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PHYSICO-CHEMICAL CHARACTERISTICS, FATTY ACID PROFILE, AND CHOLESTEROL CONTENT OF KEDU CHICKEN MEAT BASED ON VARIOUS COOKING METHODS

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Abstract

This study aimed to assess the physico-chemical characteristics, fatty acid profile, and cholesterol content of Kedu chicken meat based on various cooking methods. Kedu chicken with an average weight of ± 1,200 g was slaughtered and taken the chicken breast, grouped three types of treatment, namely searching, frying, and microwave with 5 replication. Furthermore, the samples were tested for the physical and chemical quality of chicken meat. The results showed that boiling, frying, and microwave cooking had a very significant effect ($P<0.01$) on the moisture, fat, protein, and collagen content of Kedu chicken meat. The physical quality of meat showed that chicken meat cooked by different methods had a significant ($P<0.05$) effect on the pH value of chicken meat, and a very significant effect ($P<0.01$) on cooking loss, tenderness, and water holding capacity of chicken meat. Different meat cooking methods had a very significant effect ($P<0.01$) on SFA (Saturated Fatty Acid), MUFA, (Monounsaturated Fatty Acid) PFA (Polyunsaturated Fatty Acid), and UNFA (Unsaturated Fatty Acid) Kedu chicken, meat. Meat cholesterol showed a very significant result ($P<0.01$) with different cooking methods. It can be concluded that Kedu chicken meat cooked by the fried method showed the best chemical quality, while chicken meat cooked by the boiled method showed the best physical quality and fatty acid profile and cholesterol content of Kedu chicken cooked by the microwave method was the best.

Keywords: cholesterol of meat, cooking methods, fatty acid profile of meat, Kedu chicken, physico-chemical characteristics of meat

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INTRODUCTION

In Indonesia, some indigenous chicken are found, one of them is Kedu chicken. Kedu chicken is a chicken that is commonly found in Indonesia, especially in Central Java (Abubakar *et al.* 2014). There are different kinds of Kedu chicken i.e., Cemani, Black Kedu, Red Kedu, White Kedu and Lurik Kedu that have specific characteristics and are potential to be conserved and developed as indigenous germ plasma (Ismoyowati *et al.* 2012). Kedu chicken has characteristics similar to Cemani chicken which is a completely black appearance that includes the beak, nails, soles of the feet, skin, meat, and tongue (Rofii *et al.* 2018). The superiority of Kedu chicken meat was an attraction for people to process and cook it into more useful products such as fried and boiled as a local chicken meat product.

Meat is an important food ingredient in fulfilling human nutritional needs. Higgs (2000) add that meat is a concentrated nutrient source, previously considered essential to optimal human growth and development. One type of meat that is commonly consumed by the public is chicken meat the composition consists of water, fat, protein, minerals, and carbohydrates. Chicken meat has several advantages, among which it has an important role in fulfilling human nutrition because it contains high-quality protein and essential amino acids, essential fatty acids, vitamins, and minerals (Givens, 2005). Meat is categorized as a perishable food so it needs good handling so that the quality of the meat is maintained. The purpose of cooking is to make the meat tasty, easy to digest, and microbiologically safe. Meat products undergo many changes during the cooking process, such as weight loss, shrinkage, and texture (Mora *et al.* 2011). This port is subject to denaturation of proteins and loss of water during cooking. In addition, the quality of meat products is influenced by the composition and characteristics of the muscles, the cooking method, and the cooking time and temperature (Lee *et al.* 2006).

The influence of different cooking methods on the sensory and physico-chemical properties of foods is a topic that concerns scientists, cooks, chefs, gastronomes, and consumers alike in every culture. The cooking of meat is considered an ancient practice that has evolved into refined cooking techniques (Sara *et al.* 2020; Suman *et al.* 2016). defined the cooking of meat as heating the food to a sufficiently high temperature to denature the different proteins that are present. During the heating process, myofibrillar, sarcoplasmic, and connective tissue proteins denature and they cause structural changes in the meat, producing modifications in the mechanical properties (Li *et al.* 2013). Furthermore, cooking helps in the production of pleasant characteristics taste, flavor, and tenderness. It also decreases the microbial load, and therefore it prolongs the shelf-life of meat (Domiguez *et al.* 2014; Rasinska *et al.* 2019; Abdel-Naeem *et al.* 2021). In contrast, cooking decreases the nutritional value of meat by destructing some vitamins and minerals, lowering moisture content, denaturing muscle proteins, and changing the structure of myofibrillar and connective tissue. according to the method of heat treatment including the cooking environment (dry or moist), cooking temperature, and cooking time (Combes *et al.* 2004).

Although most of the previous research focused on the study of cooking methods on the muscular structure of different species such as beef, pig, and rabbit (Angel-Rendon *et al.* 2020; Kaur *et al.* 2014; Rasinska *et al.* 2019), as well as in chicken meat quality (Chumngeon *et al.* 2018; Qi *et al.* 2018) that revealed the effect of different cooking methods on microstructure and sensory quality on chicken meat and the effect of different cooking in different chicken strain on fatty acid content (Mancinelli *et al.* 2021).

However, no research explains the quality of Kedu chicken meat which is a local chicken from Indonesia. Therefore, the current study was conducted to clarify the effect of different cooking methods such as boiling, frying, and microwave cooking on physico-chemical characteristics, fatty acid profile, and total cholesterol on Kedu chicken meat.

MATERIALS AND METHODS

The Experimental Design and Meat Sampling

The preparation stage of the meat sampling was the selection of chickens of relatively the same sex, weight, and age at Kedu District, Temanggung Regency, Central Java in Indonesia. Kedu chickens with relative weight ±1200 g were slaughtered using the halal method until then the carcass of the Kedu chicken was taken. The animal slaughter procedure was approved by the Ethical Clearance Committee, and it was performed following the Guidelines of Animal Use of the Faculty of Veterinary Medicine, Universitas Gadjah Mada, Indonesia. Furthermore, the carcass of Kedu chicken meat is cut into sopartsart and take some breast from the chicken carcass. The treatment was prepared into four groups of treatment with five replication which was Fresh Kedu chicken meat, Kedu chicken meat cooked by boiling at a temperature of 100 ^{o}C for 30 minutes in 1 liter of water, Kedu chicken meat cooked by frying at a temperature of 188 ^{o}C for 10 minutes with 500 ml of cooking oil and Kedu chicken meat cooked by microwave with a high-temperature level so that the level of maturity is well done. After cooking the meat is tested by chemical, physical, fatty acid profile, and cholesterol tests.

Physico-Chemical Examination

The proximate quality test of meat includes moisture content, protein content, fat content, and collagen content using Near-Infrared Spectroscopy (NIRS). Meat weighted 30 g, mashed with a mixer then placed in a simple pat cell put in the foodscan. The analysis was carried out using infrared light and the results were recorded. Determination of physical quality on Kedu chicken meat for pH value was chicken meat sample weighing 10 g was chopped, added 10 ml of distilled water, and stirred until homogeneous. The pH of the sample was measured with a pH meter that had been calibrated with a pH buffer of 7.0 and 4.0. The pH value was measured three times and the results were averaged (Bouton *et al.* 1971). Water holding capacity was tested according to the Hamm method (Hamm, 1986) and samples were weighed as much as ± 0.3 g. The sample was placed on filter paper and pressed with two plates then pressed with a load of 35 kg for ± 5 minutes. Draw the area with the transparent plastic and determine the area (cm^2). Determine the total moisture content: filter paper weighed (Wks). Samples were weighed ± 1 g (Ws) and wrapped in filter paper. Samples were heated in an oven at 110 ^{o}C for 8 hours. For tenderness on meat was determined with the Warner bratzler shear force device. The cut sample was placed on a warner bratzler shear force cutting tool. Then read the value on the tool. The level of the tenderness of the meat was indicated by the amount of strength (kg/cm^3) needed to cut the meat sample. Tenderness measurements were carried out at three different places and the results were averaged (Swatland, 1984). The chicken meat was cut and weighed as much as 25 g. The meat was cooked by boiling, frying, and microwaving. The meat was then cooled then the final weight was weighed and then calculated the difference between the initial weight and final weight (Soeparno, 2015).

Fatty Acid Profile Examination

Determine the fatty acid profile of meat was carried out according to the method (AOAC, 2005). The analytical method used has the principle of converting fatty acids into their derivatives, namely methyl

esters so that they can be detected by chromatography. Gas chromatography has the working principle of separating gases and thin films of liquids based on different types of materials. The gas chromatography was conditioned first according to the standard and the type of sample that 2 µl of solvent was injected into the column. The solvent peak will be visible in approximately 1 minute. After the pen returned to the zero-line, 5 µl of the standard fatty acid solution was injected. When all the standard peaks have been removed, the retention time, peak area, and individual components can be viewed. The peak area of each identified fatty acid was used to calculate the proportion (%) against the total identified peak area.

Total Cholesterol Examination

Meat cholesterol testing was carried out using the GC-MS method (Yasser, 2017). The chicken meat is mashed and then homogenized. Meat samples were weighed and then taken as much as ± 5 g randomly or randomly. A solution of 0.25 N KOH has added as much as 10 ml to the chicken meat sample. The meat samples were heated in a water bath at 80 ºC for 3 hours, while occasionally being shaken. Next, the meat sample was cooled until warm then added 20 ml of ethanol solution and then extracted with 20 ml of a mixed solution of diethyl ether and petroleum benzene (1:1) and kept overnight. The top layer of the meat sample was taken, then concentrated in a water bath at 40ºC. The oil obtained was dissolved using a Toluene solution with a volume of 1 ml. The sample solution was vortexed until homogeneous and then centrifuged if the solution was cloudy. The sample is taken in clear solution and then put into the GC vial. Next, a cholesterol standard solution was made and the sample was injected as much as 1 µl of the sample solution and the standard solution into the GC.

RESULTS AND DISCUSSION

Physico-Chemical Characteristics of Meat

The result of the chemical quality on Kedu chicken meat is shown in Table 1. The results showed that the different cooking methods had a very significant effect ($P<0.01$) on the moisture, protein, fat, and collagen content of Kedu chicken meat. The highest moisture content was found in fresh meat, which was fresh meat, while the lowest water content is found in fried meat. Protein content on meat shows that the cooked meat with boiled, fried, and microwave methods increase the protein content of chicken meat and the highest protein content found in fried meat. Fat content on meat showed that the fried meat increase fat content while the boiled and microwaved meat decreased the fat content of Kedu chicken meat. Collagen content on meat showed that fried meat and microwaved meat were higher than boiled meat on cooking methods.

Cooking is a processing process that can reduce the water content in food (Ozca and Bozkurt, 2015) and the product will lose water during heating at a temperature of 50 to 60 ºC, the loss of water in this temperature range can reach 80% (Ranken, 2000). The moisture content of boiled meat was higher than that of meat cooked by frying and microwave methods because the boiling process used water, which is water that is used for cooking was in direct contact with the meat, so the water content of boiled meat was higher. Ersey (2011) found that the highest water loss was found in fried meat samples because the loss of water during frying results in higher fat content. The decreased moisture content in cooked meat is due to changes in tissue structure and chemical changes in meat proteins, especially myofibrillar proteins and sarcoplasmic proteins (Babji and Kee, 1994). Winarno (2004) states that the higher the temperature used, the more water molecules come out of the surface.

Frying and microwave methods used a higher temperature than the boiling method so that the percentage of moisture content was decreased and the percentage of protein content increases. Ranken (2000) states that heating with higher temperatures and faster times will result in higher water losses. Slower heating at lower temperatures results in lower water losses. The difference in the amount of water lost is what causes the difference in meat protein content. The tendency to increase protein content can be caused by the increase in dry matter per unit weight of the sample, due to the shrinking of the meat sample size (Tornberg, 2005), and the increase in protein content in cooked meat is thought to be due to reduced water content after cooking (Garcia-Arias *et al.* 2003). The cooking process can cause changes in the characteristics of meat proteins, especially connective tissue proteins and myofibrillar proteins. The cooking process can dissolve the connective tissue (collagen), which results in increased tenderness, while the heat will also denature myofibrils proteins which cause hardness in the meat.

The fat content of fresh chicken meat decreased after boiling and microwave cooking treatment. This is presumably by boiling the fat contained in the chicken meat that melts in water by this process. Winarno (2004) states that in the presence of water, fat can be hydrolyzed into glycerol and fatty acids. While microwaved meat, the fat on the meat will melt out with the water in the meat thanks to the heat from the microwaves. This is the opinion of Kumiasari *et al.* (2008) stated that microwave ovens work by passing microwave radiation to water, fat, and sugar molecules that are often found in food ingredients. The increase in fat content is thought to be due to the presence of cooking oil which is absorbed by the chicken meat which causes the fat content in the chicken to increase. In accordance with the opinion of Saguy and Dana (2003) who stated that the increase in fat content occurs due to the penetration of oil into the meat after the water in the meat has evaporated. According to Kassama and Ngadi (2004), the increase in fat content of fried meat is the result of heat transfer that occurs during frying. This heat transfer results in a mass transfer of oil into the sample and meat water in the form of water vapor that moves from the sample to the sample surface.

Chicken cooked by frying increased collagen levels compared to chicken cooked using boiled and microwave methods. This is presumably due to an increase in the cooking concentration of the meat when it is fried. The increase in collagen levels was due to an increase in meat cooking losses as a result of the high cooking temperature at the frying time. According to Tornberg (2005) that the temperature between 53 to 63 ^{o}C collagen is denatured. The first involves the breakdown of hydrogen bonds which increases the structure of myofibrils and the contraction of collagen molecules. If uncontrolled the collagen fibers shrink to a quarter and stop at a heating temperature of 60 to 70 ^{o}C. If the collagen fiber is unstable with bonds between heat-resistant molecules, it will dissolve into gelatin.

The result of the physical qualify on Kedu chicken meat is shown in Table 2. The results of pH value showed that the boiled, fried, and microwave meat increased ($P<0.05$) the pH value of Kedu chicken meat. The result of cooking loss, tenderness, and water holding capacity showed very significant results ($P<0.01$) on Kedu chicken meat. Cooking loss on chicken meat showed that fried meat gives the highest cooking loss, while the microwaved meat treatment was higher than boiled meat on the cooking method. Tenderness of meat shows that cooked meat with boiling, frying, and microwaving increases the tenderness of chicken meat. The highest value of tenderness was on fried meat and the lowest value of chicken meat was on

boiled meat. Different with tenderness, water holding capacity on meat showed that cooking with boiling, frying, and microwave was decreasing water holding quality of chicken meat.

The pH value of chicken meat increased significantly after cooking, but different cooking methods resulted in relatively the same pH value. This was because the meat used comes from relatively the same parts of chicken meat, so the muscles have almost the same activity when the animal is still alive. Muscle activity will determine the muscle glycogen content which in turn will determine the pH value of the meat. The high muscle glycogen content when the animal was milled would produce a higher amount of lactic acid in the animal after slaughter and meat acidification (Fernandez and Tornberg, 1991). The amount of lactic acid content will determine the high and low pH value of the final meat after the cutting process. Cooking will cause an increase in the pH value of the meat because there is a decrease in the acidic group so that the isoelectric point of the meat will change and be at a higher pH value. Cooking at different temperatures and periods will result in differences in meat quality for example pH, cooking loss, tenderness, and length of the sarcoma (Soeparno, 2015). The pH value obtained from the earlier study was lower than that of Chol *et al.* (2016), and the pH of chicken cooked by boiling and microwaved methods of 5.98 and 5.85.

The tenderness of meat increased significantly in frying and microwave cooking. The high temperature of roasting and microwave cooking can increase the denaturation of myofibrils proteins, causing changes in the properties of these proteins, including meat's ability to bind water. The ability to bind water causes the meat juices that come out during cooking to be bigger so that the loss of meat mass becomes greater. Cooking losses are influenced by temperature and cooking time (Lawrie, 2003). Higher cooking temperature and longer cooking time affect the greater loss of meat moisture content until it reaches a constant level. Soeparno (2015) stated that cooking loss is due to the cooking process as a function of temperature and duration of cooking. The tenderness of the chicken meat increased with cooking so looking with the boiling, frying, and microwave methods causes the hardness of the chicken to increase. This is because the cooking process will cause denaturation and increase myofibril hardness. Tonberg (2005) stated that myofibril protein denatured at cooking 40 to 60 ^{o}C and caused hardness in the meat. Babji and Kee (1994) added that muscles with a larger myofibrillar structure and containing more connective tissue have more tough properties. According to Soeparno (2015) one of the factors that influence meat tenderness is the postmortem factor, one of which is the cooking method.

Cooking and confidence affect the quality of the meat, especially in the frying pan, which is caused by the high cooking temperature. The heat will evaporate the air, and cause connective tissue to develop so that it will affect the meat and water holding capacity (WHC). Lawrie (2003) states that the higher the amount of air released, the lower the water holding capacity. Meat protein plays a role in air binding so high protein levels will cause the ability of the protein to hold air. The amount of water in the meat can change, this is the amount of tissue itself and the handling of the product (Huff-Lonergan *et al.* 2000). Changes in the air-holding capacity of the meat caused by heat during the meat maturation process are uncomfortable with denat the duration of myosin and actin (Bertram *et al.* 2006). Chicken cooked by frying and microwaving produces the lowest water holding capacity. Therefore, it is possible to postulate that microwave and roast treatments cause different degrees of denaturation of actin due to different rates

(Bertram *et al.* 2006). Water holding capacity decreased with higher temperature, and possibly due to changes in collagen fibers and heat-resistant of intermolecular meat bonds at different temperatures (Yang *et al.* 2016).

Fatty Acid Profile and Cholesterol Characteristics of Meat

Fatty care ids identified in saturated fatty acids (SFA), monounsaturated fatty acids or monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and unsaturated fatty acids (UNFA). The fatty acid profile of chicken meat can be seen in Table 3. The results showed that the cooking method had a significant effect ($P<0.01$) on the saturated fatty acids of chicken meat. Table 3 shows that palmitic acid was the highest SFA content, both in fresh and cooked chicken meat. Kedu chicken meat cooked with microwave method had the highest palmitic acid content while the fresh Kedu chicken meat was the lowest. Palmitic acid had a very significant increase ($P<0.01$) in the presence of fried and microwave cooking treatments, namely 27.95 and 28.79%, respectively that palmitic acid and oleic acid are the most dominant on meat fatty acids (Larsen *et al.* 2010). The heating process can cause changes in the fatty acid components into volatile compounds such as aldehydes, ketones, and hydrocarbons. The percentage of palmitic acid increased after the chicken meat was fried, it was suspected that the increase in palmitic acid came from palm oil when the chicken meat was fried. Palmitic acid is often found in palm oil, cheese, and meat. Foods of animal origin (fatty meat, cheese, butter, whole milk, yoghurt, ice cream, and milk cream), in addition to containing saturated fatty acids, also contain cholesterol (Povey, 2016). Saturated fatty acids, apart from being found in animal fats, are also found in coconut oil, palm oil, olive oil, corn oil, etc.). Palm, as well as other oils that have been used for frying, although initially, they were unsaturated fatty acids palmitic acid can increase cholesterol levels (French *et al.* 2002).

The results of MFA showed that the different cooking methods had a very significant effect ($P<0.01$) on linoleic and linolenic. Table 3 showed that linoleic acid is a polyunsaturated fatty acid with the highest content, both in fresh chicken meat and cooked chicken meat. Fresh chicken meat contains 32.59% linoleic acid, while boiled, fried and microwaved chicken contains 32.65, 32.30, and 33.52% linoleic acid. The results of linoleic fatty acid showed that the cooking method had a very significant effect ($P<0.01$). The linoleic acid content of fresh and boiled chicken meat is different from the linoleic acid content of fried and microwaved percentages. Cooking methods by frying and microwaving cause an increase in the linoleic fatty acid of meat. Reguiska and Ilow (2002) stated that the cooking process by frying either done conventionally or using a microwave does not lead to a reduction in the omega-3 fraction which is linoleic acid from the total content of fatty acids. The hot cooking process can cause lipids to hydrolyze and produce free fatty acids and in the boiling process of meat will produce carbonyl compounds. The carbonyl compounds formed during processing came from oxidized lipid products (Gladyshev *et al.* 2006).

Linoleic acid was PFA that cannot be synthesized by the body and therefore needs to be supplied from the outside through food. Linoleic fatty acid or commonly called omega 9 plays a role in the growth, maintenance of cell membranes, regulation of cholesterol metabolism, and lowering blood pressure. Linoleic acid has benefits including preventing skin damage, assisting in the transport of blood cholesterol metabolism, and is a precursor to the active components of prostaglandins which are needed in all body tissues and their activities affect blood clotting and heart function (Whelan and Fritsche, 2013). Linoleic acid

deficiency can cause decreased reproductive ability, impaired growth, and susceptibility to infection (Schlotz *et al.* 2010).

Total cholesterol of Kedu chicken cooked by different methods showed a very significant result ($P<0.01$). The highest total cholesterol was found in fried meat, while the lowest total cholesterol was found in microwave-cooked meat. The total cholesterol of chicken meat increased after being cooked by the fried method. The increase in cholesterol is caused by the use of vegetable cooking oil as an intermediate for cooking. Fennena (1996), the frying process causes the formation of long-chain saturated fatty acids and thermal polymerization reactions and oxidation reactions to form trans fatty acids. According to stated that the content of saturated fatty acids in coconut oil can increase cholesterol content when fried (Abiona *et al.* 2011). Cooking with the microwave method was causes a decrease in the cholesterol of chicken meat. This decrease is caused by the heat generated during cooking with microwaves or microwaves so that the cholesterol contained in the meat comes out along with the fat and water. Microwave-heated chicken showed the percentage of oxidation in cholesterol was 0.36%, indicating that microwave heating caused the highest oxidation of cholesterol that causing cholesterol to dissolve along with the release of water from the meat (Echarte *et al.* 2003).

CONCLUSION

It can be concluded that Kedu chicken meat cooked by the fried method showed the best chemical quality, while chicken meat cooked by the boiled method showed the best physical quality. The fatty acid profile and cholesterol content of Kedu chicken cooked by the microwave method was better than the fried and boiled methods.

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Table 1 Chemical quality of Kedu chicken meat using different cooking methods (%)

Variable	Cooking Method				Sig. Stat.
	Fresh meat	Boiling	Frying	Microwave	
Moisture	71.52±0.16^{d}	68.36±0.17^{c}	64.36±0.10^{a}	66.28±0.09^{b}	**
Protein	22.09±0.44^{a}	23.23±0.11^{b}	24.63±0.15^{d}	23.94±0.09^{c}	**
Fat	6.12±0.47^{a}	6.46±0.09^{b}	7.39±0.05^{c}	6.78±0.06^{b}	**
Collagen	1.83±0.22^{a}	1.84±0.03^{a}	2.47±0.04^{b}	2.04±0.22^{b}	**
Sig. Stat. = Significant Statement; a,b,c,d = mean superscript within the same row differ very significantly (P<0.05); ** = P<0.01					

Table 2: Physical quality of Kedu chicken meat with different cooking methods

Variable	Cooking Method				Sig. Stat.
	Fresh meat	Boiling	Frying	Microwave	
pH value	5.44±0.15^{a}	5.66±0.17^{b}	5.74±0.15^{b}	5.68±0.15^{b}	*
Cooking loss (%)	-	32.70±0.98^{a}	43.51±0.52^{c}	40.60±1.47^{b}	**
Tenderness (kg/cm^{3})	2.44±0.27^{a}	8.02±0.13^{b}	9.54±0.21^{d}	9.12±0.13^{c}	**
Water holding capacity (%)	36.86±3.61^{c}	29.09±3.27^{b}	23.73±1.92^{a}	24.84±2.12^{b}	**
Sig. Stat. = Significant Statement; a,b,c,d = mean superscript within the same row differ very significantly (P<0.05); * = P<0.05; ** = P<0.01					

Table 3: Fatty acid profile and total cholesterol of Kedu chicken meat cooked with different cooking methods

Variable	Cooking Method				Sig. Stat.
	Fresh meat	Boiling	Frying	Microwave	
SFA					
Lauric acid	0.22±0.00^{b}	0.24±0.00^{c}	0.20±0.00^{a}	0.30±0.00^{d}	**
Myristic acid	0.99±0.00^{b}	0.91±0.02^{a}	0.90±0.02^{a}	0.98±0.01^{b}	**
Pentadecanoic acid	0.17±0.00	0.17±0.00	0.17±0.00	0.17±0.00	ns
Palmitic acid	27.43±0.03^{a}	27.41±0.00^{a}	27.95±0.01^{b}	28.79±0.00^{c}	**
Heptadecanoic acid.	0.30±0.01^{b}	0.30±0.16^{b}	0.16±0.00^{a}	0.30±0.01^{b}	**
Stearic acid	0.20±0.00^{b}	0.12±0.00^{a}	0.26±0.00^{c}	0.21±0.01^{b}	**
Heneicosanoic acid	0.41±0.01^{b}	0.41±0.00^{b}	0.48±0.00^{c}	0.34±0.00^{a}	**
Tricosanoic acid	2.44±0.03^{c}	2.46±0.00^{c}	1.92±0.00^{b}	1.87±0.00^{a}	**
Lognoceric acid	0.83±0.02^{c}	0.82±0.01^{c}	0.76±0.01^{b}	0.56±0.01^{a}	**
MUFA					
cis-10-pentadecanoic acid	0.24±0.01	0.25±0.00	0.17±0.27	0.10±0.01	ns
Oleic acid	13.40±0.11^{c}	13.35±0.11^{c}	13.08±0.00^{b}	12.18±0.00^{a}	**
cis-11-eicosonoic acid	0.25±0.00	0.25±0.00	0.24±0.00	0.25±0.00	ns
Erucic acid	0.58±0.01^{b}	0.58±0.00^{b}	0.65±0.00^{c}	0.44±0.02^{a}	**
Nervonic acid	0.40±0.00^{b}	0.40±0.00^{b}	0.41±0.01^{b}	0.34±0.00^{a}	**
PUFA					
Palmioleic acid	2.47±0.00^{a}	2.55±0.05^{b}	2.88±0.00^{c}	2.95±0.00^{d}	**
Linoleic acid	32.59±0.09^{a}	32.65±0.00^{a}	33.30±0.00^{b}	33.52±0.00^{c}	**
Linolenic acid	16.19±0.04^{b}	16.29±0.12^{c}	15.46±0.00^{a}	16.07±0.01^{b}	**

cis-11.14-eicosadienoic acid	0.50 ± 0.00^{c}	0.49 ± 0.01^{c}	0.46 ± 0.01^{b}	0.34 ± 0.00^{a}	**
Dihomotinolenic acid	0.22 ± 0.00^{b}	0.23 ± 0.02^{b}	0.17 ± 0.00^{a}	0.17 ± 0.00^{a}	*
Docosahexanoic acid	0.18±0.05	0.16±0.02	0.22±0.01	0.13±0.00	ns
SFA	32.99 ± 0.01^{b}	32.83 ± 0.01^{a}	32.79 ± 0.05^{a}	33.52 ± 0.02^{c}	**
MUFA	14.87 ± 0.11^{b}	14.82 ± 0.11^{b}	14.71 ± 0.07^{b}	13.31 ± 0.00^{a}	**
PUFA	52.15 ± 0.11^{a}	52.35 ± 0.10^{a}	52.50 ± 0.02^{b}	53.18 ± 0.02^{c}	**
UNFA	67.01 ± 0.01^{b}	67.17 ± 0.01^{c}	67.21 ± 0.05^{c}	66.48 ± 0.02^{a}	**
Cholesterol Content	40.70 ± 0.65^{b}	40.58 ± 0.21^{b}	42.21 ± 0.23^{c}	39.02 ± 0.17^{a}	*

SFA = Saturated fatty acids;
MUFA = Monounsaturated fatty acids;
PUFA = Polyunsaturated fatty acids;
UNFA = Unsaturated fatty acids;
Sig. Stat. = Significant Statement;
a,b,c,d = mean superscript within the same row differ very significantly ($P<0.05$);
* = $P<0.05$;
** = $P<0.01$;
ns = non-significant