MEAT CONTAMINATION THROUGH SINGEING WITH SCRAP TYRES IN AKROPONG-AKUAPEM ABATTOIR, GHANA

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ABSTRACT

Chemical contamination of meat through the use of scrap tyre for singeing as the processing method is a major issue of concern for food safety and public health in Ghana. The study examined the reasons for the use of scrap tyres for meat singeing in Akropong-Akuapem and the possibilities of heavy metal contamination. Four butchers operating the Abattoir in the Municipal capital were purposively sampled and interviewed using interview guide. Samples of freshly unwashed, washed and boiled meat singed with the scrap tyres were taken for laboratory analysis for selected heavy metals. Three different samples of goat meat and beef were used for the study. It was revealed that butchers used the scrap tyres because they were cheap source of fuel for singeing and easily accessible. The results of heavy metal analysis indicated high levels of Fe, Cu, Zn and Cd in the meat of goat and cattle samples but Hg was however low in all the sampled meat. Consumers of meat singed with scrap tyres are exposed to ingestion of heavy metals. This threatens meat safety and public health protection and promotion. An assessment of human health risk associated with such meat is recommended.

Key Words: Heavy Metals, Akropong-Akuapem, Singeing meat and Contamination

1. INTRODUCTION

Malnutrition and its associated health effects on people is a global issue with much emphasis on children but the worse affected people are in developing countries. UNICEF-WHO-World Bank (2011), reports that African countries have about 36% of children experiencing stunted growth. Food safety issues have become a major concern to consumers and health based organisations, with many meat scandals hitting European countries and China. FAO/WHO (2001) noted that outbreak of foodborne diseases were on the increase and international food trade was confronted with many disputes over food safety and quality requirements by countries and consumers. Food contamination at every stage of the food production chain is unacceptable since it threatens the health of consumers of such foods. Demand for protein food from both plants and animal sources have increased to address malnutrition issues (Obiri-Danso et al., 2008).

Scrap tyres are known to contain different compounds with heavy metals and other compounds (Table 1). Grosse-Daldrup and Scheubel (1996) classified used tyres which are synthetic products as an alternative solid fuel for the cement industry in the developed countries. However Mokrzycki, and Ulias...
Bochen’czyk (2003) cautioned that before using any material as an alternative fuel (scrap tyre) the toxicity (organic compounds, heavy metals), composition, content of ash, content volatiles, calorific value, should be evaluated first. A study by Adachi and Tainosho (2004) indicated the presence of heavy metals in tyre wear debris to include Mn, Fe, cobalt (Co), Nickel (Ni), Copper (Cu), Cadmium (Cd), and Lead (Pb). Blok (2005) indicated that Zn accounts for about 1% by weight of tyre tread material which can be release into the environment in significant quantities through tyre wear. Thorpe and Harrison (2008) stated that several trace elements have been used in tyre manufacture, including Cd, Cu, (Pb), and Zinc (Zn). The implication is that scrap tyres contain some amount of heavy metals which can be released into the environment through several ways such as combustion and tyre wearing.

The use of scrap tyres for singeing meat is worrying since it can introduce different contaminants into the meat, thereby rendering it unsafe for human consumption. The use of scrap tyres for singeing meat is said to pose a serious public health risk to people working in and living around slaughter houses in Ghana because the open burning practices can release volatile organic compound (VOCs) and polycyclic aromatic hydrocarbons (PAHs) into the environment (Afriyie-Gyawu et al., 2013).

Table 1: Hazardous Chemical Composition of Scrape Tyres as stated in Basal Convention

<table>
<thead>
<tr>
<th>Chemical name</th>
<th>Remarks</th>
<th>Content (% weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper compounds</td>
<td>Alloying constituent of metallic reinforcing material</td>
<td>Approximately 0.02%</td>
</tr>
<tr>
<td>Zinc compounds</td>
<td>Zinc oxide, retained in the rubber matrix</td>
<td>Approximately 1%</td>
</tr>
<tr>
<td>Cadmium</td>
<td>On trace levels, as cadmium compounds</td>
<td>Maximum 0.001%</td>
</tr>
<tr>
<td></td>
<td>attendant substance of the zinc oxide</td>
<td></td>
</tr>
<tr>
<td>Lead compounds</td>
<td>On trace levels, as attendant substance of the zinc oxide</td>
<td>Maximum 0.005%</td>
</tr>
<tr>
<td>Acidic solutions or acids in solid form</td>
<td>Stearic acid, in solid form</td>
<td>Approximately 0.3%</td>
</tr>
<tr>
<td>Organohalogen compounds</td>
<td>Halogen butyl rubber (tendency: decreasing)</td>
<td>Maximum 0.1%</td>
</tr>
</tbody>
</table>

Source: UNEP (1999)

The general conditions of slaughterhouses in Ghana have been studied and the use of scrap tyre for singeing meats was identified in five regions with conclusion that the conditions of the slaughterhouses were poor (Annan-Prah et al., 2012). Studies have identified high levels of some heavy metals in meats singed with scrap tyres. In Kumasi, Obiri-Danso et al. (2008) found that heavy metals levels in meat hides singed with scrap tyres were higher than an un-singed counterpart. Essumang et al. (2007) reported on elevated levels of some heavy metals in singed cattle hide, popularly called “wele”, which shows that singeing of carcass can affect the quality of meat produced for consumption. According to Obiri-Danso et al. (2008) unsuspecting consumers of meat from slaughter houses are ingesting unknown quantities of heavy metals such as Fe, Hg, Cr, Cu, Cd, Pb, and Zn into their bodies due to the use of scrap tyres in singeing such meat. These heavy metals could significantly compromise the quality of the meat because
they have various degrees of health effects on consumers and are bioaccumulative and can be bioconcentrated in organisms and therefore affect the food chain.

Consumption or exposure to high level of various heavy metals has many burdens on different organs of the body, for example Cu is known to cause damage to the liver; Pb may cause cognitive development problems, increase blood pressure and cardiovascular diseases; Hg can cause low intelligent quotient (IQ) and may affect the kidney, Zn has been found to produce adverse nutrient interactions with Cu (FDA, 2001; Ikem & Egiebor, 2005). Others have found that Zn reduces immune function and the levels of high density lipoproteins. A metal like Cd can cause kidney dysfunctions and reproductive deficiencies (FDA, 2001; Ikem & Egiebor, 2005).

The reasons why butchers have resorted to the use of scrap tyres are not well known and their perception about the safety of the meat produced in the process is not well captured in the literature. Therefore the study aimed at investigating the reasons for butchers’ use of scrap tyres for singeing meat, their perception about the safety of the meat and levels of heavy metals in the meat.

2. DESCRIPTION OF STUDY AREA

The Akuapem North Municipality lies between longitude 00 000 E and 00 200 E of Greenwich Meridian and latitude 50 510 and 60 100 north of the equator. The District shares boundaries with four other Districts within the Eastern Region and one in the Greater Accra Region. It has an estimated population of about 136,438 with a growth rate of 1.8% (Ghana Statistical Service, 2012) and covers about 450 sq km of the total land of the region with its capital being Akropong. Akropong host a number of high level service facilities such as two tertiary institutions, college of education, special school for the blind and two secondary schools. Most of the places designated to be abattoir in the Municipality have been closed down due to lack of required facilities to meet the required standard. The operations of these abattoirs were supervised by the Environmental Health Department of the Municipal Assembly. There is one abattoir currently in operation at Akropong, for slaughtering and preparation of meats for sale to the public. Some butchers use fire wood while others use scrap tyres for singeing slaughtered animals.

3. METHODOLOGY

A structured interview guide was used to interview four (4) of the butchers who normally slaughter animals at the Akropong-Akuapem Abattoir site to solicit information about the use of scrap tyres in singeing meats as well as the factors that prompt them to use the material. These four butchers were purposively selected because they were regular users of the slaughter house and have been doing this work more than for the past five years. Their responses were written down in the local “Twi” language and later translated into English language. The Head of Environmental Health Unit of the Assembly was also interviewed. The study also concentrated on laboratory analysis of 12 samples of singed meat of cattle and goats at three (3) different stages: singed unwashed, singed and washed and singed washed and boiled meat from Akropong slaughterhouse. It is important to state that, the hides of animals slaughtered at the slaughter house were not removed and therefore are consumed together with the other parts of the meat, hence the sample.

Laboratory analysis of the different stages of the meat samples was conducted at Ghana Atomic Energy Commissions’ Laboratory in Accra for the levels of selected heavy metals (Cd, Pb, Hg, Cu, Zn, Fe and Cr). Approximately 3.0 g portions of the singed meat were carefully taken from one cattle and one goat directly from the butchers in two separate occasions. Each sample was oven dried at 105 °C to constant weight, homogenized using porcelain mortar and pestle into a powdered form and wet digested. Standards for atomic absorption analysis were prepared from commercial stock metal standards of each metal.
Levels of Cr, Cd, Pb, Cu, Hg, Zn and Fe in each digested samples were determined in triplicates using Atomic Absorption Spectrophotometer, with the blank solution set as zero (0) and the standards used for calibration of the spectrophotometer. Mean concentration of Cu, Zn, Cr, Pb, Hg Cd and Fe in meat of goat (chevon) and cattle (beef) were compared with the FAO/WHO permissible levels for meat meant for consumption.

4. RESULTS AND DISCUSSIONS

Reasons for butchers’ use of scrap tyres for singeing meat and their perception about the safety of the meat

The ages of the butchers interviewed were within the range of 50 -60 years and have been in the slaughtering business for over 10 years. It came up that they had been educated by the Environmental Health Officers of the Municipal Assembly not to use scrap tyres for singeing meat at the abattoir because it can cause contamination of the meat and affect their health. Butchers agreed that they use the scrap tyre for singeing carcasses of animals because of the ease of availability, low cost and high combustibility of the tyres. In comparison with the fuel wood and LPG, the butchers were of the view that fuel wood is expensive because it cost them between GH₵ 5 – 10 (ie. 2 – 4 US dollars) to purchase a bunch of fuel wood which could singe only few carcasses. There was no facility to use the LPG. This has the highest cost (about GH₵ 35 or $15 US for 13 kg). They indicated that it only cost 50 Ghana Pesewas to get a scrap tyre which can singe more than one carcase in a few minutes. The availability issue was also prominent because they claimed that the scrap tyre was like waste to the vulcanising shops where they normally get them from. They also indicated that the fuel woods are sometimes scarce and difficult to access. On the safety of the meat, they indicated that they have no idea what may be the specific health effect of the use of the scrap tyres on their health and on the meat. However, since the Environmental Health Officers have cautioned them then it can have some effect on the quality of the meat and their own health.

The head of the Environmental Health Unit indicated that, the abattoir was closed down in 2012 from their books yet the butchers were still using the facility. The closure was as a result of lack of the necessary facilities to hygienically manage the place. It also came up that the Veterinary Officer responsible for inspecting animals slaughtered in the abattoir stopped visiting the place in about 2010. The Environmental Health Unit was doing the inspection in collaboration with the Veterinary Officer but when the latter stopped the Environmental Health Officers were carrying out inspection at the abattoir only on the hygienic conditions of the facility/premise, not the quality of the meat. This therefore implies that nobody is inspecting the meat produced by these butchers from the slaughter house. Therefore consumers of meat prepared from this slaughter house in Akropong are prone to some risk of consuming meat from diseased or dead animals.

Table 2: FAO Recommended Maximum Permissible Levels of Heavy Metals in Meats

<table>
<thead>
<tr>
<th>Metals</th>
<th>Maximum Permissible Level (MPL) in mg/kg</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>0.01</td>
<td>FAO/WHO (2000)</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.05-0.5</td>
<td>FAO (1982)</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.5</td>
<td>FAO (1983)</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.1</td>
<td>FAO (1983)</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.3-1.0</td>
<td>FAO (1982)</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.1</td>
<td>FAO (1983)</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>0.05</td>
<td>Codex Alimentarius Commission, 1994</td>
</tr>
</tbody>
</table>

Source: (WHO & FAO, 2011)
Table 3: Average levels of heavy metals in Chevon (goat meat) singed with scrap tyre

<table>
<thead>
<tr>
<th>Sample Identity</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cd</th>
<th>Cr</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwashed Meat (mg/kg)</td>
<td>19.0</td>
<td>1.2</td>
<td>3.5</td>
<td>0.5</td>
<td>0.9</td>
<td>0.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Washed Meat (mg/kg)</td>
<td>13.6</td>
<td>1.5</td>
<td>4.7</td>
<td>&lt;0.001</td>
<td>0.4</td>
<td>0.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Boiled Meat (mg/kg)</td>
<td>9.4</td>
<td>0.5</td>
<td>2.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 4: Average levels of heavy metal in Beef (cattle meat) singed with scrap tyre

<table>
<thead>
<tr>
<th>Sample Identity</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cd</th>
<th>Cr</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unwashed fresh Meat</td>
<td>13.46</td>
<td>0.64</td>
<td>0.48</td>
<td>0.10</td>
<td>0.32</td>
<td>0.48</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Washed fresh Meat</td>
<td>15.63</td>
<td>0.22</td>
<td>0.58</td>
<td>0.08</td>
<td>0.46</td>
<td>0.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Boiled Meat</td>
<td>9.59</td>
<td>0.61</td>
<td>6.36</td>
<td>&lt;0.001</td>
<td>0.39</td>
<td>0.30</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Levels of heavy metals in chevon and beef

The levels of heavy metals identified from the carcase of the goat meat (Chevon) and the beef (cattle meat) varied for all the metals from the freshly singed to washed and boiled samples. The concentration decreased (Table 2) with respect to Fe, Cd and Cr the in the meat samples (unwashed meat > washed meat > boiled meat). It was observed that Cu and Zn exhibited different pattern in concentration where the unwashed singed goat meat showed lower concentration, increased after washing with water and reduced after boiling the meat. With respect to the beef, the trend decreased from the unwashed meat > washed meat > boiled meat for Pb and Cr as shown in Table 3. The concentrations of Fe and Cd exhibited different pattern where the unwashed singed goat meat showed lower concentration, increased after washing with water and reduced after boiling the meat. The concentration of Zn in the increased from the unwashed, washed to boiled meat samples.

This implies that the water used for washing the meat probably contributed to the level of Cu and Zn in the meat. This confirms a similar finding by Obiri-Danso et al. (2008) who reported increased in Cu concentration in hides singed with car tyres after washing with water. The level of Pb in the meat was fairly stable for the unwashed and the boiled meat and was above the acceptable daily intake level. The concentrations of Fe, Zn, Cr, Cd and Cu (Table 3 & 4) were all above the recommended levels of daily intake shown in Table 2 (FAO & WHO, 2011). The increased in Zn concentration may also be due to its presence in the cooking utensil used for boiling the meat. The high levels of zinc may cause acute effects such as vomiting and gastrointestinal irritation such as nausea, cramps, diarrhoea (FAO & WHO, 2011). It has also been said that (Costa, 2000; Heng, Jusoh, Ling & Idris, (2004) Cd mostly competes with and displaces Zn in human bodies and disrupts some activities of enzymes. Cadmium also accumulates in animal milk and fatty tissues (Figueroa, 2008) hence; consumers are exposed to cadmium when they consume such contaminated animal meats. Cadmium in the human body negatively affects the liver, kidney, lung, bones, placenta, brain and the central nervous system (Castro-González & Méndez-Armenta, 2008). Mercury levels in all the meat samples were below detection levels which may imply that the level of mercury in the scrap tyres are low and such cannot contribute much to contaminate the meat. The levels of all the heavy metals in the goat meat were higher than cattle from the observations of the concentration.
5. CONCLUSION

The use of scrap tyres for meat processing is still being practiced by some butchers, which helps to reduce scrap tyre waste but present huge meat safety challenge in Akropong. Even though the cost of accessing scrap tyres is low and has excellent combustion properties, it introduces heavy metals into the meat singed with such scrap tyres. Sector policy to criminalise such acts is important to promote food safety and to ensure sound public health. Furthermore municipal by-law on such practices and enforcement are appropriate to promote food safety in the Assembly since they have jurisdiction powers to curb some of these developments.

The study indicated that meat samples washed with water had the elevated concentration of Fe in both goats and cattle carcass. The amount of Hg in singed meat was not detectable in the meat. Upon boiling chevon (goat meat) and beef, heavy metals such as Fe and Cr concentrations increased in goat meat whilst Zn, Cu, Cd and Cr increased in cattle. Cr and Fe concentration were still beyond the maximum permissible level by FAO/WHO after boiling which implies that meat singed with scrap tyres were unwholesome even after boiling. Consumers of goat meat may be at high risk of accumulating the heavy metals than those consuming cattle meat. It can be said that consumers of freshly grilled meat which is popularly called “chinchings” may be at high risk of consuming high levels of heavy metals from meat singed with scrap tyres. Therefore continuous consumption of meat singed with scrap tyres in Ghana might have significant health implications in view of the high levels of heavy metal concentrations. Health risk assessment for consumption of meat singed with scrap tyres should be conducted to inform policy reforms and consumption decisions.

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References


