used was nitrogen (N_2) with pressure of 3kg/cm^2 and had a Flame Ionisation Detector(FID).

Statistical analysis.

Data obtained were analysed using one way ANOVA and if there were significant differences the analysis was continued using Turkey test. The data was presented as means ± standard deviation at significancy level of $P<0.05$ using SPSS versi 20 software (Chicago, IL, USA).

Results and Discussion

The physicochemical and cholesterol content analysis results are presented in Table 1. and it was observed that the physicochemical characteristics of broiler meat was significantly different ($P<0.05$) than indigenous Manado chicken and spent hen meat. The highest moisture and fat contents were found in broiler

meat, whilst the lowest protein was also found in broiler meat. However fat and protein contents of indigenous Manado chicken meat were significantly difference (P<0.05) and moisture content was not significantly different (P>0.05) compared to spent hen meat.

Table 1 : Physicochemical and cholesterol content breast and thigh fillets mixture of indigenous Manado chicken, broiler and spent hen*.

NO	Variables	Indigenous Manado chicken	Broiler	Spent hen
1	Moisture content (%)	73.30 ± 0.23 a	75.48 ± 0.09 b	73.45 ± 1.07 a
2	Fat content(%)	0.41 ± 0.04 a	3.99 ± 0.03 b	5.20 ± 0.02 c
3	Protein content(%)	24.66 ± 0.07 c	21.81 ± 0.09 a	23.99 ± 0.08 b
4	Cholesterol content (mg/100 g)	73.63 ± 3.67 a	374.76 ± 21.96 c	281.80 ± 30.47 b

*: Same letter of notation at same column indicated there was no differenece (P>0.05) between samples.

Okarini *et al.,* reported that the highest moisture content (73.48%) and fat content (4.70%) were also observed in broiler meat, while the lowest protein content (18.94%) was found in indigenous Balinese chicken and spent hen meat [17]. However in this study moisture (75.48%) and fat (5.20%) of broiler meat purchased in Manado, North Sulawesi were slightly higher. This condition could possibly due to different of environmental condition, feeding and rearing systems. According to Xiong *et al*.,[18,9,10,13] the chemical composition of chicken meat was affected by species, sex, age, part of meat as well as carcass processing. Bragagnolo noted that these factors were varied according to the area where the animals were reared [7].

Chicken meat with protein and fat contents of 19% and 5% respectively, were the main source of protein with low fat compared to pork and beef [10]. There were quite a number of studies which reported that species, sex, age and feeding system affected the growth rate of an animal as well as its meat composition. Chemical composition of chicken meat had showed affected by age and rearing system as explained by moisture, fat and protein contents of indigenous Thai chicken, broiler and spent hen meat[3,5]. The composition and structure changes, meat protein properties and meat quality of indigenous Thai chicken during the growth period of 6 – 24 weeks had been investigated, and it was reported that moisture content decreased from 77.8 % to 71.6%, whilst protein and fat contents increased from 21.5% to 24.0% and 1.35% to 3.90% respectively [13].

The cholesterol content of mixture of breast and thigh fillet of indigenous Manado chicken, broiler and spent hen meat are significantly different (P<0.05), where the highest cholesterol content was found in broiler meat and the lowest one was in indigenous Manado chicken. The slow growth rate and feeding system of indigenous Manado chicken could be the reason of this difference. Molee reported there were no significant differences (P>0.05) in cholesterol contents of breast fillet (32.93mg/100g) and thigh fillet (60.14 mg/100g) of indigenous Thai chicken reared in conventional indoor system compared to cholesterol content of breast fillet (34.65 mg/100g) and thigh fillet (59.79 mg/100g) of chicken free range rearing system with access to grass field. However, there was significant difference (P<0.05) between breast and thigh fillets [19].

De Almeida *et al*., also reported that mixture of drumstick and thigh fillets of chicken were the most consumed by diabetic patient and contained 80.30 mg/100g cholesterol,77.49% moisture, 18,83% protein and 4.08% fat[20]. In this study the cholesterol content of mixture of breast and thigh fillets of broiler and spent hen were higher compared to cholesterol content of chicken meat samples of previous studies, while colesterol content of indigenous Manado chicken meat was lower. These differences possibly due to different mixture of fillet used as samples as well as location where those fillets were obtained. Fletcher also noted that chicken meat composition could affected by ante-mortem factors of live animals such as genetics, physiology, nutrition, management and diseases [21].

Fatty acids profile of those fillets mixture are presented in Table 2 and oleic acid was observed as the highest amount fatty acid followed by palmitic acid, linoleic acid and stearic acid.

Table 2. Fatty acids profile of mixture of breast and thigh fillets of indigenous Manado chicken, broiler and spent hen*.

Fatty acids profile	Indigenous Manado chicken	Broiler	Spent hen
Capric Acid (C10:0)	0.05 ± 0.03 a	0.04 ± 0.01 a	0.02 ± 0.01 a
Lauric Acid (C12:0)	0.45 ± 0.12 a	0,76 ± 0.11 a	0.60 ± 0,21 a
Myristic Acid (C14:0)	0.72 ± 0.04 a	0.94 ± 0.13 a	0.86 ± 0.06 a
Palmitic Acid (C16:0)	22.35 ± 0.41 a	21.95 ± 0.49 a	21.94 ± 0.43 a
Stearic Acid (C18:0)	8.70 ± 0.08 c	4.44 ± 0.12 a	6.20 ± 0.40 b
Anachidic Acid (C20:0)	0.46 ± 0.02 b	0.65 ± 0.04 c	0.39 ± 0.04 a
Behenic Acid (C22:0)	2.67 ± 0.04 c	0.51 ± 0.01 b	0.30 ± 0.02 a
Total Saturated fatty acid(SFA)	35.40 ± 0,53 b	29,29± 0,65 a	30,32± 0,15 a
Palmitoleic Acid (C16:1n-7)	3.99 ± 0.12 b	6.38 ± 0.17 c	3.50 ± 0.07 a
Oleic Acid (C18:1n-9)(Omega-9)	38.97 ± 0.26 a	42.28 ± 1,15 b	43.85 ± 2,22 b
TotalMonounsaturatedfatty Acid(MUFA)	42.97 ± 0,16 a	48.66±1,31c	47.34 ± 2,15 bc
Linoleic Acid (C18:2n-6)(Omega-6)	17.60 ± 0.10 a	19.01±0.26b	18.65 ± 0.87 ab
Linolenic Acid (C18:3n-3)(Omega-3)	0.19 ± 0.02 b	0.35 ± 0.05c	0.10 ± 0.02 a
TotalPolyunsaturatedfattyacid (PUFA)	17.79 ± 0,09 a	19.35±0,31 bc	18.75 ± 0,89 ab
Total Unsaturated Fatty Acid	60.76 ± 0.18 a	68.01 ± 1.62 b	66.09 ± 3,02 b

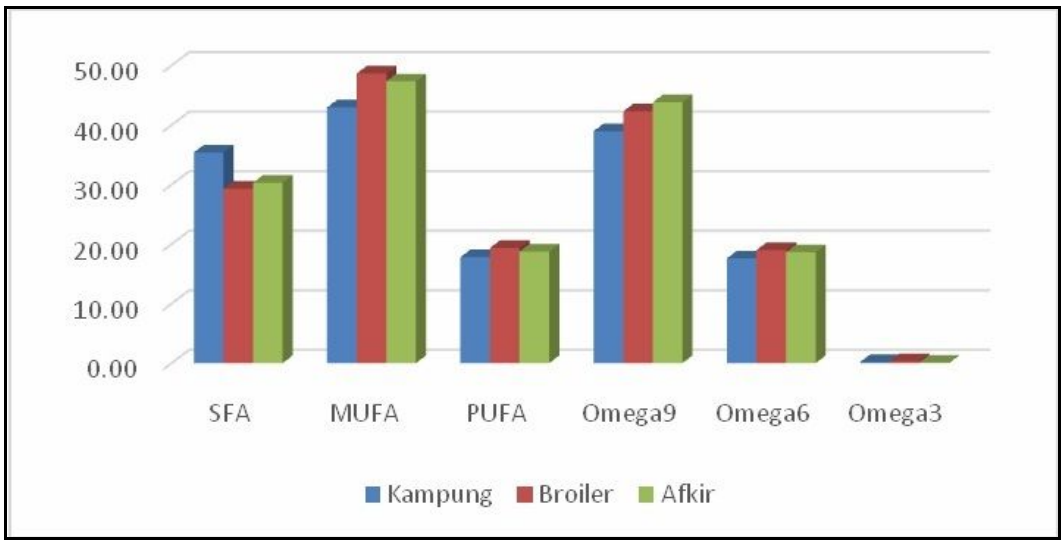

Figure.1. Fatty Acid SFA, MUFA, PUFA, Omega-9, Omega-6 and Omega-3 Proportion at Indigenous Manado chicken, Broiler and Spent hen.

Saturated fatty acid content of breast and thigh fillets mixture consist of capric acid (C10:0),lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), anachidic acid (C20:0) and behenic acid (C22:0). The lowest SFA content (29.29%) was found in broiler meat and not significant different ($P>0.05$) compared to SFA content (30.32%) of spent hen meat, but significant different ($P<0.05$) with SFA content (35.40%) of indigenous Manado chicken meat. This condition indicated that broiler meat produced in Manado, North Sulawesi is more beneficial for health because of the lowest SFA content compared the other types of meat. It is possibly due to the feeding system as either broiler and spent hen are reared by controlled feeding system, while the indigenous Manado chicken scavenging everywhere. Furthermore, according to Estiasih long chain SFA consist of 14 up to 24 carbons which means that long chain SFA are more slower digested and absorbed, hence could increase the cholesterol level in blood serum [22].

Supadmo reported that SFA content of chicken meat varied between 34.35% and 37.49% [23]. A slight difference SFA content (35.67%) in breast fillet of spent hen chicken as reported by Liwa [24]. While Gross *et al.,* noted that higher amount of PUFA and lower SFA content explained the decrease of cholesterol level in blood serum up to 18% in microalbuminuric diabetic patient type if they change red meat consumption with chicken meat [25].

MUFA of broiler meat in this study consist of palmitoleic acid (C16:1n-7) and oleic acid (C18 : 1n-9) and found as the highest amount (48.66%) compared to the other types of meat, although not significant difference ($P>0.05$) with total MUFA (47.34%) of spent hen, but significant difference ($P<0.05\%$) with MUFA content (42.97%). These results also showed that broiler meat contained better MUFA compared to the other two types of meat, Liwa also reported that MUFA content (44.57%) in spent hen chicken meat sample was slightly higher than the one found in this study [24].

The highest PUFA content (19.35%) was determined in broiler meat and consist of linoleic acid (C18 :2n-6) and linolenic acid (C18 : 3n-3) and no significant difference ($P>0.05$) with PUFA content of spent hen meat but significant diference ($P<0.05$) with PUFA content (17.19%) of indigenous Manado chicken meat. Liwa also found a similar PUFA content (17.79%) in breast meat of spent hen chicken meat [24].

Therefore, total unsaturated fatty acid (USFA – 68.01%) in broiler meat was determined as the highest USFA content and not significant difference ($P>0.05$) compared to USFA content (66.09%) of spent hen meat, but significant difference ($P<0.05$) compared to USFA content (60.76%) of indigenous Manado chicken meat.

The spent hen meat contained the highest amount of oleic acid (C18 : n1-9) or omega-9 (43.85%), although not significant difference ($P>0.05$) compared to omega 9 content (42.28%) of broiler meat and significant difference compared to omega 9 content (38.97%) of indigenous Manado chicken meat.

Broiler meat was observed contained linoleic acid (C18 : 2n – 6) or omega 6 about 19.01% and it was the highest omega 6 content and not significant difference compared to omega 6 content (18.65%) of spent hen meat , but significant difference ($P<0.05$) compared to omega 6 content (17.60%) of indigenous Manado chicken meat. The results of this study showed that broiler meat with relatively high omega 6 content considered as a good nutritive source for the diet, as Hernandez *et al*., noted that omega 6 consist of linoleic acid (C18 : 2n-6) and arachidonic acid (C20 : 4n-6) are the most important components in body fat especially during growth and development period [26].

The linolenic acid (C18 :3n-3) or omega 3 content (0.35%) of broiler meat are the highest omega 3 content (0.35%) and significant difference ($P<0.05$) compared to either omega 3 content (0.19%) of spent hen meat and 0.10% of indigenous Manado chicken meat. Wattanachant *et al*., reported that thigh and breast fillets of broiler contained omega 9: 35.81% and 38.50%, omega 6: 9.13% and 7.95% ,and omega 3: 1.47% and 1.32% respectively [3]. These amounts of omega 9, 6 and 3 are higher compared to the one in breast and thigh fillets of indigenous chicken meat i.e. omega 9 : 27.30% and 31.86%, omega 6 : 4.74% and 3.36% and omega 3 : 0.95% and 0.90% respectively. This results are similar to the one observed in this study, where broiler breast and thigh fillets contained higher omega 9, 6 and 3 compared to breast and thigh fillets of indigenous Manado chicken.

Furthermore,Wattanachant *et al.,*also reported that breast and thigh fillets of indigenous chicken contained SFA 65.55% and 62.64% respectively which is higher compared to breast and thigh fillets of broiler SFA i.e. 50.1% and 48.76% respectively. However, MUFA contents of breast and thigh fillets of indigenous chicken i.e. 28.77% and 33.09% are lower than MUFA content of same fillets of broiler i.e. 39.25% and 41.82% as well as PUFA content of indigenous chicken breast and thigh fillets i.e. 5.69% and 4.26% compared to broiler chicken breast and thigh fillets i.e. 10.74% and 9.42% respectively [3]. A similar results are also found in this study that SFA content of broiler are lower and MUFA and PUFA contents are higher compared to indigenous Manado chicken, although fatty acids profile spent hen meat are similar to broiler meat.

One of the reason that affected fatty acids profile of those meat are the use of fish meal in the feeding system in Manado, North Sulawesi which probably could increase the MUFA and PUFA content of broiler and spent hen meat. According to Belyavin *et al.,* the addition of 10% fish meal in broler feed could increase the MUFA and PUFA content (especially omega 3 content increased from 4.63% to 6.52% or increased up to 71.01%) with fatty acids of fish meals contained total SFA 32.7%, total MUFA 20.9% and total PUFA 40.3% [27]. While Wattanachant reported that indigenous chicken are allowed to scratch their own feed from surrounding without any feed concentrate added [14].

Jaturasitha *et al*., reported differently as they observed that indigenous chicken meat because containing low fat and cholesterol and more beneficial fatty acids profile [4]. As the omega 6 content of broiler meat are relatively higher, hence broiler meat are considered could fulfill the nutrition needs. The beneficial effect of PUFA depends on the ratio of omega 6 (n-6) and omega 3 (n-3), which in general the ideal ratio is 04 : 01, however Schaefer *et al.,* noted that in western diet varied between 20 to 30 : 1 [29]. There are some reports noted that although chicken feed with same feeding materials a different unsaturated fatty acids content were observed and this is possibly due to the feeding behaviour of those chicken species. Bragagnolo noted that fatty acids composition in chicken meat are affected by many factors such as species, internal and external of fat level, rearing surrounding environment and feeding system where these factors varied according the location of animal farming [7].

Conclusion

The present study showed that mixture of breast and thigh fillets of broiler contained moisture and cholesterol contents are higher and protein content are lower compared to spent hen and indigenous Manado chicken. Broiler meat produced in Manado are still good to be consumed as the SFA content is quite low and MUFA and PUFA, omega 6 and omega 3 contents are higher compared to spent hen and indigenous Manado chicken meat.

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