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Research Note

Assessment of Formaldehyde Levels in Local and Imported Fresh Fish in Ghana: A Case Study in the Tamale Metropolis of Ghana

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ABSTRACT

Fish is an important source of protein all over the world, including in Ghana. The fishery sector plays a major role in meeting the domestic need of animal protein and also contributes greatly in foreign exchange earnings. The domestic supply of fish does not meet the demand, so Ghana imports fish and fish products from other countries. Media reports in Ghana have alleged the use of formaldehyde to preserve fish for increased shelf life and to maintain freshness. This research, therefore, sought to establish the levels of formaldehyde in imported and local fresh fish in the Tamale Metropolis by using a ChemSee formaldehyde and formalin detection test kit. Positive and negative controls were performed by using various concentrations of formalin (1, 10, 30, 50, 100, and 300 ppm) and sterile distilled water, respectively. Three times over a 6-month period, different fish species were obtained from five wholesale cold stores (where fish are sold in cartons) and some local sales points (where locally caught fish are sold). A total of 32 samples were taken during three different sampling sessions: 23 imported fish (mackerel, herring, horse mackerel, salmon, and redfish) and 9 local tilapia. The fish were cut, and 50 g was weighed and blended with an equal volume (50 ml) of sterile distilled water. Samples were transferred to test tubes and centrifuged. A test strip was dipped into the supernatant and observed for a color change. A change in color from white to pink or purple indicated the presence of formaldehyde in fish. The study showed that no formaldehyde was present in the imported and local fish obtained. The appropriate regulatory agencies should carry out this study regularly to ensure that fish consumed in Ghana is safe for consumption.

The fishery sector plays an important role in the Ghanaian economy. It contributes 4% of the gross domestic product and 5% of the agricultural gross domestic product *(10)*. It is estimated that 60% of the total animal protein requirement in the Ghanaian diet comes from fish *(1)*. The average per capita fish consumption is 27 kg per annum, which is higher than the world's average of 13 kg. The estimated domestic supply of fish is about 435,000 tons and a demand of about 840,000 tons *(6)*. Fish is one of Ghana's most important nontraditional export commodities. Nevertheless, Ghana is a net importer of fish because domestic fish supplies continue to fall short of meeting total domestic demand *(4)*. Fish must be preserved until when ready to be consumed. Various traditional methods, including smoking, drying, salting, frying, fermenting, and various combinations of these are used to preserve and process fish in Ghana *(9)*, but some unscrupulous fishmongers are purported to preserve fish with certain chemicals, with formalin as the most widely used.

Formaldehyde is the simplest member of the aldehyde family but a very reactive chemical. The gaseous form is known as formaldehyde, and the liquid form as formalin. Formaldehyde is readily soluble in water, alcohols, and other polar solvents. Pure formaldehyde is not available commercially but is sold as 30 to 50% (by weight) aqueous solutions. Formalin (37% CH_2O) is the most common solution. Formalin is used as a preservative in medical laboratories, as an embalming fluid, and as a sterilizer due to its effectiveness in killing microorganisms. According to the U.S. Environmental Protection Agency, the maximum daily dose reference for formaldehyde is 0.2 μg/kg of body weight per day *(13)*. Ingestion at concentrations of 100 ppm are immediately fatal, while long-term exposure to low concentrations in the air or on the skin can cause asthma-like respiratory problems and skin irritations, such as dermatitis, as well as cancer *(12)*. It is has been classified by the International Agency for Research on Cancer as carcinogenic to humans *(8)*.

Fish must be kept fresh until it arrives to the final consumer, and this is mostly achieved by storing in cold temperatures. However, some people illegally use formalin to keep fish fresh. Fishermen and fishmongers in the Western Regional town of Axim, Ghana, were alleged to be using formalin to preserve fish *(2)*. Also, in a food poisoning outbreak in Kpando, Ghana, some mourners at a funeral found themselves in the hospital after consuming fish suspected to have been preserved with formalin *(11)*. Fishmongers in the country have denied using formalin for fish preservation. These allegations have generated an

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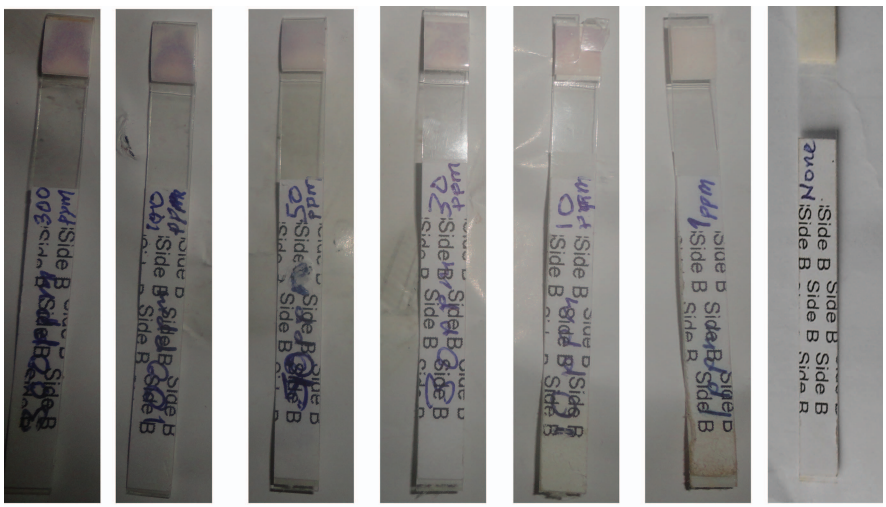

FIGURE 1. *Results of the negative control test strip, showing no color change (white; extreme right) and results of the positive control (300, 100, 50, 30, 10, and 1 ppm) test strips, showing color changes (pink and purple).*

impasse among fishmongers, the government, and the general public. In this study, we assessed the levels of formaldehyde (formalin) in some local (tilapia) and imported fresh fish (mackerel, herring, horse mackerel, salmon, and redfish) with a formalin detection test kit to determine safety for the consumer.

MATERIALS AND METHODS

Fish samples were purchased from five wholesale cold stores in the Tamale Metropolis. Local fish samples were obtained at the Kumbungu market, Tamale main market, and the Tamale Jubilee Park, which are the first points of sale after harvest or capture from the lake or pond. Imported fish samples obtained from Russia, China, Taiwan, Japan, Morocco, Mauritania, Chile, Argentina, Cyprus, Italy, and The Netherlands included mackerel, herring, horse mackerel, salmon, and redfish, while tilapia fish was the only local species that was sampled. The analysis was done in the Spanish Laboratory of the Faculty of Agriculture of the University for Development Studies, Tamale, Ghana.

The fish samples were collected three times over a 6-month period at the various cold stores to ensure that different batches of the fish were sampled. Samples were taken in December 2013, February 2014, and May 2014. A total of 32 samples were taken during three different sampling sessions: 23 imported fish and 9 local tilapia. The fish were cut, and 50 g weighed and blended in a portable electric blender with an equal volume (50 ml) of sterile distilled water. Samples were transferred into test tubes and then centrifuged at 10,000 $\times$ *g* for 5 min to release formalin into the supernatant. A test strip from the formaldehyde detection test kit (ChemSee, Appealing Products, Inc., Raleigh, NC) *(3)* was dipped into the supernatant for 5 s. The test strip was left for 3 min and then observed for color change. A change in color from white to pink or purple means formaldehyde is present in the fish, while no color change indicates the absence of formalin. The color expressed is compared with a color chart to determine the level of formalin present. The intensity of the color determines the concentration (parts per million) of formalin and formaldehyde in samples. The test kit can be used to detect formaldehyde levels as low as 5 to 250 ppm (0.0005 to 0.025%). Positive and negative controls were performed by using various concentrations of

TABLE 1. *A summary of results from the three sampling sessions*

	First sample		Second sample		Third sample	
Country of origin	Fish species	Presence of formalin	Fish species	Presence of formalin	Fish species	Presence of formalin
Russia	Herring	Negative	Herring	Negative	Herring	Negative
	Herring	Negative	Salmon	Negative		
China	Red fish	Negative				
	Mackerel	Negative				
Taiwan	Mackerel	Negative				
Morocco	Salmon	Negative	Salmon	Negative		
Mauritania	Salmon	Negative	Salmon	Negative		
	Mackerel	Negative	Mackerel	Negative		
Chile	Mackerel	Negative	Mackerel	Negative	Mackerel	Negative
Argentina	Red fish	Negative			Red fish	Negative
Cyprus			Salmon	Negative		
Italy					Red fish	Negative
The Netherlands					Mackerel	Negative
Japan					Mackerel	Negative

TABLE 2. *A summary of results of the local Tilapia fish samples*

Place of origin and sample no.	First sample		Second sample		Third sample	
	Fish species	Presence of formalin	Fish species	Presence of formalin	Fish species	Presence of formalin
Yapei 1	Tilapia	Negative				
Yapei 2	Tilapia	Negative				
Kumbungu 1	Tilapia	Negative				
Kumbungu 2			Tilapia	Negative		
Yapei 3			Tilapia	Negative		
Yapei 4					Tilapia	Negative
Yapei 5					Tilapia	Negative
Yapei 6					Tilapia	Negative
Kumbungu 3					Tilapia	Negative

formalin (1, 10, 30, 50, 100, and 300 ppm) and sterile distilled water, respectively.

RESULTS AND DISCUSSION

The positive and negative results confirmed the authenticity and sensitivity of the formalin test kit used for this work, as shown in Figure 1. The research found that the major species of foreign fish sold in the market includes salmon, horse mackerel, herring, and the local tilapia. Imported fish samples taken originated from Russia, China, Taiwan, Japan, Morocco, Mauritania, Chile, Argentina, Cyprus, Italy, and The Netherlands, while the local tilapia came from Yapei and Kumbungu, all in the Northern Region of Ghana. The survey found that wholesalers (cold stores) did well to provide the cold temperatures for the preservation of the fish because the fish samples obtained were in good physical condition (fresh) at the time of sampling. All the foreign fish samples were within the expiration dates at the time of sampling. The results are summarized in Tables 1 and 2.

The research was done to assess formalin concentrations in local and imported fish. A total of 32 samples were taken: 23 foreign samples, representing 71.87%, and 9 local fishes, representing 28.13%. Most of the fish species sampled (36.4%) were from Asia (China, Japan, Taiwan, and Russia), followed by Europe (Cyprus, Italy, and The Netherlands) with 27.3%, and Africa (Morocco and Mauritania) with 18.2%, as well as South America (Chile and Argentina) with 18.2%. Most of the local species obtained were from Yapei (66.7%) and Kumbungu (33.3%). No formaldehyde was detected in the imported and local fish obtained. The negative results obtained in this study indicate that fish coming from those companies are free from formalin during the study. There are similar reports, detailing a public outcry from the use of formalin in fish, but the research or surveillance conducted showed that there were none *(5, 7)*. However, formalin and formaldehyde were detected in other investigations *(14, 15)*.

Formalin-laced foods are dangerous to public health, and using them might cause people harm, ranging from pains and vomiting to cancer. The use of formalin in food affects our health and increases the cost of health care because outbreaks put pressure on already underresourced clinics and hospitals. Also, by offering a healthy and reliable product (fish), traders can increase their sales and promote a better economy. This research, although carried out in the Tamale Metropolis, may be generalized for all Ghana because the commercial fish sampled are distributed throughout the country, and not limited to Tamale alone.

It is recommend that this research be carried out in other regions to determine the safety of the fish that may not be included in this study. In addition, the research should be expanded to include other foods, such as meat, milk, and vegetables, because there are reports of formalin being used to preserve them. The appropriate regulatory agencies should carry out this testing regularly to ensure that fish consumed in Ghana is safe for consumption.

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