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Research Article
Nutritional Quality and Safety of Chicken Meat Consumed in Ota, Ogun State

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Abstract

Background and Objective: Imported chicken meat is smuggled into the country through the porous borders of Idiroko road which leads into Ota, Ogun State and sold to retailers in the open market. This study was carried out to assess and compare the nutritional composition and safety profile of the imported frozen, exotic commercial and indigenous chicken meats consumed in Ota metropolis. **Materials and Methods:** A total of 21 chicken meat samples were used for the study. Group 1, 2 and 3 comprise of seven samples each of imported frozen, exotic commercial and local chicken meat, respectively. The samples were digested and nutritional composition assessed by determination of proximate composition and essential elemental analysis. The safety profile was determined by quantification of levels of heavy metals (cadmium, lead and chromium), malondialdehyde and lipid profile of the chicken meats. Data analysis was done using SPSS version 15.0. The level of significance was set at $p<0.05$. **Results:** The proximate composition revealed significantly higher ($p<0.05$) levels of food nutrients in groups 2 and 3 compared to group 1. Similarly, the elemental analysis showed that groups 2 and 3 had significantly higher ($p<0.05$) levels of the elements and their concentration is within permissible limits compared to group 1 with significantly higher levels ($p<0.05$) of heavy metals such as lead, chromium and cadmium. Furthermore, the lipid profile analysis revealed significant increase ($p<0.05$) in levels of Low-Density Lipoprotein-Cholesterol (LDL-C), triglyceride and total cholesterol in the group 1 samples while group 3 has significantly higher levels ($p<0.05$) of High-Density Lipoprotein-Cholesterol (HDL-C). Malondialdehyde levels were also significantly higher in the group 1 samples compared to groups 2 and 3. **Conclusion:** The local and exotic commercial chicken meat are more nutritious and safer for consumption compared to the imported chicken meats sold in Ota, Ogun state.

Key words: Chicken meat, proximate composition, lipid profile, malondialdehyde, heavy metals

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry refers to domesticated birds which are raised for use and consumption by humans. Common poultry include chickens, turkeys, ducks, geese and quail. Less common poultry species include guinea fowl and peafowl, pheasants, pigeons, emus and ostriches[1]. The most common poultry types in Nigeria are chickens, turkeys and guinea fowl[1].

The importation of chicken meat was banned in Nigeria in 2003 in order to increase local production[2]. Interestingly, thousands of tones are still been smuggled into the country on daily basis illegally. A Nigerian newspaper survey reveals that not less than 85% of poultry products consumed by Nigerians are smuggled into the country through the country's borders with the Republic of Benin[3]. The import ban has, therefore, reduced but not eliminated the consumption of the foreign chicken meat in Nigeria.

The Nigerian poultry industry in particular has been rapidly expanding in recent years and is, therefore, one of the most commercialized (capitalized) subsectors of Nigerian agriculture[1]. Despite these, local poultry production has not been keeping pace with rapidly increasing domestic consumption[4]. This may contribute substantially to dependence of the populace on imported frozen chicken meat. Chickens can be raised and ready for slaughter between the five to seven weeks (those that are been fed or injected with growth hormones) although the normal growing strains to reach slaughter weight at approximately 14 weeks of age.

The local breed also known as village chickens are types of chickens with un-manipulated physical and biological trait, commonly called domestic fowls, found scavenging around the vicinities of rural communities in most developing countries. The local chicken flocks usually comprise between five to twenty birds kept by one family. These flocks are most often managed by the women providing them with an independent source of income. The local chickens constitute the majority of poultry raised in Nigeria, being about 103 million with more than 80% in the rural areas where they contribute substantially to annual meat and egg productions[5].

Lipid peroxidation (which is measured by the levels of malondialdehyde in a sample) is the introduction of a functional group containing two catenated oxygen atoms, O-O, into unsaturated fatty acids in a free radical reaction[6]. Polyunsaturated fatty acids susceptible to free radical attack are initiated by the formation of a carbon-centered radical through the abstraction of a hydrogen atom at one of the double bonds of the lipid. Lipid peroxidation is also one of major causes of quality deterioration during the storage of fats, oils or other lipid-rich foods[7].

Some metals are essential (Zn, Ni, Co, Fe, Cu) and others are non-essential (Pb, Hg, As, Cd). A deficiency in essential elements results in impairment of biological function, but when present in excess, essential elements may become toxic. Heavy metals from man-made pollution sources are continuously released into aquatic and terrestrial ecosystem and therefore, the concern about the effect of pollution on the ecosystem is growing. Contamination with heavy metals is a serious threat because of their toxicity, bioaccumulation and bio-magnification in the food chain[8]. These pollutants often have direct physiological toxic effect because pollutants stored in tissues, sometimes permanently[9]. Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels and damage to blood composition, lungs, kidneys, liver and other vital organs. Long-term exposure may result in slowly progressing physical, muscular and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer[10].

In recent years, much attention has been focused on the levels of heavy metals in fish and other seafood with little attention on the level of heavy metals in chicken meat. The main source of metals in chicken meat arises from contamination of poultry feed, water, environment, as well as handling of the processing and packaging of the meat[11]. Therefore, despite the nutritional advantages of chicken meat, it could also contain appreciable amounts of some toxicants such as heavy metals and malondialdehyde[11].

This study aimed at determining and comparing nutritional and safety profile of imported, exotic commercial and local chicken meat consumed in Ota, Nigeria.

MATERIALS AND METHODS

Sample collection: Samples of chicken wings (imported frozen chicken) were collected from retail outlets in each of four centrally located markets (Sango, Oju ore, Iyana and Oja ota) in Ota, Ogun State, Nigeria. The second batch of samples (exotic commercial chicken) was collected from poultry farms within Ota, while the last set (local chicken) comprise of wings of locally bred chicken, all from within Ota.

Groupings: Imported frozen chicken and exotic commercial chicken consisting of seven samples each was put in ice on purchase from the different retail outlet and then transferred to the laboratory freezer prior to digestion.

Local chicken consisting of seven samples were bought live from retail outlets and then slaughtered in the laboratory, the meat excised and stored at freezing temperature.

Digestion of samples

Sulfuric acid digestion: The chicken meat samples were digested according to the wet digestion method described by Jones and Case[12].

Determination of proximate composition: The methods of the AOAC[13] was used to determine the proximate composition (moisture content, total ash, crude fibre, crude protein and carbohydrate content).

Elemental analysis: The levels of minerals present in the sample were determined as described by AOAC[14]. The ash of the sample obtained was dissolved in 10 mL of 2 M HNO_3 and boiled for 5 min, filtered through a Whatman No. 1 filter paper into volumetric flask. The filtrate was made up with distilled water to 50 mL and used for determination of elemental content. Zinc (Zn), manganese (Mn), magnesium (Mg), calcium (Ca), phosphorus (P), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and iron (Fe) was determined by using atomic absorption spectrophotometer. The standard curve for each mineral was prepared from known concentrations and the concentrations were estimated from the standard curve while sodium and potassium content was determined using flame photometer.

Malondialdehyde analysis: Malondialdehyde in the chicken meat sample was determined spectrophotometrically using Thiobarbituric Acid Reactive Substances (TBARS) as described by Varshney and Kale[15].

Lipid profile analysis: Concentrations of total cholesterol and triglyceride were determined spectrophotometrically, using Randox kits, United Kingdom according to the methods of Allain *et al.*[16] and Buccolo and David[17], respectively. The HDL-cholesterol was determined with same commercial kits for total cholesterol after Very Low Density Lipoproteins (VLDL) and LDL were precipitated with heparin-$MnCl_2$ solution. The LDL cholesterol values were calculated using the values of total cholesterol, HDL-cholesterol and triglyceride according to the methods of Friedewald *et al.*[18].

RESULTS AND DISCUSSION

The results of proximate analysis presented in Table 1 reveals significantly increased ($p<0.05$) values of moisture and fat content of the imported chicken compared to the exotic commercial and local chicken which had significantly higher ($p<0.05$) levels of fibre and protein. However, no significant changes ($p>0.05$) were observed in the ash and carbohydrate values for all the measured groups. Heavy metal analysis of the meat samples (Table 2) shows significantly increased ($p<0.05$) levels of Cd, Cr and Pb in the imported chicken group compared with the exotic commercial and local chicken groups. The exotic commercial group had significantly elevated ($p<0.05$) levels of Mn, Cu and Ni compared to the other two groups.

The mineral composition of the chicken meats is presented in Table 3. The exotic commercial meat samples had significantly higher ($p<0.05$) levels of K, Ca, Fe and Na while the local chicken levels of Na and K were the least ($p<0.05$).

Table 1: Proximate analysis of the chicken meats

Groups	Moisture (%)	Fibre (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Imported frozen chicken	6.6±0.9^{a}	1.1±0.02^{a}	5.2±0.5^{a}	35.3±1.3^{a}	27.8±1.6^{a}	24.0±1.4^{a}
Exotic commercial chicken	4.8±0.5^{b}	2.1±0.01^{b}	5.9±1.3^{a}	40.0±1.8^{b}	22.0±0.2^{b}	25.2±1.7^{a}
Local chicken	4.3±0.8^{b}	4.0±0.00^{c}	6.6±1.2^{ab}	45.2±3.0^{b}	16.9±1.3^{c}	23.0±1.5^{a}

Table 2: Heavy metal analysis of the chicken meats

Groups (mg/100 g)	Cd	Cr	Mn	Zn	Pb	Ni	Cu
Imported chicken	0.08±0.02^{a}	5.73±1.02^{a}	6.86±3.61^{a}	1.29±0.64^{a}	1.32±0.01^{a}	0.92±0.07^{a}	0.94±0.00^{a}
Exotic commercial chicken	0.01±0.00^{b}	3.26±0.29^{b}	14.77±1.05^{b}	1.42±0.24^{a}	0.23±0.01^{b}	5.44±0.32^{b}	1.41±0.19^{b}
Local chicken	0.01±0.00^{b}	1.16±0.24^{c}	13.26±0.65^{b}	2.61±0.51^{b}	0.57±0.01^{c}	1.71±0.31^{a}	0.15±0.00^{c}

Table 3: Mineral composition of the chicken meats

Groups (mg/100 g)	K	Ca	Fe	Mg	Na	P
Imported chicken	118.68±1.14^{a}	38.50±3.92^{a}	26.43±1.99^{a}	5.13±0.20^{a}	228.65±16.8^{a}	25.50±0.68^{a}
Exotic commercial chicken	98.80±12.41^{a}	96.26±3.92^{b}	96.26±3.92^{b}	4.70±0.53^{a}	581.76±17.25^{b}	25.05±0.28^{a}
Local chicken	72.47±1.62^{b}	67.38±11.79^{c}	67.38±11.79^{c}	4.37±0.67^{a}	166.03±16.43^{c}	26.97±0.09^{a}

The malondialdehyde content of the meats (Table 4) was elevated significantly ($p<0.05$) in the imported and exotic groups compared to the local chicken meat. The lipid profile analysis (Table 5) similarly revealed increased levels ($p<0.05$) of all measured lipids in the imported group with the exception the HDL-C which was significantly elevated in the local meats.

Proximate composition: The local and exotic commercial chicken meats had the higher content of protein, ash, fiber and carbohydrate. Meats are usually taken for their high protein levels which helps to build and repair body tissues while the fiber aids the digestion process in the consumer. The imported poultry meat on the other hand has high content of lipids and moisture. Overconsumption of this may lead to hyperlipidemia which may predispose consumers to cardiovascular diseases and also the high moisture content will make the imported chicken more susceptible to deterioration by microorganism and may lead to food poisoning. The proximate analysis, therefore, identifies the local chicken meat as a better source of chicken meat for consumption in terms of nutritional quality.

Mineral and heavy metals: In recent years, much attention has been given to contamination of food products by heavy metals[19]. The results of this present investigation shows the local and exotic commercial chicken contains varied levels of trace elements and heavy metals such as calcium, iron, magnesium, nickel, copper, sodium, manganese, zinc and phosphorus. Their concentrations are all within permissible limits and hence their consumption are beneficial to consumers while the imported poultry have concentrations of lead, chromium and cadmium which may bioaccumulate in the tissues with consistent consumption and hence lead to toxicity complications in the consumers. Large numbers of people in the world today suffer from heavy metals contamination caused largely by the discharge of effluents of industries and increasing trends. Although people in most population groups in the globe are affected, the most wide spread and severe problems are usually encountered amongst resource poor, food insecure and vulnerable household in most developing countries. Lack of knowledge of hazards associated with contaminated food products is a key factor for many harmful diseases[20].

Table 4: Malondialdehyde levels in chicken meats

Groups	Malondialdehyde ($\times 10^{-5}$) µg MDA g^{-1} protein)
Imported chicken	18.3 ± 1.24^{a}
Exotic commercial chicken	8.7 ± 0.84^{b}
Local chicken	4.1 ± 0.27^{c}

Malondialdehyde content: The observed elevation in the imported chicken may be attributed to the prolonged storage of the chicken meats. This is in agreement with previous studies where peroxidation of lipids increased with storage time[21]. Imported chicken to Nigeria usually come through the borders via transport systems which does not have cooling capacity hence causing defrosting of the meats and subsequent refreezing by the distributors. The meats may take several months before it reaches the consumers due to time used in importation, distribution and retailing[22]. This period exceeds the USDA recommended safe time limits for refrigeration which is 3-5 days[23]. Malondialdehyde is the major and most studied toxic product of polyunsaturated fatty acid peroxidation[24], its ingestion may result in oxidative stress in consumers which has been found to be implicated in the pathogenesis of almost all metabolic diseases and thus may have serious implications for public health in Nigeria[22].

Lipid profile: Lipid metabolism in poultry differs from that in mammals since the liver is considered the main organ involved in its metabolic activity as compared to adipose tissue in mammals. In general, body fat accumulation may be considered the net result of the balance among dietary absorbed fat, endogenous fat synthesis (lipogenesis) and fat catabolism via beta-oxidation (lipolysis)[25]. In this study, the imported chicken had hyperlipidemia from increased levels of LDL-C, triglycerides and total cholesterol compared to the exotic commercial and local breeds. The local breed also had the highest levels of HDL-C which is termed the good cholesterol and hence has more nutritional benefits than the imported chicken.

Table 5: Lipid profile analysis of chicken meats

Groups	HDL-C (mg dL^{-1})	LDL-C (mg dL^{-1})	Total cholesterol (mg dL^{-1})	Triglyceride (mg dL^{-1})
Imported chicken	10.6 ± 0.2^{a}	74.0 ± 4.2^{a}	84.6 ± 0.1^{a}	6.0 ± 0.3^{a}
Exotic commercial chicken	17.8 ± 0.5^{b}	35.3 ± 2.1^{b}	53.1 ± 0.1^{b}	2.5 ± 0.8^{b}
Local chicken	35.2 ± 0.4^{c}	18.4 ± 0.0^{c}	53.6 ± 0.1^{b}	2.7 ± 0.1^{b}

CONCLUSION

Long term consumption of imported frozen chicken meat may result in heavy metal levels in excess of the allowable limits as well as predisposition to oxidative stress and lipid imbalance. The local and poultry chicken meats are safer and more nutritious for consumption.

REFERENCES

1. Adene, D.F. and A.E. Oguntade, 2006. The structure and importance of the commercial and village-based poultry systems in Nigeria. FAO. Review Nigeria, pp: 1-109.
2. Anonymous, 2015. An assessment of the Nigerian poultry sector. Sahel Capital Newsletter, Volume 11, June 2015, Lagos, Nigeria.
3. Falaju, J., 2015. Nigeria: Effects of imported poultry products on health, economy. The Guardian, Late Edn, pp: 22.
4. Rotschild, J., 2002. Nigeria poultry and products poultry update. Gain Report No. NI2025.
5. Sonaiya, E.B., 1997. African network on rural poultry development: I'rogress report, November 1989 to June 1995. Proceedings of the African Network for Rural Poultry Development Workshop, June 13-14, 1995, Addis Ababa, Ethiopia, pp: 134-143.
6. Wheatley, R.A., 2000. Some recent trends in the analytical chemistry of lipid peroxidation. TrAC Trends Anal. Chem., 19: 617-628.
7. Wang, Y., 2005. The bioavaility, potency and distribution of dietary palm tocopherols and tocotrinols in the tissues of red hybrid tilapia, *Oreochromis* sp. M.Sc. Thesis, University Sains Malaysia, Penang, Malaysia.
8. Demirezen, D. and K. Uruc, 2006. Comparative study of trace elements in certain fish, meat and meat products. Meat Sci., 74: 255-260.
9. Abd El-Salam, N.M., S. Ahmad, A. Basir, A.K., Rais and A. Bibi *et al*., 2013. Distribution of heavy metals in the liver, kidney, heart, pancreas and meat of cow, buffalo, goat, sheep and chicken from Kohat market Pakistan. Life Sci. J., 10: 937-940.
10. IOSHIC, 1999. Metals: In Basics of Chemical Safety. Chapter 7, International Labour Organization, Geneva.
11. Iwegbue, C.M.A., G.E. Nwajei and E.H. Iyoha, 2008. Heavy metal residues of chicken meat and gizzard and Turkey meat consumed in Southern Nigeria. Bulgar. J. Vet. Med., 11: 275-280.
12. Jones, J.B. and V.W. Case, 1990. Sampling, Handling and Analysing Plant Tissue Samples. In: Soil Testing and Plant Analysis, 3rd Edn., Westerman, R.L. (Ed.)., Soil Science Society of America, Madison, Wisconsin, pp: 389-427.
13. AOAC., 2005. Official Method of Analysis. 18th Edn., Association of Official Analytical Chemists International, Maryland, USA.
14. AOAC., 2005. Official Method of Analysis. 15th Edn., Association of Official Analytical Chemists International, Washington, D.C. USA., pp: 777-784.
15. Varshney, R. and R.K. Kale, 1990. Effects of calmodulin antagonists on radiation-induced lipid peroxidation in microsomes. Int. J. Radiat. Biol., 58: 733-743.
16. Allain, C.C., L.S. Poon, C.S.G. Chan, W. Richmond and P.C. Fu, 1974. Enzymatic determination of total serum cholesterol. Clin. Chem., 20: 470-475.
17. Bucolo, G. and H. David, 1973. Quantitative determination of serum triglycerides by the use of enzymes. Clin. Chem., 19: 476-482.
18. Friedewald, W.T., R.I. Levy and D.S. Fredrickson, 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin. Chem., 18: 499-502.
19. Badis, B., Z. Rachid and B. Esma, 2014. Levels of selected heavy metals in fresh meat from cattle, sheep, chicken and camel produced in Algeria. Annu. Res. Rev. Biol., 4: 1260-1267.
20. Thirulogachandar, A.M.E., M. Rajeswari and S. Ramya, 2014. Assessment of heavy metals in Gallus and their impact on human. Int. J. Scient. Res. Public., 4: 1-8.
21. Jinzhu, W., 2013. Lipid oxidation in differently aged beef: Use of static headspace gas chromatographic and 2-thiobarbituric acid reactive substance methods (TBARS). Second Cycle, A2E. SLU, Department of Animal Nutrition and Management, Uppsala.
22. Okolie, N.P., M.O. Akioyamen, N. Okpoba and C. Okonkwo, 2009. Malondialdehyde levels of frozen fish, chicken and turkey on sale in Benin city markets. Afr. J. Biotechnol., 8: 6638-6640.
23. USDA., 2005. Safe food handling: Refrigeration and food safety. Fact Sheets of the United States Department of Agriculture (USDA).
24. Del Rio, D., A.J. Stewart and N. Pellegrini, 2005. A review of recent studies on malondialdehyde as toxic molecule and biological marker of oxidative stress. Nutr. Metab. Cardiovasc. Dis., 15: 316-328.
25. Sanz, M., A. Flores and C.J. Lopez-Bote, 2000. The metabolic use of energy from dietary fat in broilers is affected by fatty acid saturation. Br. Poult. Sci., 41: 61-68.