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Formalin levels in locally produced and imported meat and fish samples from meat shops situated within Enugu metropolis, Enugu State, Nigeria

Aniobi CC[1], Offor CR[2], Akagha IC[3], Okeke O[4], Okoro MU[5]

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Author Affiliation:
[1]Department of Community Medicine, University of Nigeria, Enugu Campus, Enugu State, Nigeria
[2]Department of Biochemistry, University of Nigeria, Nsukka- Enugu State, Nigeria
[3]Department of Chemistry, Federal University of Technology, Owerri, Imo State, Nigeria
[4]Plastic Production Unit, Scientific Equipment Development Institute, Akwuke, Enugu State, Nigeria
[5]Department of Chemistry, Federal University of Technology, Owerri, Imo State, Nigeria

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ABSTRACT

Studies were carried out to evaluate the levels of formalin in the locally produced and imported meat and fish samples from meat shops situated within Enugu metropolis, Enugu State, using analytical procedures and instrumentation. The samples were thawed, homogenized with trichloroacetic acid and assayed for formalin determination using UV/ Visible spectrophotometer. Formalin were not detected in the locally produced cow and goat meat samples. The mean levels of formalin in the locally produced chicken meat, imported chicken meat, imported turkey meat, imported horse mackerel fish, imported mackerel fish, locally produced cat fish, imported chicken gizzard, and locally produced chicken gizzard samples were 12.16± 0.01, 114.22±10.25, 106.02±8.42, 146.42±6.36, 130.06±15.43, 80.17±7.26, 85.29±4.11 and 3.02±0.24µg/g respectively. The food samples contained mean formalin levels in the following decreasing order; imported horse mackerel fish > imported mackerel fish> imported chicken meat> imported turkey meat > imported chicken gizzard>locally produced cat fish> locally produced chicken meat> locally produced chicken gizzard. The formalin levels in the imported meat and fish samples were statistically higher than the locally produced samples. The mean levels of formalin in the imported mackerel horse, chicken meat, turkey meat and mackerel fish samples from the meat shops situated within Enugu metropolis were above the recommended permissible limits. The consumption of these food items is therefore a serious health risk especially over a prolonged exposure, considering the health debilities associated with high dose of formalin to animals and by extension humans.

Key words: Formalin, Enugu Metropolis, Imported and Locally produced Meats and Fishes.

1. INTRODUCTION

Fish and meat are an essential part of a healthy diet and are considered as the biggest source of protein [1]. Fish and meat contributes to the growth and health of humans by supplying nutrients such as protein, lipids, minerals and other

essential chemicals. According to [2], meat and fish contains essential nutrients such as omega-3, fatty acids, iodine and iron in very high amounts, which helps to reduce the risk of subnormal brain development, heart disease, stroke, cancer and other killer ailments. The fish and meat demand by the ever-growing Nigerian population necessitated the importation of fish and meat varieties. Essentially, the imported fish and meat are usually preserved using a whole range of chemicals to maintain their freshness especially given the epileptic power system in Nigeria. [3] stated that freshness is a property of fish and meat, that has an enormous impact on its wholesomeness. [4] reported that when a fish or meat loses its freshness leading to spoilage, it is due to a complex combination of microbiological, chemical and physical processes. According to [5], high quality fish and meat is expected to be free of every kind of biological, chemical and physical contamination. Because fish and meat are perishable food items and can only be kept fresh in ice for days, the freshness of the food items tend to be habitually sustained using formalin as a preservation agent. According to [6], many meat and fish producers and merchants deliberately add formalin, to serve as a preservation agent against spoilage of their products, especially in places where refrigeration happens not to be adequately available or where there is that possibility of a break down in the cold chain and thus accelerating the spoilage of the food products.

Formaldehyde is the most common member of the aldehyde family, in which the gaseous form is known as formaldehyde while the liquid form is known as formalin. Characteristically, formaldehyde is a colourless, strong smelling, irritating, poisonous and flammable gas, with the chemical formula of HCHO, produced by the oxidation of methanol [7]. [8] reported that formalin may be produced during the ageing of fishes and meats, but that high values of it do not build up in the fish and meat tissues due to the subsequent conversion of it to other compounds. [6] observed that the amounts of formalin in meats and fishes depends on the quality of these food items, harvesting time, temperature of storage and that formaldehyde results to muscle hardening and dehydration in meat and fish species. Also [8], stated that apart from its adverse health effects, formalin decreases the nutrient contents of meat and fish, by negatively modifying the proteins and hence causing muscle hardening.

Excluding occupational exposure in industrial settings, the major route of formalin exposure in the general population is through inhalation and to a lesser degree through ingestion [7]. The main health concern of formalin is its cancer causing ability. The international Agency for Research on Cancer, grouped formaldehyde as carcinogenic to humans, with justification that there was enough evidence for causing nasopharyngeal cancer in humans [9]. According to [10], low dose exposure to formaldehyde by the general population results in headache, rhinitis and dyspnoea while high dose exposure causes severe mucous membrane irritation, pulmonary distress, bronchitis, renal injury, lacrimination and even death. [11] stated that children exposed to the same levels of formalin as adults may receive larger doses because they have greater lung surface area resulting from smaller body weight ratio and stature. Studies by [12], indicated that professionals such as embalmists and anatomists, who are probably exposed to formaldehyde in their work are at a heightened risk of leukemia and brain cancer in comparison with the general population.

The illegal use of formalin as meat and fish preservatives appears to be on the increase, especially considering the not too long warnings by National Food and Drug Administration and Control to meat and fish producers on the health dangers associated with selling such food items preserved with formalin to unsuspecting consumers [13]. Additionally, the Nigerian Customs Service, only recently seized tons of imported poultry and fish products along the Nigerian boarders on alleged contamination with formalin [14]. With the growing advocacy against the use of formalin in preserving perishable food items such as meat and fish by food regulatory agencies and the rising seizure of contaminated frozen food items at the Nigerian boarders and the overall health implication to the unsuspecting consumers, who relies on such food items as meat and fish to meet their body's protein requirement, the assessment of the levels of formalin in locally produced as well as imported meat and fish samples from meat shops situated within Enugu metropolis, Enugu State, Nigeria, became imperative.

2. MATERIALS AND METHODS

Sample procurement and preparation

50 fish and meat samples, comprising 5 samples each of locally produced chicken meat, imported chicken meat, imported turkey meat, imported mackerel horse fish, locally produced cat fish, imported mackerel fish, locally produced cow meat, locally produced goat meat, imported chicken gizzard and locally produced chicken gizzard were purchased from designated meat shops within Enugu metropolis. Immediately after purchase, the samples were packed in neatly labeled polyethene containers and taken to the laboratory with ice blocks on them. At the laboratory, bones were isolated from the flesh of the samples with a sterile scalpel. Prior to the analysis, the bones were trashed while the flesh of the samples were kept frozen. All the reagents used were of analytical grade.

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Formalin Determination

Formalin levels were determined in the fish and meat samples as described by [15]. The samples were defrosted and chopped into small pieces and 30g of each sample was homogenized with 6 % w/w trichloro acetic acid. The mixture was filtered through a whatmann No 1filter paper and filtrate adjusted to pH 7.0 using 30% potassium hydroxide. The final volume was made up to 50ml using distilled water. For blanks determination, only 5ml of the standard (TCA) was mixed. The sample extract with 2ml Nash's reagent was heated in a water bath at 60^{o}C for 30min. The absorption at 415nm was determined immediately by UV/Visible spectrophotometer (Thermo Fischer Scientific, Walthman, MA). Formalin content was evaluated and represented as µg/g of the sample. All the experiments were carried out in triplicates.

Statistical Analysis

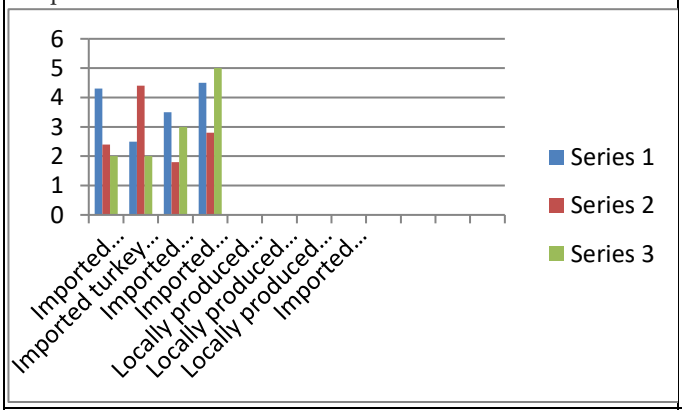
The data obtained were expressed in mean ± standard deviation and subjected to one way analysis of variance (ANOVA) at 5% confidence level using IBM SPSS version 22.0.

3. RESULTS & DISCUSSION

The result of Table 1 shows that the mean levels of formalin in the locally produced chicken meat, cat fish and chicken gizzard samples were 12.16± 0.01, 80. 17± 7.26 and 3.02± 0.24 µg/g respectively. Formalin was not detected in the locally produced cow and goat meat samples probably because of the quick sale of the food items and also the ethics of the sellers to not to use any preservative.

Result of Table 1 shows that the mean formalin levels in the imported chicken meat, turkey meat, mackerel horse fish, mackerel fish and chicken gizzard samples were 114.22± 10.25, 106.02± 8.42, 146.42±6.36, 130.06±15.43 and 85.29± 4.11 µg/g respectively.

Table 1: Mean formalin levels in both locally produced and imported meat and fish samples from meat shops situated within Enugu metropolis, Enugu State, Nigeria.

Sample 	Mean formalin levels (µg/g)	F test p value
Locally produced chicken meat	12.16 ±0.01	0.01
Imported chicken meat	114.22 ± 10.25	
Imported turkey meat	106.02±8.42	
Imported mackerel horse fish	146.42 ±6.36	
Imported mackerel fish	130.06 ±15.43	
Locally produced catfish	80.17± 7.26	
Locally produced cow meat	-	
Locally produced goat meat	-	
Imported chicken gizzard	85.29 ± 4.11	
Locally produced chicken gizzard	3.02 ±0.24	
Permissible limits [7]	100	

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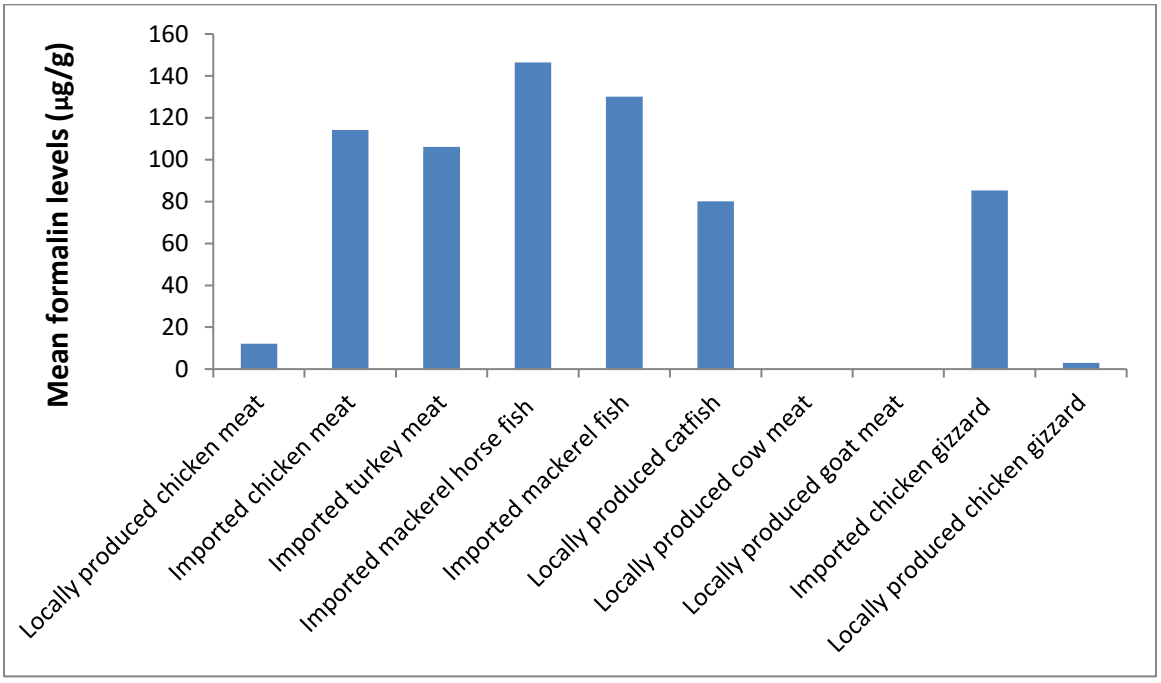

Figure 1: Bar chart representation of the mean formalin levels in the locally produced and imported meat and fish samples from meat shops situated within Enugu metropolis.

Figure 1 shows that the mean formalin levels decreased in the investigated food samples in the following order ; imported mackerel horse fish > imported mackerel fish > imported chicken meat > imported turkey meat > imported chicken gizzard > locally produced cat fish > locally produced chicken meat > locally produced chicken gizzard. The mean formalin levels in the determined imported and locally produced meat and fish samples were statistically significant. The imported mackerel horse fish, mackerel fish, chicken meat and turkey meat samples had mean formalin levels above the permissible limits in edible food items as established by [7]. The reason for this development could be a combination of factors such as advertent addition of formalin in the food items prior to packaging, importation and storage, and also long period of storage of the food items, both in transit importation and the eventual sale of the items. Because of the perishability of the food items and the envisaged long period of storage during importation and the eventual sale, preservatives such as formalin tend to be added by meat and fish merchants to keep the freshness of the food items before it gets to the final consumer. The locally produced chicken meat, chicken gizzard, cat fish and imported gizzard samples had mean formalin levels within the recommended permissible limits. The mean values of formalin obtained for the locally produced chicken meat and chicken gizzard samples may be as a result of their long stay before sale that precipitated some biochemical reactions and not directly associated with the use of formalin by the sellers of the food items. [8] observed that formalin may be produced during the ageing of fishes and meat, but are converted to other compounds in their tissues. Although the locally produced cat fish and imported chicken gizzard samples had mean levels of formalin within the recommended permissible limits, however, the possibility of these food samples to accumulate formalin to elevated levels that would be above the threshold limits remains very high especially where the food items has overstayed with intermittent poor refrigeration. [15] obtained lower mean values of 1.42±0.13 and 1.82±0.27mg/kg for formalin in the mackerel and horse mackerel fish samples respectively, consumed in Calabar, Nigeria, than what was reported as mean values of formalin in the investigated fish samples sold at meat shops within Enugu metropolis.

[17] reported a higher mean values of 158.17±14.25 and 196.56± 13.36 mg/kg for formalin in the imported chicken and turkey meat samples sold in selected cities (Abuja, Port Harcourt and Lagos) in Nigeria, than what this study obtained for the meat samples in meat shops situated within Enugu metropolis. Variation in the storage duration of the food items from importation to sale, the refrigeration condition and levels of formalin used by the meat and fish merchants to preserve the food items could have been the reason for the variation in the mean levels of formalin in meat and fishes samples consumed across the investigated cities in Nigeria. [18] reported a higher mean values of 288.16±20.02 and 292.80± 16.14 mg/kg for formalin in mackerel and chicken meat samples respectively, at Somdet market, Kalaghan Province, Thailand, than what was reported for the investigated mackerel and chicken meat samples of this study.

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The health risk of exposure to formalin has been extensively studied with main concern being its genotoxic and carcinogenic potentials [10]. According to [19], apart from the implications of formalin on health, it reacts in the protein muscle resulting in the muscle hardness, protein denaturing and subsequently, protein solubility.

4. CONCLUSION

Formalin was present in both the locally produced and imported fish and meat samples sold in meat shops within Enugu metropolis. The mean levels of formalin in the imported meat and fish samples were found to be significantly higher than the locally produced samples. Apart from the imported chicken gizzard samples, the mean levels of formalin in all the other investigated imported meat and fish samples were at toxic levels. If the government is to win the war against undue exposure to formalin by the Nigerian population, concerted effort must be made by all concerned stakeholders to encourage local production of fish and livestock animals to meet the general populations' demand for the food items for their protein needs and in that way ensure a strict ban on the importation of these food items, which has been shown to be highly contaminated with formalin. Regular power supply is very necessary to ensuring the freshness of the harvested fish and meat before the eventual sale to the final consumers, in that way, discourages the food item's sellers from the unwholesome practice of using formalin to preserve the freshness of their commodities prior to sale. Regular assessment of meats and fishes sold at meat shops in Nigerian cities for possible contamination with formalin is crucial to protecting the people from undue exposure to this dangerous chemical.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Ashie I.N. A., Smith J.P., Simpson B.K. and Haard N. E. (1996). Spoilage and shelf-life extension of fresh fish and meat. Critical Reviews in Food Science and Nutrition, 3(1&2): 87-101.
2. Cunnane S. and Stewart K. (2010). Human brain evolution influence of fresh water and marine resources. John Wiley and sons, USA. 1210-1224.
3. Connel J.J. (1993). Control of fish and meat quality. 4th edn., Fishing News Books Ltd, London- United Kingdom. 133-143.
4. Pedrosa-Menbrito A. and Regenstein J. M. (1990). Shelf-life extension of fresh fish and meat. A review. Part III. Fish and meat quality and methods of assessment. Journal of Food Quality, 13: 209-233.
5. Ingr I. (1989). Meat and fish quality. Defining the terms by modern standards. Fleisch, 69: 1268-1284.
6. Otuh P.I., Ogunro B.N. and Etim E. U. (2013). Formaldehyde levels in imported frozen meat in Ibadan, Nigeria: its public health implications. Journal of Veterinary Public Health, 11(1): 11-17.
7. World Health Organization (2002). Formaldehyde. Concise assessment international document and guidelines 40. Geneva-Switzerland. 81-122.
8. Sotelo G.C., Pineiro C. and Perez-Matin R.I. (1995). Denaturation of fish proteins during storage: role of formalin. Food Chemistry, 100: 1049-1053.
9. International Agency for Research on Cancer (2004). Monographs on the evaluation of formaldehyde, 2-butoxy-ethanol and 1-tert- burtoxy-2 propanol to humans, Vol.88, Lyon.
10. Norliana S., Abdulamir A. S., Abubakar F. and Salleh A.B. (2009). The health risk of formaldehyde to humans. American Journal of Pharmacology and Toxicology, 4: 98-106.
11. Uzairu A., Yiase S.G., Ugye T.J. and Anhwange B. A. (2010). Formaldehyde levels in some manufactured regular foods in Makurdi, Benue State, Nigeria. Journal of Applied Sciences in Environmental Sanitation, 5 (3): 223-226.
12. National Cancer Institute (2013). Formaldehyde. Accessed March 1, 2013 from http://www.cancer.gov/cancer topics/factsheet/risk/formaldehye.
13. Business Post (2021). Preserving frozen foods with formalin dangerous. 5th October, 2021.15.
14. Premium Times (2019). Nigerian Customs Services destroys imported meat and fish products. 17th May, 2019. 9.

15. Nash T. (1953). The colorimetric estimation of formalin by means of hantzsch reaction. Biochemical Journal, 55: 416-421.
16. Akpe M.A., Onyebuenyi I.Z. and Inezi F.P. (2020). Formalin content of three iced fish species (mackerel, horse-mackere and sadinella) consumed in Calabar, Nigeria. Global Journal of Pure and Applied Chemistry Research, 8(1): 46-52.
17. Abu O.A., Ologhobo V.O., Olabisi O.A., Adelani S., Alarima C.I., Aromoye R.A., Abiola S.S. and Tewe O.O.(2017). Heavy metals and formaldehyde levels in turkey and chicken meat samples in selected cities in Nigeria. Ibadan Journal of Agricultural Research, 13 (2): 39-48.
18. Suwanarvang J. (2018). Formalin contaminated in sea food and frozen meat at Somdet market, Kalasin province, Thailand. Journal of Environmental Protection, 9: 1286-1293.
19. Leelapongwattana K., Benjakul S., Vissesanguan B. and Howell N.K. (2005). Physicochemical and biochemical changes during fresh storage of minced flesh of lizard fish (*Saurida micropectoralis*). Food Chemistry (1-2): 141-50.

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