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Effect of Smoke Inhalation on Methaemoglobin, Oxyhaemoglobin and Packed Cell Volume of Plantain ("Bole") Roasters in Port-Harcourt, Nigeria

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Research article

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Abstract

Bole is a popular delicacy in Port Harcourt, Nigeria. Bole is roast plantain, roasted above burning charcoal. It is usually roasted alongside yam, and fish. In the course of roasting Bole, women are exposed to smoke which in the long run may produce some effects on the blood. The study examines how the smoke inhaled by these women affects their packed cell volume, methaemoglobin and oxyhaemoglobin levels. This study was carried out on blood samples collected from women who roast Bole (test subjects), in Port Harcourt, specifically in Diobu and Borikiri area. Control subjects were apparently healthy women that were not exposed to smoke. A total of 40 samples (20 from test subjects and 20 from control subjects) were collected through standard vein-puncture technique. Packed cell volume was determined using microhaematocrit method, oxyhaemoglobin and methaemoglobin levels were analyzed using spectrophotometric method. Methaemoglobin level (4.94 ± 4.17%) and PCV level of the test subjects (39.45 ± 1.32%) were significantly greater than that of control subjects (methaemoglobin: 1.64 ± 0.39%) and (packed cell volume: 38.50 ± 1.40%); (p-value = 0.00114 and 0.032887 for methaemoglobin and PCV respectively). The Oxyhaemoglobin levels of test subjects (11.38 ± 1.29g/dl) was significantly lower than the oxyhaemoglobin level of the control subjects (15.39 ± 0.89g/dl); (p- value = 0.000). The study therefore reveals that exposure to smoke increases methemoglobin levels and decreases oxyhaemoglobin level; this does not support adequate physiological oxygen delivery to body tissues and organs and could lead to hypoxia. We therefore recommended that these women use other means which produces less smoke to roast their plantain (bole), increase hydration, and make use of nose masks to reduce smoke inhalation.

Keywords: Methaemoglobin; Oxyhaemoglobin; Packed Cell Volume; Bole

Abbreviations: HB: Haemoglobin; NADH: Nicotinamide Adenine Dinucleotide.

Introduction

In the past in Africa, we were meant to believe that the fathers were the bread winners of the family; hence they provided all the financial needs of the family while the mothers stayed at home solely cooking the meals and taking care of the children. Today, this is not the case as we see mothers work very hard to support their husbands. This has led to majority of women to venture into different businesses one of which is roasting of plantain (Bole). In the course of roasting Bole, they are exposed to smoke which in the long

run, is believed to have some effect on the blood.

In this study, we looked at how the smoke inhaled by these women affects the methaemoglobin and oxyhaemoglobin. This Bole is roast plantain, roasted above a burning charcoal. It is usually roasted alongside yam, and fish. It is very common in Port Harcourt city of Rivers State, Nigeria. It is served with pepper and palm oil sauce. It is a delicious meal that so many persons residing in Port Harcourt rush to eat during break (Lunch Break) while at work.

Smoke is a collection of airborne solid and liquid particulates and gases emitted when material undergoes combustion or pyrolysis, together with the quantity of air that is entrained or otherwise, mixed into the mass. It is commonly an unwanted by-product of fires (including stoves, candles, oil lamps, and fireplaces). Smoke is sometimes used as a flavouring agent and preservative for various food stuffs. Smoke is an aerosol (or mist) of solid particles and liquid droplets that are close to the ideal range of sizes capable of scattering visible light [1].

Methaemoglobin is haemoglobin that is not functional in oxygen carriage. A small amount of methaemoglobin is always present in erythrocytes but is usually converted back to haemoglobin through successive electron transfers, by nicotinamide adenine dinucleotide (NADH)–dependent methaemoglobin reduction in the diaphorase pathway [2].

Oxyhaemoglobin is the compound formed when a molecule of haemoglobin binds with molecule of oxygen. It is a bright red substance formed by the combination of haemoglobin with oxygen, present in oxygenated blood. In humans, oxyhaemoglobin forms in the red blood cells as they take up oxygen in the lungs [3]. The study was aimed at investigating the effect of smoke inhalation on Methemoglobin, Oxyhaemoglobin, and PCV in women who roast Bole. Since a lot of persons are exposed to a form of fume, either directly or indirectly, it is necessary to investigate the implication of these exposures on the haematolgical parameters so that measures can be taken to avert any serious health challenge. It is also necessary that persons are aware of the dangers of these exposures in order to protect themselves.

Materials

Study Design

This was a case-control study aimed at assessing the effects of smoke inhalation on Methemoglobin and Oxyhaemoglobin and comparing it with those who are not exposed to smoke.

Study Area

The research was carried out on blood samples gotten from women who roast Bole (test subjects) in Port Harcourt, specifically Diobu area, and Borikiri areas. The controls were gotten from women who were not exposed to smoke and were apparently healthy and lives in Port Harcourt.

Study Population

A total number of 20 test samples were studied and a total number of 20 controls were used. They were all females aged between 23 to 45 years.

Ethical Approval

Informed consent was gotten from individuals recruited for the study

Eligibility Criteria

All subjects in the study were females within the age of 23 and 45 years, and they were not exposed to other fumes from electricity generator, exhaust from automobiles, and were apparently healthy women.

Blood Sample Collection and Storage

Blood sample was collected using standard venepuncture technique. The quantity collected was 3ml. The anticoagulant used was K_3-EDTA, with a concentration of 1.2mg/ml. The sample was transported from the site of collection in a cooler to the haematology laboratory of Rivers State University where they were analysed. The samples were not stored, but analyzed immediately.

Determination of Oxyhaemoglobin

Haemoglobin was converted to oxyhaemoglobin by dilution with ammoniated water. The standard haemoglobin solution was prepared as described by the manufacturer. Fresh ammoniated water was prepared by adding 0.04ml of ammonia to 100ml of distilled water. Well mixed sample and 0.02ml of prepared reagent was added to the test tube and stoppered with rubber bung; and mixed well by inversion. The standard solution and the test solution was read in the spectrophotometer using light-path of 1cm and wavelength of 540nm or yellow green filter against the ammoniated water. Results was obtained using this formular below.

$$\text{Calculation} = \frac{\text{O.D of Test (gm/dl)}}{\text{O.D of Std} \times \text{Conc. of Std}}$$

Determination of Methaemoglobin

Manual method for methaemoglobin (Hi) measurement in blood, as described by Evelyn and Malloy (1938) was carried out. Hi has a maximum absorption at 630nm. When cyanide is added, absorption band disappears, the resulting change in absorbance is directly proportional to the concentration of Hi. Total Haemoglobin is then measured after complete conversion to HiCN by the addition of ferricyanide – cyanide, reagent. The conversion measures oxyhaemoglobin and methaemoglobin but not sulphaemoglobin. Thus, the presence of a large amount of sulphaemoglobin will result in an erroneously low measurement of total Haemoglobin. Turbidity of the haemolysate is neutralized by the addition of a nonionic detergent.

Calculation: Methemoglobin = $\frac{[D1- D2]}{[D3-D4]} \times 100\%$

Normal Range= 1-2%

Determination of PCV

Anticoagulated blood was centrifuged in a sealed capillary tube at 1500rpm for 5-7 minutes, and the packed cell volume was determined by reading with a microhaematocrit reader.

Results

Methemoglobin, Oxhaemoglobin and Packed Cell Volume in the Study Population

The methaemoglobin level of the test subjects (4.94 ± 4.17) was significantly greater than that of the control subjects (1.64 ± 0.39), (p-value = 0.00114).

The PCV level of the test subjects (39.45 ± 1.32) is significantly greater than the PCV level of the control subjects (38.50 ± 1.40). (p-value is 0.032887).

The Oxyhaemoglobin levels of the test subjects (11.38 ± 1.29) was significantly lower than the oxyhaemoglobin level of the control subjects (15.39 ± 0.89), (p-value = 0.000). Details shown in Table 1.

	Methaemoglobin (%)	PCV (%)	Oxyhaemoglobin (g/dl)
Test (mean ± SD)	4.94 ± 4.17	39.45 ± 1.32	11.38 ± 1.29
Control (mean ± SD)	1.64 ± 0.39	38.50 ± 1.40	15.39 ± 0.89
P-Value (2-tail)	0.00114	0.032887	0.000
Remark	Significant	Significant	Significant

Table 1: Methemoglobin, Oxhaemoglobin and Packed Cell Volume in the Study Population.

Discussion

The study was aimed at assessing the levels of methemoglobin, oxyhaemoglobin and packed cell volume levels in Bole roasters in Port Harcourt and comparing the value obtained with that of control subjects that were apparently healthy and were not exposed to smoke. For Methemoglobin, the result obtained, showed a significant increase (p=0.00114) in the percentage level of methaemoglobin of Bole roasters than in the control subjects. There was an increase from the level of (1.64±0.39) in control subjects to a level of (4.94±4.17) in Bole roasters as indicated in table 1.

The result of Methemoglobin level of Bole roasters agrees with the observation made by Christian et al., in their study on effects of occupational exposure hazard on Methemoglobin level in abattoir workers, where they observed significant increase in the Methemoglobin levels of abattoir workers who roast meat as against apparently healthy control subjects [4].

The research result also showed a significant reduction in the Oxyhaemoglobin levels (11.38±1.29) for the test subjects compared to (15.39±0.089) for the control subjects. It is in line with the physiological fact that increase in affinity of carbon for oxygen from haemoglobin in turn lowers oxygen capacity of blood which can result in suffocation and eventual death [5]. It was stated by a few of the bole roasters that they suffered respiratory difficulties, and sometimes they had chest pains.

The result of low oxyhaemoglobin levels tallies with physiological facts, that under lower partial pressures, haemoglobin releases its bound oxygen to the tissues leading to a decrease in the concentration of oxyhaemoglobin, as a result, insufficient oxygen is transported to the tissues leading to hypoxia [6], which if not remediated will lead to anoxia.

The findings from this study also supports the fact that an increase in methaemoglobin does not favour shifts in oxy-

haemoglobin dissociation curve to the right, which implies a decrease in the affinity of oxygen for haemoglobin thereby risking oxygen distribution [7]. This results to a decreased Oxyhaemoglobin level.

From the results obtained from packed cell volume, there was significant increase of (39.45±1.32) for Bole roasters compared to (38.50±1.40) for the control subjects. This increase may be as a result of decrease in plasma level, due to dehydration resulting during the heat generated from the roasting process which invariably leads to an increase in packed cell volume.

Conclusion

The study has revealed significant increase in methaemoglobin level, and decrease in oxyhaemoglobin level of Bole roasters compared to control subjects. The study therefore reveals that exposure to smoke increases methemoglobin levels and decreases oxyhaemoglobin level; this does not support adequate physiological oxygen delivery to body tissues and organs and could lead to hypoxia; thereby resulting in respiratory abnormalities and difficulty in breathing.

We therefore recommended that these women use other means which produces less smoke to roast their plantain (bole), increase hydration, make use of nose masks to reduce smoke inhalation. Also, they should take time off once in a while in order to reduce the degree of exposure.

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