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Comparative study of lipid profile of pigs, goats and cattle slaughtered at Nsukka Municipal Abattoir, Enugu State, Nigeria

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Abstract

Fat contents of meat largely determine consumer's choice and the general acceptability by people. Thus, this research was carried out to compare the lipid profile of pigs with that of goats and cattle in the study area. One hundred and ninety two animals; 64 from each species, aged two to three years slaughtered at Nsukka Municipal abattoir were used. Samples of Rectus abdominus muscle, liver, kidney, brain, skin and large intestine were collected. Two g of each of the sample was grinded, centrifuged, decanted and the supernatants used to determine their cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL) and triglyceride profile by enzymatic colorimetric method using reagents test kits. Result showed that although cholesterol profile in liver, kidney and intestine of the goats was significantly ($p < 0.05$) higher than in pigs and cattle, its concentration was significantly ($p < 0.05$) higher inmuscle and skin ofthe pigsthangoats and cattle. Highest concentration of cholesterol which ranged from 1205.34 to 1328.34mg/dL was from brain tissues of the animals. The HDL in muscles of the pigs and goats showed no significant ($p > 0.05$) difference but were significantly ($p < 0.05$) higher than that of cattle.There was no significant ($p > 0.05$) difference in LDL and triglyceride profiles in tissues/organs of the three animal species.It was concluded that Nigerian pig todays share similar lipid profile with goats and cattle.

Keywords: Swine, cholesterol, food animal, chevron, beef, Nigeria.

Introduction

Pork is one of the preferred meats in the world, ranking first in per capita meat consumption in the world and third in the United States (Davis and Lin, 2005). Meat has generally been exposed to great criticism because it contains fats, saturated fatty acids, cholesterol, and sometimes carcinogenic substances. According to WHO (1992) report, the association between animal fats and atherosclerosis has been studied and recommendations range from total exclusion to moderate consumption due to essential role of fat in human body. As a result, emphasis has shifted from quantity to quality of meat fat (WHO, 1992).

Several swine breed associations in the developed countries have over the years made significant changes in their breeding and management programmes that have resulted in increased availability of lean pork (Williams *et al*., 2006). For instance, the United State Department of Agriculture (USDA) reported that pork sold in the US compares favourably for fat, calories and cholesterol with many other meats and poultry. While providing a greater amount of vitamins and minerals, many cuts of pork are as lean or leaner than chicken (USDA, 2006).

On the contrary, available breeds of pig in Africa including Nigeria are indigenous or local pigs, exotics and their crosses (Holness, 1991; Rim, 1992). Indigenous pigs are generally hardy, slow in growth and

have high back fat thickness (Holness, 1991). The Nigerian indigenous pigs have not been selected but were reported to exhibit great deal of genetic variability with no organized breeding programme (FLD, 1992; Agbagha *et al*., 2001; Oseni, 2005). The management systems of pigs in the tropics range from extensive/scavenging, semi intensive to intensive (Holness, 1991). This scavenging method which is a primitive form of management not only results in low productivity but will no doubt negatively affect the quality of pork.

Many people including those whose religion and or culture do not prohibit rearing and consumption of pork not only regard the pig as dirty animal but are often of the opinion that contains higher concentration of cholesterol than other common food animals (Pond and Maner, 1974; Asuamah *et al*., 2013). Thus the report of Asuamah *et al*. (2013) show that this health concerns are among the major reasons pork is rejected in many parts of the tropics.

While much is known about swine production systems in Nigeria, there is paucity of information on their general nutritional status and lipid profile in particular. This study was therefore designed to compare the lipid profile of pork with chevron and beef obtained from goats and cattle slaughtered at Nsukka Municipal Abattoir, Enugu State, Nigeria.

Materials and methods

Study area

The study was carried out at the Nsukka Urban Municipal Abattoir in Local Government Area (LGA) of Enugu State, Nigeria.The abattoir is the only one in the LGAthat serves an estimated population of 309, 633 people according to the 2006 population census report.Again, majority of the animals slaughteredhere like in most other abattoirs across the country are sourced from Northern Nigeria.

Samples collected

Meat samples including liver, kidney, brain, skin large intestine and muscle (*Rectus abdominus*), were collected from pigs, goats and cattle slaughtered within three months at the abattoir. The animals were between the ages of 2 to 3 years. Their ages were determined according to the methods of Bayer (1992) as follows: for cattle, displacement of incisors, medially and laterally; in goats, eruption of incisors/shedding of temporal incisors, laterals and corners; wearing of permanent incisors, laterals in the lower and centrals in the upper jaw were used to age the pigs. In all, a total of 192 animal samples were collected and used for this study; 64 samples from each species.

Two g of each sample was weighed with an electronic weighing balance (Sartorius, Canada). The weighed sample was ground with blender with the addition of 2 mL of distilled water. It was then transferred to an already labeled sample bottles and centrifuged at 12,000 rpm for 5 min. After spinning, the supernatant of each sample was immediately decanted from the meat residues and put in labeled sample bottles from where their lipid profiles were determined. Lipid profiles of the test samples were determined using Cholesterol, triglycerides and lipoprotein reagents test kits (Biosystem, Spain). All the procedures were carried out following the reagents manufacturer's instructions.

All data generated were subjected to one-way analysis of variance (ANOVA) with SPSS editor version 20. (2012) and significance accepted at $p < 0.05$.

Results

The liver, kidney and intestinal cholesterol concentration of goat was significantly ($p < 0.05$) higherthan that of cattle and pig (Table 1).

Table 1: Mean (± S.E.) cholesterol and triglyceride profiles (mg/dL) of pigs, goats and cattle slaughtered at Nsukka Municipal Abattoir (n= 192)

Organs/tissues	Pig	Goat	Cattle
Cholesterol (mg/dL)			
Liver	58.34 ± 7.49 [b]	78.46 ± 11.47[a]	69.99 ± 5.21[b]
Kidney	56.54 ± 2.21 [b]	76.48 ± 12.37[a]	59.90 ± 9.50[b]
Intestine	32.36 ± 4.16 [b]	62.58 ± 8.59 [a]	44.12 ± 6.13 [b]
Brain	1205.34 ± 87.69[a]	1308.34 ± 67.41[a]	1328.34 ± 88.09 [a]
Muscle	50.42 ± 4.24 [a]	20.13 ± 2.66[b]	25.43 ± 2.23 [b]
Skin	61.69 ± 6.89 [a]	17.88 ± 1.39[b]	19.53 ± 1.34 [b]
Triglyceride (mg/dL)			
Liver	4.30±1.57 [a]	3.89 ± 1.01 [a]	4.80 ± 1.54 [a]
Kidney	5.14 ± 1.49[a]	3.86 ± 01.47[a]	4.43 ± 0.21 [a]
Intestine	2.28 ± 0.12[a]	2.89 ± 0.34[a]	2.69 ± 0.55 [a]
Brain	4.38±0.20 [a]	3.09 ± 0.13[a]	3.28 ± 0.03 [a]
Muscle	2.68±0.23 [a]	2.04 ± 0.33[a]	2.29 ± 0.63 [a]
Skin	2.55±0.2 9[a]	1.55 ± 0.24[a]	1.44 ± 0.75 [a]

[a,b,] **Row means with different superscripts differ significantly at p < 0.05.**

Highest concentration of cholesterol which ranged from 1205.34 ± 87.69 to 1328.34 ± 88.09 mg/dL, was obtained from the brain tissues of the animals. There was a significant ($p < 0.05$) difference in the means of *Rectus abdominus* muscle and skin cholesterol contents of the three animals studied with pig having the highest value (Table 1). Result of triglyceride profiles showed no significant ($p > 0.05$) difference among the three animals studied (Table 1).

There was no significant ($p > 0.05$) difference in the mean of LDL contents of all the organs or tissues of the three animals investigated (Table 2).

Table 2: Mean (± S.E.) low and high density lipoprotein (mg/dL) profiles of pigs, goats and cattle slaughtered at Nsukka Municipal Abattoir (n= 192)

Organs/tissue	Pig	Goat	Cattle
LDL (mg/dL)			
Liver	15.68 ± 2.11[a]	16.79 ± 0.99[a]	19.69 ± 2.21[a]
Kidney	18.34 ± 4.09[a]	20.10 ± 01.47[a]	19.37 ± 2.01[a]
Intestine	19.37 ± 1.94[a]	16.76 ± 2.31[a]	15.97 ± 1.79[a]
Brain	26.48±0.23 [a]	28.04 ± 0.30[a]	27.29 ± 0.63[a]
Muscle	15.96 ±2.79[a]	15.40 ± 2.06[a]	15.51 ± 1.78[a]
Skin	11.25 ± 3.79[a]	9.88 ± 1.08 [a]	8.00 ± 1.78 [a]
HDL (mg/dL)			
Liver	42.67 ±8.80 [b]	11.21 ± 1.67 [c]	50.31 ± 6.45[a]
Kidney	14.25 ± 1.09[a]	14.44 ± 4.47[a]	15.53 ± 5.21[a]
Intestine	13.08 ± 4.10[c]	45.83 ± 4.91 [a]	28.15 ± 7.11[b]
Brain	12.88 ± 4.23[a]	14.94 ± 5.33[a]	12.72 ± 3.66[a]
Muscle	26.09 ±3.10 [a]	26.62 ± 4.14 [a]	9.92 ± 2.36 [b]
Skin	19.85 ± 8.08[a]	11.01 ± 1.57 [b]	10.39 ± 1.39[b]

[a,b,c] Row means with different superscripts differ significantly at $p < 0.05$

There was significant ($p < 0.05$) difference in the mean of HDL profile of liver and intestine of the three animals with that of goats being significantly ($p < 0.05$) higher than the values recorded in pigs and cattle (Table 2). *Rectus abdominus* HDL content of pig and goat was significantly ($p < 0.05$) higher when compared to that of cattle. The HDL concentration recorded in pig skin was significantly ($p< 0.05$) higher than in goat and cattle (Table 2).

Discussion

The intention for undertaking this study was to update current and or intending pork consumers on how Nigerian pork today compares with the indigenous goats and cattle in terms of lipid profile. Secondly, understanding the basic lipid profile of the Nigerian pork could help change the perception of people about pigs and possibly increase its market demand.

We noted cholesterol range of 17.88 to 1328.34 mg/dL in the three food animals studied (Table 1). This is higher than the range of 40 to 90 mg/100g obtained in raw and cooked beef and poultry products (Bragagnolo 2009; Honikel 2009). The inclusion of brain tissue in our present study might have contributed to the differences. These variations could also be due to the differences in the gender or species of animal sampled (Duckett *et al*., 2009). For the *Rectus abdominus* of cattle, a mean cholesterol value of 50.42 mg/dL obtained is within the reported range 43 to 84 mg/100 g in raw bovine meat by Dinh (2010).

The cholesterol content of their liver and kidney were significantly ($p < 0.05$) higher than the figure obtained in the muscles [56. 54to 78.46 vs. 20.13 to 50.42 mg/dL (Table 1)]. These findings agree with earlier reports of Anderson (1988) and Sinclair *et al.* (2010) that most organ meats contain substantially more cholesterol than skeletal muscle or tissue of their respective species.

Again, according to Williams (2007), bone marrow and brain contain much greater cholesterol content that could be up to several hundred milligrams per 100g. Therefore, our observation that the highest concentration of cholesterol (> 1000 mg/dL) was noted in the brain of all the three animals investigated is reminiscent with this report. Multiple factors including gender, age, degree of marbling, subcutaneous fat thickness, animal breed, diet, feeding treatments (restricted diet or *ad libitum*), and muscle location (type of cut) affect the cholesterol content in meat (Duckett *et al.*, 2009).

Although the emphasis was not on all of these factors, but within our limit however, efforts were made to eliminate them in this study. Thus we selected animals within the same age range, similar muscle cut, organs and tissues which have similar cholesterol uptake pattern; receptor-mediated process in liver or receptor-independent in muscles and intestine (Dietschy *et al*., 1993).

It is important to note that although brain tissues of animals are not major sources of food for man, in southeast Nigeria, however, it is often used as a recipe in the preparation of a dish popularly known as *nkwobi* which is relished by people of the area. Therefore, the high cholesterol profile noted in the brain samples of the three food animals investigated should be a course for concern as these figures are much higher than 200 mg/dL which according to Burkitt (2016), could lead to heart attack, stroke, and peripheral artery diseases in man.

The mean cholesterol content of 50.42 mg/dL recoded for pork muscle in this study is within a range of 40 to 90 and 30 to 81 mg/100g reported in raw pork by other researchers (Honikel, 2009; Bragagnolo, 2009). This figure is however; lower than

the value of 70 mg/100g previouslyreported by Pond and Maner (1974). This could be an indication that Nigerian pork today like its counterparts in other developed countries is now leaner than pork produced some decades ago.

This low cholesterol profile could also be attributed to the fact that many pig farmers in Nigeria in an attempt to cut production cost, not only compound diets using agro industrial by-products, most of which are high in fiber but mostly maintain their animals of all age group on restricted feeding (Abonyi *et al.*, 2012).

In this study, we noted that the pork muscle and skin cholesterol concentrations were higher than that of beef and chevron. This is in line with the reports of Bragagnolo (2009), who attributed this to the fact that swine have intramuscular fat and like the domestic fowl, deposit significant amount of cholesterol in their skin.

However, the mean skin cholesterol value of 61.69mg/dL in the present studyis lower than intramuscular fat range of 75 to 99 mg/100g reported in pigs by Chizzolini *et al*. (1999).

The goat liver, kidney and intestinal cholesterol concentrations were significantly ($p < 0.05$) higher than that of the pigs and cattle (Table 1). This is in line with the finding of Enser *et al*. (1998), who reported that goats deposit reasonable percentage of fat in these organs. Again, Vernon and Flint (1988) observed that although ruminant species are typically fed low cholesterol diets, the *de novo* synthesis in their intestines and extra-hepatic tissues greatly contributes to total cholesterol deposition in these organs.

The results of this study tend to suggest that despite the poor feeding regimen and lack of technical know-how common among many Nigerian pig farmers (FLD, 1992), the Nigeria pork does not only compare favourably in terms of cholesterol profile to her chevron and beef but also with pork from other parts of the world.

According to Blood *et al*. (2007), triglycerides are the most common form of fat in the animal body and are digested to provide the energy required for metabolism. However, at high concentrations, it could be a risk factor for atherosclerosis, the narrowing of arteries with the buildup of fatty plaques in humans (Burkitt, 2016). In our study, there was no outstanding difference in the mean of triglyceride profile of the animals investigated (Table 1). Pork had triglyceride range of 2.28 to 5.14 mg/dL and the three animals recorded a range of 1.44 to 4.80 mg/dL (Table 1). These figures are far below 150 mg/dLthat could trigger cardiovascular diseases in man (Burkitt, 2016).

The similarity in the mean of LDL content of the organs and tissues of the animals within the experimental period (Table 2) was noted. This is reminiscent to the report of Maki *et al*. (2012), who found no difference in the mean concentrations of LDL between red and the white meat they investigated.

According to Bragagnolo (2009), LDL is regarded as bad cholesterol that triggers the development of atherosclerosis in man. In the present study, the three animal species investigated had LDL range value of 8.00 to 28.04 mg/dL (Table 2). This figure is below the range of 130 to 159 mg/dL that is positively correlated with the formation of atherosclerosis in man (Fine and Davidson, 2008; Bragagnolo, 2009). This may be an indication that the pigs as well as goats and cattle slaughtered at Nsukka Municipal abattoir within the study period were safe to human consumers in terms of risk of development of atherosclerosis arising from their LDL contents.

According to Dessi and Batetta (2003), high HDL facilitates the removal of tissue cholesterol via the reverse cholesterol pathway and or by competing with LDL for non- specific binding to cells, thereby reducing the uptake of LDL and enhance its removal.

From our result, HDL profile in the muscle and skin of pigs and goats were higher than the value obtained in cattle (Table 2). This suggests that they may be more health beneficial to humans than beef. This appears to support an earlier report of USDA that pork is leaner, has higher quality protein which provides more essential amino acids, B-Vitamins and minerals to human consumers than beef (USDA, 2010).

Conclusion

This study showed that the Nigerian pork today share similar lipid profile with her chevron and beef counterparts. Rejection of Nigerian pork due to the prevailing dogma that it is high in dietary LDL and triglyceridescan no longer be justified.

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