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Quantification and Risk Assessment of Trace Metal Levels in Street Roasted Chickens Sold in Uyo Metropolis, Akwa Ibom State, Nigeria

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ABSTRACT

Levels of Zn, Pb, Cd, Fe and Mn in public/street-roasted chicken (PRC) and un-roasted chicken (URC) samples sold in Uyo were quantified using AAS. Levels of the trace metals were equally quantified in self-roasted chicken (SRC) samples to serve as the controls. Samples were obtained from five sampling points along five major roads linking Uyo Metropolis. The results (mg/kg) gave the levels of the trace metals in the samples as follows: Zn levels ranged from 1.81±0.01 in PRC to 4.34±0.02 also in PRC and were below detection limit in the SRC from one of the sampling points. Pb levels ranged from 0.01±0.00 in the URC to 0.20±0.01 in the PRC and were below detection limit in both PRC and SRC samples from one of the sampling points. Cd was only detected in the URC and SRC samples obtained from two of the sampling points. Fe levels ranged from 0.12±0.01 in PRC to 1.91±0.01 in URC and Mn ranged from 0.54±0.01 in PRC to 2.19±0.01 in URC. Except Pb whose level exceeded the FAO/WHO maximum permissible limit of 0.1 mg/kg (in foods) in some of the PRC samples, the levels of all the other trace metals in all the samples were low compared with the FAO/WHO maximum permissible limits of such metals in foods. Accordingly, the levels of some of the trace metals in the samples were comparable with those reported in literature. Human health risk assessment through consumption of roasted chickens in Uyo Metropolis using the risk assessment models [target hazard quotients (THQs) and hazard indices (HIs)] indicated that the THQ values were higher in children than in adults. The combined non-carcinogenic effect of all the trace metals expressed as hazard index (HI) was less than unity (HI<1), indicating a negligible risk on consumption of street roasted chickens in the area. The study gives a representative data on levels of Zn, Pb, Cd, Fe and Mn in street roasted chickens consumed in Uyo Metropolis. The data will serve as base line references for future studies of such metals in street roasted chickens and related food samples in the area and its environ.

Key words: Trace metals, Street Roasted Chickens, Health Risk Assessment, Uyo

INTRODUCTION:

Quantification of levels of trace metals in foods and food products such as street-roasted chickens sold in urban areas has been a great concern to scientists due to the fact that foods ingestion is a major route

through which human being may be exposed to toxic amount of trace metals (Okafor et al, 2012). In recent days, street-food vendings have been on the increase in urban areas especially in cities of developing countries of the world as it is the case in Uyo metropolis, Nigeria. These foods are prone to chemical pollutants such as trace metals from numerous sources (Bamuwamye et al, 2015), ranging from methods, materials for processing, handling, environmental factors and human activities including traffic and traffic related materials.

Trace metal contamination poses a serious threat to human health due to its bioaccumulation, biomagnification and toxicity. It has caused widespread concern about human health, and therefore, scientists are focusing their studies on the levels of these metals in food consumed by humans, so as to evaluate the risk associated with exposure to trace metals (Hussain et al, 2012; Khan et al, 2015). Anthropogenic activities and urbanisation have adversely influenced the release of trace metals into the urban environment, and the potential health risks associated with them is high. Pollutants enter the urban atmosphere in the form of gases, particles, or as aerosols, by evaporation of liquids, by evaporation of dissolved solvents from water and by wind erosion of soil. These pose detrimental effects to humans and other animals in different ways, ranging from cancer, infertility, sexual underdevelopment, altered or reduced sexual behaviour and birth defects amongst others (Perlroth and Branco, 2017). Although the road side roasted chickens vending is one of the contributors to the economy of cities, the question of safety of these products has not been fully addressed in many African countries (Oguttu, 2015).

The general handling of street roasted meats in particular, possess a safety threat because the meats are prepared and sold in open and dusty environments with high levels of trace metals contamination (Bamuwamye et al, 2015). However, studies evaluating street roasted chickens of urban settings in developing countries are limited especially in Nigeria.

Due to the influx of population into Uyo, (Capital of Akwa Ibom state) and the emergence of new entrepreneurs in the state, Uyo has witnessed an alarming increase in street roasted foods vending and the safety stand of this particular set of foods is in doubt and there appears to be no information on trace metal contamination of street roasted chickens in Uyo Metropolis before or as at the time of this research. This study is therefore set to quantify the levels of trace metals and human health risk associated with the consumption of street roasted chickens sold in Uyo Metropolis.

MATERIALS AND METHODS

Study Area/Sampling points

Figure 1 shows the map of Uyo showing study areas/sampling points (SP) along five major roads linking the centre of Uyo Metropolis. The sampling points considered in this study were: Aka Road by Udo Udoma Roundabout/Aka Etinan Road Junction (SP1), IBB/Atiku Abubakar Way by Abak Road Roundabout (SP2), Ikot Ekpene Road by Oku Street Junction and the University of Uyo Roundabout (SP3), Calabar/Itu Road by Itam Junction Roundabout (SP4) and Oron Road by Nwaniba Junction Roundabout (SP5).

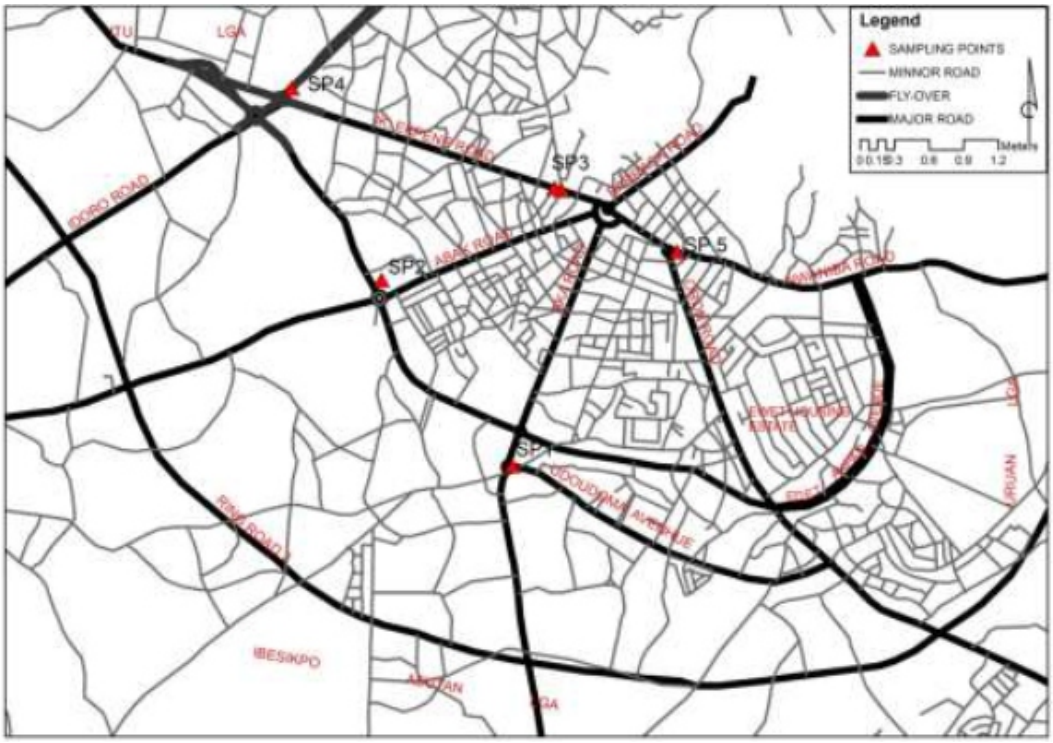

Figure 1: Map of Uyo Showing the Study Area/Sampling points

SAMPLES AND SAMPLING

A total of 15 chicken samples of three different sets: public/street-roasted chicken (PRC) and un-roasted chicken (URC) meat samples sold in Uyo Metropolis as well as self-roasted chicken (SRC) samples which serve as the controls, were randomly collected between the months of April and May, 2016, from different roadside roasted chickens vendors from the five sampling points (identified above as SP1, SP2, SP3, SP4 and SP5 along the five major roads linking the centre of Uyo Metropolis). The collected samples were properly labeled, kept in polythene bags and taken to the laboratory for subsequent preparations, treatments and analyses.

Preparations and Treatments of Samples

Sample preparations and treatments were done using standard procedures. Each of the three sets of samples were differently chopped into small pieces and dried in an oven at about 60°C until constant weights were obtained. The dried samples were then ground into fine powder, stored in labeled polyethylene bags and kept in a refrigerator until used for acid digestion.

Digestion of Samples

The dried ground samples (1.0 g each) were taken into differently properly labeled crucibles and ashed in a SXL muffle furnace at a temperature range of 750°C - 850°C for 4 hours. After the ashing, the crucibles with the ashes were allowed to cool overnight to room temperature. The crucibles were then removed from the furnace and the ashes leached with 5 cm^3 of 6M HCl and transferred into 50 cm3 volumetric flasks. Distilled water was used to rinse crucibles into the volumetric flasks, and the volumes made up to 50 cm3 marks with distilled water (Ogner et al, 1991). The solutions for the blank determinations were treated in a similar manner but without the samples (Whiteside, 1979). The samples and the blank solutions were then stored in labeled plastic reagent bottles for trace metals analyses using Atomic Absorption Spectrophotometer (AAS). The reagent bottles used were previously soaked in a 10% nitric acid for 48 hours and later rinsed with distilled water with 3ml of concentrated HNO_3 and 3 cm3 of 50% H_2O_2.

Determination of Trace Metal Levels in the Samples

Levels of trace metals in the sample solutions of the PRC, URC and SRC samples were determined as stipulated by the AOAC (2010) using the AAS (UNICAM 939/959 model). The trace metals analysed for their levels in the sample solutions were Zn, Pb, Cd, Fe and Mn. The solutions of the samples were aspirated into the instrument and the absorbance obtained was used to determine the concentrations of the metals in the different samples from calibration curves. The instrument was operated in accordance with the instrument's handbook while calibration was done using a mixed calibration standard solution prepared from the pure British Drug House (BDH) Analar grade salt of each metal. As a control, a blank determination was also made using the same procedures.

Estimated Daily Intake (EDI) of Trace Metals

The health risks posed to consumers were determined by the specific dietary intake of each contaminant and compared with the toxicologically acceptable levels.

The estimated daily intake (EDI) of trace metals (Zn, Pb, Cd, Fe and Mn) depended on both the metal concentration in the PRC and the amount of consumption of the respective food. The EDI of trace

metals from consumption of PRC and vended chicken meats was estimated using the following equation adopted by Copat et al (2013):

$$EDI = \frac{C \times IR}{BW} \qquad (1)$$

Where: C is level of trace metal in chicken meat samples (mg/kg), IR represents ingestion rate of roasted chicken meats in the area (g/person/day), BW is the average body weight (kg).

The average daily chicken meats intakes were taken as 150 and 100 g/person/day for adults and children respectively, while the average body weights were taken as 60 and 30 kg for adults and children respectively (Ihedioha and Okoye, 2013; Iwegbue et al, 2008).

Hence, exposure to trace metal was worked out in terms of estimated daily intakes (EDI) based on IR of 150g and 100g respectively for adults and children. The metal intakes were compared with the tolerable daily intakes for metals recommended by the FAO/WHO (2010), WHO (2000) and FSA (2006).

The health risks for adult and children were considered separately since the contact pathwa y with each exposure changed with age.

Target Hazard Quotient (THQ)

The health risks from consumption of public roasted chicken by the local inhabitants were assessed based on the THQ. The THQ is a ratio of determined dose of a pollutant to a reference dose level. If the ratio is less than 1, the exposed population is unlikely to experience obvious adverse effects. The method for estimating risks using THQ was provided in the U.S. EPA Region III risk-based concentration table (USEPA IRIS, 2007) and as expressed in the equation from by Udosen, et al, 2014.

$$THQ = EDI/ Rfd \qquad (2)$$

Where: THQ is the target hazard quotient, EDI is the estimated daily intake of roasted chickens (kg person-1day -1) and Rfd represents oral reference dose (mg /kg/day). Oral reference doses were based on 3E-01, 4E-03, 1E-03, 7E-01 and 1.4E-01 mg/kg/d for Zn, Pb, Cd, Fe and Mn respectively (USEPA, 1997; USEPA IRIS, 2007).

DATA AND STATISTICAL ANALYSES:

Three replicates of the digested samples were analysed under the same conditions and statistical analysis was performed to calculate means ± standard errors (SE) using Excel 2007 spreadsheet, while IBM

SPSS 20.0 Statistical software (SPSS Inc., Illinois, USA) was used to perform ANOVA, followed by Tukey's test. ANOVA and Tukey analyses were used to compare levels of trace metals in the different chicken samples from the five sampling sites of the study and differences were considered statistically significant at $p < 0.05$. The geochemical results were interpreted using Estimation of Daily intake (EDI) and pollution indices such as Target hazard quotient (THQ) and Hazard index (HI).

RESULTS AND DISCUSSIONS

Levels of Some Trace Metals in the Chicken Samples

The levels of Zn, Pb, Cd, Fe and Mn in the roasted chicken samples investigated in this study are presented in Table 1. From the Table, the results (mg/kg) indicated that Zn ranged from 1.81±0.01 in PRC to 4.34±0.02 also in PRC samples from the different sampling points. Zn was however below detection limit in the SRC sample from one of the sampling points. Zn is emitted into the environment as a result of wear from tires of automobiles, combustion from motor vehicle exhausts as a result of zinc-containing compounds in lubricating oils (Adebiyi et al., 2008). The increased levels of Zn in the PRC

Table 1: Levels (mg/kg) of Trace Metals in Roasted Chicken Samples Sold in Uyo Metropolis, Nigeria.

Samples	Metals		Sampling	Sites		
		SP1	SP2	SP3	SP4	SP5
URC	Zn	2.11±0.01	1.20±0.01	2.71±0.01	2.24±0.01	3.10±0.01
PRC		3.92±0.01	3.11±0.01	3.40±0.01	1.81±0.01	4.34±0.02
SRC		3.32±0.01	BDL	2.40±0.01	3.76±0.01	3.81±0.01
URC	Pb	0.03±0.01	0.04±0.01	0.02±0.01	0.01±0.00	0.01±0.01
PRC		0.20±0.01	BDL	0.19±0.01	0.21±0.01	0.10±0.01
SRC		0.06±0.01	BDL	0.05±0.01	0.08±0.01	BDL
URC	Cd	BDL	BDL	0.01±0.01	BDL	0.02±0.01
PRC		BDL	BDL	BDL	BDL	BDL
SRC		BDL	BDL	BDL	BDL	0.03±0.01
URC	Fe	1.52±0.01	1.50±0.01	1.85±0.01	1.42±0.01	1.91±0.01
PRC		0.12±0.01	0.40±0.01	0.40±0.01	0.42±0.01	0.53±0.01
SRC		1.63±0.01	0.89±0.01	1.61±0.01	1.02±0.01	1.55±0.01
URC	Mn	1.79±0.01	1.85±0.01	2.01±0.01	0.92±0.01	2.19±0.01
PRC		0.54±0.01	0.61±0.01	0.62±0.01	0.94±0.01	1.08±0.01
SRC		1.59±0.01	1.22±0.00	1.61±0.01	1.20±0.01	1.70±0.01

URC = un-roasted chickens; PRC= public-roasted chickens; SRC= self-roasted chickens (Controls), BDL = below detection limit. SP1, SP2, SP3, SP4 and SP5 are the sampling sites as defined under the study area/sampling points section. The above values are mean ± standard deviation of triplicate analyses.

samples in this study could be attributed to traffic emissions and road dusts (Shinggu et al., 2010). Generally, Zn levels reported in this study were lower than those reported by Bamuwamye (2015) in a

similar study in Kampala and those reported by Nesta et al (2015) in Ghana. Zn levels reported by Okafor (2012) and Makanjuola (2016) in Nigeria are comparable with those reported in this study.

Pb (mg/kg) ranged from 0.01±0.00 in the URC to 0.20±0.01 in the PRC samples and was below detection limit in both PRC and SRC samples from one of the sampling points. Pb is a highly toxic metal whose widespread use has caused extensive environmental contamination and health problems in many parts of the world. Pb levels in all the PRC samples increased markedly when compared with those obtained in the other samples. Levels of Pb in samples other than the PRC samples varied from 0.01±0.00 to 0.04±0.01 mg/kg in the trend SP4 and SP5 < SP3 < SP1 < Sp2 for URC samples and 0.05±0.01 to 0.08±0.01 mg/kg in the SP3 < SP1 < SP4 in the SRC samples. The highest Pb level of 0.21±0.01 mg/kg in this study was obtained in the PRC samples collected from the SP4 sampling point. The sources of Pb are gasoline and paint, which have now been extended to lead bullets, plumbing pipes, pewter pitchers, storage batteries, toys and faucets (Thu rmer et al., 2002). Other reported sources of Pb in the environment include automotive gasoline piston engines, oil burners, lead pipes, incinerators, industrial effluents and smokestack fallout (Sharma and Street, 1980). Pb levels reported by Bamuwamye (2015) were lower than the ones recorded in this study and those reported by Nesta et al (2015), Okafor (2012) and Makanjuola (2016) were comparable with those reported in this study.

Little levels of Cd (0.01±0.01 and 0.02±0.01mg/kg) were detected only in URC samples collected from SP3 and SP5 sampling points, respectively, as well as 0.03±0.01mg/kg in SRC sample collected from SP5 sampling point. These results were in agreement with those reported by Frederick (2015), Makanjuola (2016), Nesta et al (2015) and Bamuwamye (2015).

Fe (mg/kg) ranged from 0.12±0.01 in PRC to 1.91±0.01 in URC samples. The Fe levels in terms of sampling points were in the trend SP5 > SP3 > SP1 > SP2 > SP4 for URC samples, SP5 > SP4 > SP3 and SP2 < SP1 for PRC samples and SP1 > SP3 > SP5 > SP4 > SP2 for SRC samples. Accordingly, the Mn levels (mg/kg) ranged from 0.54±0.01 in PRC to 2.19±0.01 in URC samples. The Mn levels in terms of sampling points were in the trend SP5 > SP3 > SP2 > SP1 > SP4 for URC samples, SP5 > SP4 > SP3 and SP2 < SP1 for PRC samples and SP5 > SP3 > SP1 > SP2 > SP4 for SRC samples. Fe levels reported in this study were generally lower than those reported by Bamuwamye (2015), Nesta et al (2015) and Makanjuola (2016) while Mn levels were comparable with those of Makanjuola (2016). As noted by Joyce et al (2016), the results generally indicated that levels of Fe and Mn were affected by action of heat used in roasting the chicken meats.

Except for Pb whose level exceeded the FAO/WHO maximum permissible limit of 0.1 mg/kg in foods, in some of the PRC samples, the levels of all the other trace metals in all the samples investigated, were low when compared with the FAO/WHO maximum permissible limits for such metals in foods.

HUMAN HEALTH RISKS ASSESSMENT

The evaluation of human's exposure to trace metals in roasted chickens sold in Uyo Metropolis was obtained for adults and children. The estimated daily intake of trace metals in the URC, PRC and SRC samples are summarised in Tables 2 and 3. Considering the worst scenario, which in this case was the estimated daily intakes (EDIs) of the metals (Zn, Pb, Cd, Fe and Mn) by children through consumption of roasted chickens sold in Uyo Metropolis (Table 3), the computed values showed that Zn was below the detectable limit in SRC samples collected from SP2 sampling point, but highest (1.42E-02 mg/kgbw/day) in PRC samples collected from SP5 sampling point. It indicated that children consuming the PRC are likely to be exposed to high levels of zinc metal intakes. However, the EDI values of zinc computed in this study were below the provisional maximum tolerable dialy intakes (PMTDI) of 3E-01 to 1 mg/kgbw/day for Zn. Daily intake of Pb computed for children ranged from 3.3E-05 to 6.7E-04 mg/kgbw/day. Comparison with PMTDI showed that the computed values are lower than the PMTDI value (4E-03 mg/kgbw/day) for Pb. Similarly, EDIs values were obtained for Cd, Fe and Mn with highest values (1E-04, 5E-02 and 6E- 02) mg/kgbw/day, which are lower than their corresponding PMTDI values of (1E-03, 8E-01 and 5) mg/kgbw/day respectively. The results revealed that the estimated daily intake values (EDIs) calculated for Zn, Pb, Cd, Fe and Mn via the consumption of the investigated samples collected from the five sampling sites of this study were low compared to FAO/WHO (2011) and FAO (2009) PMTDI. Pb showed major contributions through the consumption of PRC for both adults and children, while Cd contributed less or were below detectable level in almost all samples obtained from all sampling points. Children are especially vulnerable to acute, sub-acute and chronic effects of ingestion of chemical pollutants, since they (children) consume more (twice of the amount) food per unit of body weight as adults (ENHIS, 2007). Comparing Tables 2 and 3, this study revealed that the EDIs in children due to consumption of roasted chickens obtained from the different sampling points were higher than those of the adults. As a result, intakes of these toxic metals through food could be higher for children consuming the roasted chickens for seven days per week in Uyo Metropolis.

Table 2: Estimated Daily Intake of Trace Metals via Roasted Chickens Consumed in Uyo Metropolis by Adults

Sites	Samples	Zn	Pb	Cd	Fe	Mn	CDI
SP1	URC	5.3E-03	7.5E-05	BDL	3.8E-03	4.5E-03	1.4E-02
	PRC	9.8E-03	5E-04	BDL	3E-04	1.4E-03	1.2E-02
	SRC	8.1E-03	1.5E-04	BDL	4.1E-03	4E-03	1.6E-02
SP2	URC	3E-03	1E-04	BDL	3.8E-03	4.6E-03	1.2E-02
	PRC	7.8E-03	BDL	BDL	1E-03	1.5E-04	9.0E-03
	SRC	BDL	BDL	BDL	2.2E-03	3.1E-03	5.3E-03
SP3	URC	6.8E-03	5E-05	2.5E-05	4.6E-03	5E-03	1.6E-02
	PRC	8.5E-03	4.8E-04	BDL	1E-03	1.6E-03	1.2E-02
	SRC	6E-03	1.3E-04	BDL	4E-03	4E-03	1.4E-02
SP4	URC	5.6E-03	2.5E-05	BDL	3.6E-03	2.3E-03	1.2E-02
	PRC	4.5E-03	5.3E-04	BDL	1.1E-03	2.4E-03	8.5E-03
	SRC	9.4E-03	2E-04	BDL	2.6E-03	3E-03	1.5E-02
SP5	URC	7.8E-03	2.5E-05	5E-05	4.8E-03	5.5E-03	1.8 E-02
	PRC	1.1E-02	2.5E-04	BDL	1.3E-03	2.7E-03	1.5 E-02
	SRC	9.5E-03	BDL	7.5E-05	3.9E-03	4.3E-03	1.8 E-02

CDI =Cumulative daily intake; URC = un-roasted chickens; PRC= public-roasted chickens; SRC= self-roasted chickens (Controls); BDL = below detection limit. SP1, SP2, SP3, SP4 and SP5 are the sampling sites as defined under the study area/sampling points section.

Target Hazard Quotient (THQ) and Hazard Index (HI) via Consumption of Roasted Chickens Sold in Uyo Metropolis

The target hazard quotient (THQ) and hazard index (HI) in adults via the consumption of roasted chickens sold in Uyo Metropolis are presented in Table 4 while those in children are presented in Table 5. All the THQ values calculated for URC, PRC and SRC samples in both adults and children were less than unity in the five sampling points for Zn, Pb, Cd, Fe and Mn. These suggest that the risk associated with the consumption of roasted chickens could not be adverse on humans. However, caution must be taken since perennial intake of these contaminated food animals is likely to induce adverse health effects arising largely from exposure to Pb. The highest THQ values for Pb or other trace metals in this study were in PRC samples obtained from SP4, Sp1 and SP3 sampling points. It is assumed that the toxic risk due to potentially hazardous chemicals in the same medium is cumulative; therefore, the summation of the THQs was done to obtain the overall toxic risk, which is the hazard index (HI). The HI values were computed from the THQ values. The HI values for children were significantly higher compared to those of adults. Generally, all the computed HI values for roasted chickens from the five sampling poits in URC, PRC and SRC samples were less than unity for both children and adults. Like the THQ, a HI < 1 represents a potential for no adverse health effect on the population via consumption of the roasted chickens. These findings were in agreement with those reported in Iraq by Salwa (2014) and in Nigeria by Okafor et al (2012) who concluded that the exposure to excessive metals (Cd, Pb, Mn, Zn and Ni) via chicken meats, livers, and gizzards consumption do not pose any imminent health risk.

Table 3: Estimated Daily Intake of Trace Metals via Roasted Chickens Consumed in Uyo Metropolis by Children

Sites	Samples	Zn	Pb	Cd	Fe	Mn	CDI
SP1	URC	7E-03	1E-04	BDL	5E-02	6E-02	1.2E-01
	PRC	1.3E-02	6.7E-04	BDL	4E-04	1.8E-03	1.6E-02
	SRC	1.1E-02	2E-04	BDL	5.4E-03	5.3E-03	2.2E-02
SP2	URC	4E-03	1.3E-04	BDL	5E-03	6.2E-03	1.5E-02
	PRC	1.0E-02	BDL	BDL	1.3E-03	2E-03	1.3E-02
	SRC	BDL	BDL	BDL	3E-03	4.1E-03	7.1E-02
SP3	URC	9E-03	6.7E-05	3.3E-05	6.2E-03	6.7E-03	2.2E-02
	PRC	1.1E-02	6.3E-04	BDL	1.3E-03	2.1E-03	1.5E-02
	SRC	8E-03	1.7E-04	BDL	5.4E-03	5.4E-03	8.2E-03
SP4	URC	7.5E-03	3.3E-05	BDL	4.7E-03	3.1E-03	1.5E-02
	PRC	6E-03	7E-04	BDL	1.4E-03	3.1E-03	1.1E-02
	SRC	1.3E-02	2.7E-04	BDL	3.4E-03	4E-03	2.1E-02
SP5	URC	1E-02	3.3E-05	6.7E-05	6.4E-03	7.3E-03	2.4E-02
	PRC	1.4E-02	3.3E-04	BDL	1.8E-03	3.6E-03	2E-02
	SRC	1.3E-02	BDL	1E-04	5.2E-03	5.7E-03	5.9E-01
PMTDI (mg/kg bw/day)		0.3-1	0.004	0.001	0.8	5	

URC = un-roasted chickens; PRC= public-roasted chickens; SRC= self-roasted chickens (Controls), BDL = below detection limit. SP1, SP2, SP3, SP4 and SP5 are the sampling sites as defined under the study area/sampling points section, CDI = Cumulative daily intake; PMTDI = Provisional maximum tolerable dialy intakes.

Table 4: Target Hazard Quotient (THQ) and Hazard Index (HI) in Adults via Consumption of Roasted Chickens Sold in Uyo Metropolis

Sites	Samples	Zn	Pb	Cd	Fe	Mn	HI
SP1	URC	2E-02	2E-02	BDL	1E-02	3E-02	8E-02
	PRC	3E-02	1.3E-01	BDL	4E-04	1E-02	1.7E-01
	SRC	3E-02	4E-02	BDL	6E-03	3E-02	1.1E-01
SP2	URC	1E-02	3E-02	BDL	1E-02	3E-02	8E-02
	PRC	3E-02	BDL	BDL	1.4E-02	1E-03	8E-02
	SRC	BDL	BDL	BDL	3E-03	2E-02	2E-02
SP3	URC	2E-02	1E-02	3E-02	1E-02	4E-02	1.1E-01
	PRC	3E-02	1.2E-01	BDL	1.4E-03	1E-02	1.6E-01
	SRC	2E-02	3E-02	BDL	6E-03	3E-02	9E-02
SP4	URC	2E-02	1E-02	BDL	1E-02	2E-02	6E-02
	PRC	2E-02	1.3E-01	BDL	1.6E-03	2E-02	1.7E-01
	SRC	3E-02	5E-02	BDL	4E-03	2E-02	1E-01
SP5	URC	3E-02	1E-02	5E-02	1E-02	4E-02	1.4E-01
	PRC	4E-02	6E-02	BDL	1.9E-02	2E-02	1.2E-01
	SRC	3E-02	BDL	8E-02	6E-03	3E-02	1.5E-01
PMTDI: (mg/kg bw/day)		0.3-1	0.004	0.001	0.8		5

URC = un-roasted chickens; PRC= public-roasted chickens; SRC= self-roasted chickens (Controls), BDL = below detection limit. SP1, SP2, SP3, SP4 and SP5 are the sampling sites as defined under the study area/sampling points section; HI = hazard index; PMTDI = Provisional maximum tolerable dialy intakes.

CONCLUSIONS

Based on the analyses and results, this study has been able to establish the levels of Zn, Pb, Fe, and Mn in all the chicken samples investigated. Cd was below detection limit, except in URC samples obtained from SP3 and SP5 sampling points and in SRC sample obtained from Sp5 sampling point. The levels of Pb in the PRC samples obtained from three sampling points (Sp1, SP3 and SP4) were higher than the FAO/WHO maximum permissible limit of 0.1 mg/kg in foods. The levels of all the other trace metals in all the samples were low compared with the FAO/WHO maximum permissible limits for such metals in foods. Accordingly, the levels of some of the trace metals in the samples were comparable with those reported in literature. The contamination of the street roasted chickens with trace metals could have been associated with vehicular emissions, street dusts and other aerial particulates as well as the methods of processing and handling of the street roasted chickens.

Table 5: Target Hazard Quotient (THQ) and Hazard Index (HI) in Children via Consumption of Roasted Chickens Sold in Uyo Metropolis

Sites	Samples	Zn	Pb	Cd	Fe	Mn	HI
SP1	**URC**	2E-02	3E-02	BDL	7E-02	4E-02	1.6E-01
	PRC	4E-02	1.7E-01	BDL	6E-04	1E-02	2.2E-01
	SRC	4E-02	5E-02	BDL	8E-03	4E-02	1.4E-01
SP2	**URC**	1E-02	3E-02	BDL	1E-02	4E-02	9E-02
	PRC	3E-02	BDL	BDL	1.9E-03	1E-02	4E-02
	SRC	BDL	BDL	BDL	4E-03	3E-02	3E-02
SP3	**URC**	3E-02	2E-02	0.03	1E-02	5E-02	1.4E-01
	PRC	4E-02	1.6E-01	BDL	1.9E-03	2E-02	2.2E-01
	SRC	3E-02	4E-02	BDL	8E-03	4E-02	1.2E-01
SP4	**URC**	3E-02	1E-02	BDL	1E-02	2E-02	7E-02
	PRC	2E-02	1.8E-01	BDL	2E-03	2E-02	2.2E-01
	SRC	4E-02	7E-02	BDL	5E-03	3E-02	1.5E-01
SP5	**URC**	3E-02	1E-02	7E-02	1E-02	5E-02	1.7E-01
	PRC	5E-02	8E-02	BDL	2.6E-03	3E-02	1.6E-01
	SRC	4E-02	BDL	1E-02	7E-03	4E-02	1.9E-01

URC = un-roasted chickens; PRC = public-roasted chickens; SRC = self-roasted chickens (Controls), BDL = below detection limit. SP1, SP2, SP3, SP4 and SP5 are the sampling sites as defined under the study area/sampling points section; HI = hazard index.

Human health risk assessment through consumption of roasted chickens in Uyo Metropolis using the risk assessment models [target hazard quotients (THQs) and hazard indices (HIs)] indicated that the THQ values were higher in children than in adults. The combined noncarcinogenic effect of all the metals as hazard index (HI) was less than unity (HI<1) indicating a negligible risk on consumption of street roasted chickens from the study area.

The high levels of Pb and Zn in the PRC samples suggest the need for regular and consistent monitoring of street foods of urban environment against chemical contaminations. The study gives a representative data on the levels of Zn, Pb, Cd, Fe and Mn in street roasted/vended chickens consumed in Uyo Metropolis. The data will serve as base line references for future studies of such metals in street roasted chickens and related food samples in the area and its environ.

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Review of Offshore Pipeline Span Creation Mechanism

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ABSTRACT

The various span creation mechanisms have been studied in great detail and this work has presented the state of the art in the area of offshore pipeline span creation mechanism analysis. The different span creation mechanisms of a pipeline during operation include residual uplifts, scouring, sandwaves, underwater landslides, strudel scour, etc. With this information a software can be formulated which can incorporate the different characteristics of elements of span creation.

INTRODUCTION:

A free span can be defined as a section of submerged pipeline not in contact with the seabed over its length [90]. According to Gou et al. [36], pipeline spanning usually occurs when the contact between the pipeline and seabed is lost over a long depression on a rough seabed. Due to highly uneven sea bed terrain, the pipelines can be said to rest on mountains with possible free spans ranging between 50-100m [126] [81].

Presently, the oil and gas industry is moving towards harsher environments often characterized by uneven seabed and deep water [2]. The number of submarine pipelines being laid in such environments is increasing at a massive rate in different parts of the world. Thus, free spanning pipelines are becoming more frequent and are often unavoidable during pipeline installation [80]. The formation of submarine pipeline spans may have a critical influence on the safety and integrity of the pipelines [44]. There are records of recent failures due to free spanning of pipelines thus necessitating an increased attention on pipeline span analysis. Spans can develop during pipelay due to irregular bedform, (coupled with factors such as pipe weight, pipe stiffness, etc.) or during the service life of the pipeline, due to dynamic seabed [84]– scouring, etc. and, in some cases, due to horizontal movements. A background on span creation mechanisms can be found in the Appendix.

The existence of a pipeline free span can cause excessive deformation and bending or vibration of the pipeline section. Pipeline free span evaluation involves the determination of the maximum or critical span length under the effects of hydrodynamic loads [25]. Span analysis involves consideration of structural failure due to overstress from steady state loads, fatigue failure due to vibrations from dynamic

loads (such as Vortex Induced Vibrations) and severe damage due to third party activities (hooking from trawl gears or drop objects) [73; 113].

Span creation mechanism

According to Wei et al [110], submarine pipeline spanning mechanism may occur due to (i) absence of sediment sources, (ii) complexity in subsea floors and (ii) strong hydrodynamics.

Residual Uplifts

Residual uplifts can be described as isolated protuberances in the surrounding sea bed that have not eroded. Scour holes are concaves formed by hydrodynamic differential erosion, in which the strike is parallel to the direction of tide. The strike of residual uplifts and scour holes are basically considered perpendicular to the direction of the pipelines. Their presence and development impacts the integrity of submarine pipelines. This is according to results obtained from studies in a certain gas field.

Wei et al. noted that since pipelines in certain areas studied are not completely susceptible to mud and piping effects leads to more intensive erosion, the expansion of scale of the grooves is an inevitable trend.

It was also reported that for a particular area in the field a stratum associated with factors such as sand waves, lack of sediment sources, etc. was formed which prevented pipeline trenching; and sediment transportation in the area associated with hydrodynamic effect lead to the burial of grooves resulting in an illusion about the pipeline integrity and an intermittent exposure of the groove resulting in large free spans.

High temperature high pressure (HP/ HT) flow can cause the creation of free spans if upheaval buckling takes place due to restricted thermal expansion in buried pipelines [106]. Reduced overburden due to liquefaction may, in some cases, lead to upheaval buckling particularly in high temperature pipelines [41]. Details on upheaval buckling mechanisms and design can be found in DNV RP F110 (2007), Ommundsen (2009) and Bartolini et al. (2011).

For flowlines installed on uneven seabed, the combination of lateral buckles during operation (due to conditions such as pressure and temperature) and shut-downs may cause tension in the pipeline and the development of several free spans [121].

Scour

Several studies [39][14][27][114][16][56][57][58][60][15][11][33][34] [118][28][117][32][119] [91] [112] [17] [62] have been carried out recently under this subject some of which include: The scour processes around pipelines include the onset of scour, the tunnel and lee-wake erosion and then the three-dimensional scour processes. An extensive literature on this can be found in Sumer and Fredsoe [94] where scour depth under various conditions; effects of factors such as pipe roughness, angle of attack, armouring, water depth, shields parameter, pipeline verticality, etc.; width of scour hole under various conditions; time scale in various conditions; effect of sagging on scour; free span length; mathematical modelling; etc. were covered.

According to Gou et al. [35], there may exist two phases in the sand scouring process around pipelines with initial embedment: (a) Phase I: scour beneath pipe without VIV, and (b) Phase II: scour with VIV of pipe.

During Phase II, the pipe vibration amplitude gets larger and its frequency gets smaller whilst the sand below the pipe is being scoured, and finally the pipe vibration and sand scour reaches an equilibrium state. This indicates that sand scouring has an effect upon not only the amplitude of pipe vibration but also on its frequency [35].

Gao and Luo [34], noted that during the onset of scour the influences of soil internal friction angle and pipe embedment on the critical flow velocity for pipeline spanning are significant. The critical dimensionless flow velocity V_{cr} , changes approximately linearly with soil internal friction angle for $0 < e/D < 0.25$. Figure 0-1 shows the criteria for the onset of scour in currents based on analysis by cheng et al [16].

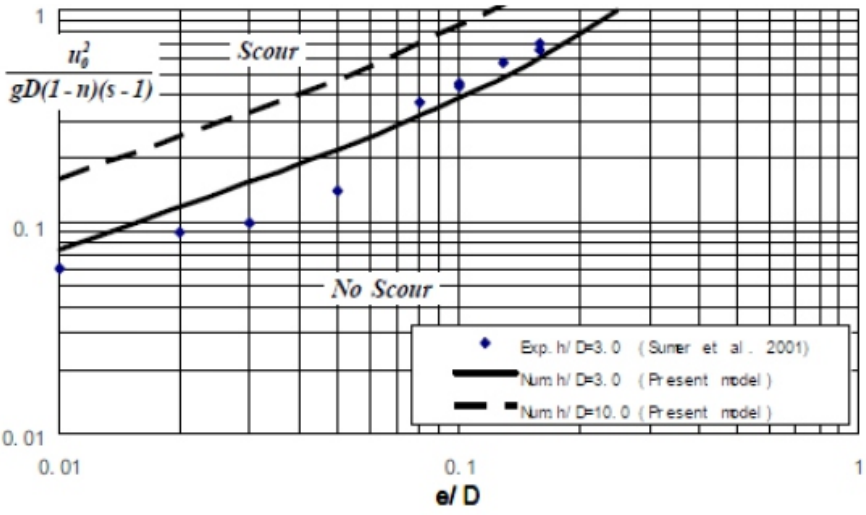

Figure 0-1: Onset condition for scour in currents. Source: Cheng et al [16]

The equilibrium scour depth decreases with increasing initial gap-to-diameter ratio for both fixed pipes and vibrating pipes [33].

According to Wu and Chiew [112], the development of 3D scour below pipelines can be divided into a rapid phase and slack phase. In the rapid phase of the development, the scour hole propagates in a faster and constant velocity; while in the slack phase of development, the scour hole propagates in a slower and reducing velocity. The temporal development of the 3D pipeline scour exhibits three patterns, namely, (1) rapid-phase dominant (2) Rapid and slack phase coexistent (3) slack-phase dominant, which is determined by the balance between environmental force and stability force. Lastly, the propagation velocity is very sensitive to Froude number, F for $0.155 \leq F \leq 0.249$, but not so to the shields parameter θ in the range of $0.014 \leq \theta \leq 0.021$. Cheng and Zhao, [17], revealed that scour development in the span wise direction is primarily caused by the flow velocity around the span shoulders, provided the gap between the pipeline and bed is small.

Mirmohammadi and Ketabdari [62] developed a model claimed to be a powerful tool to simulate complex free surface and Newtonian-non Newtonian fluid interaction problems.

Myrhaug et al [65] provided a practical method for estimating the scour depth below pipelines exposed to nonlinear random waves plus current for wave-dominated flow conditions with $0 \leq U_c/(U_c + U_{rms}) \lesssim 0.4$. Under the condition studied the scour depth below the pipeline can be expressed as Eq. (0-1).

$$S = \hat{S}D \tag{0-1}$$

Where

$$\hat{S} = \frac{S_{scur}}{D}\frac{5}{3}KC_{rms}^{a}\beta^{a}\left(1 + \frac{1}{2}a\beta t\right)exp(2.3b)$$

$$a = 0.557 - 0.912\left(U_{cw1/n} - 0.25\right)^2$$

$$b = -1.14 + 2.24\left(U_{cw1/n} - 0.25\right)^2$$

$$U_{cw1/n} = \frac{U_c}{(\beta + (1/2)t\beta^2)U_{rms} + U_c}$$

Myrhaug et al [66] provided a practical approach for estimating the scour depth below a pipeline exposed to random waves with normal incidence to the pipeline 'in shoaling conditions'. Eq. (0-2) can be used to calculate the scour depth for a certain condition studied.

$$\frac{S}{D} = aU_{RPrms}^{b}\left(E\left[\hat{H}_{1/n}\right]\right)^{3b} \tag{0-2}$$

$$E\left[\hat{H}_{1/n}\right] = \binom{1.416}{1.800} - \binom{0.140}{0.830}k - \binom{0.749}{0.447}k^2 + \binom{0.887}{0.985}k^3 - \binom{0.413}{0.478}k^4;\ \ n = \binom{3}{10}$$

The vibration forces shed from the bottom side of the vibrating pipeline due to currents contribute to an increase in scour depth and scouring is always stronger in the case of vibrating pipe than in the case of the fixed one [32; 119]: The smaller the gap ratio the larger the effect of the pipe vibration. The scour pit underneath a two-degree-of-freedom vibrating pipeline is deeper than that under a pipeline vibrating only in the transverse flow direction. Water depth has a weak effect on the scour depth but it affects the time scale of the scour. The shallower the water depth is, the less time it requires to reach the equilibrium state of the scour.

Cao and Qin [11] studied the relationship between the scour depth and certain factors by numerical simulation.

Sandwaves

Sand waves also referred to as tidal dunes are large scale rhythmic [8] offshore bed forms which develops a prominent regular pattern occurring at water depths of 10 to 50 *m* of sandy seas observed in the continental shelf far from the near-shore region [69; 70].

Steady and superharmonic velocity components are generated by the interaction of the forcing oscillatory tidal current with the bottom waviness [8]; and when the hydrodynamic and morphodynamic parameters (particularly the wavelength of the bottom waviness) gives rise to steady recirculating cells [9] such that the sediment is steadily dragged by these velocity components from the troughs towards the crests of the bottom perturbation. The latter grows and gives rise to sand waves.

Several authors [69; 101; 120] have stated that sand waves can lead to the formation of pipeline free spans. According to Zou et al. [120] due to the movement of sand waves, pipelines may become exposed which may result in free spans, which in turn cause the pipeline to buckle or break.

According to Wei et al. [110], a pipeline laid on sand waves can cause spanning near the crest, and the direction of sand wave movement is a crucial factor for span evolution. Due to sand crest movement the pipeline may sink thereby reducing the dimensions of the span.

Several authors [21] [22] [42] [55][69][70] [49][50][61][69][72] [69] [97] [100][101] [102] [67] [102] have carried out extensive research on the mechanisms of sand waves and others their impact on pipelines [72; 76].

Wavelength of sand waves increases with increasing water depth, tidal ellipticity and grain size (coarse sand), while it decreases with increasing tidal current amplitude and grain size (fine sand). Also, the influence of factors such as sand wave shape, tidal current type, grain size, etc. on factors such as migration speed, wave length, timescale, etc. have been studied [102].

Li et al [55], developed an effective formula Eq. (0-3) to predict the migration rate of sand waves which takes the effects of the environment and the features of sand waves into consideration.

$$c = SIG(\alpha)(\varphi_1\theta + \varphi_2\phi) \quad (0\text{-}3)$$

$$\phi = \omega A\zeta\alpha^2\beta \quad (0\text{-}4)$$

$\theta =$ Shields parameter, $\varphi_1 = 0.013$, $\varphi_2 = 0.86$, $\omega =$ tidal frequency, $A = 0.535Q^2$ (embodies the influence of the wind-driven flow) and $SIG(\alpha)$ a sign function.

Sand waves are usually assumed to migrate in the direction of the residual current. The tidal flow can change the sea floor shape through sand transport; and in turn the shape of the sea floor can then affect the tidal flow, creating a feedback mechanism [102]. According to da Silva et al [21], sediment transport is mainly caused by the oscillatory motions induced by surface short gravity waves.

Nemeth [69], discovered that a steady current inducing an asymmetry in the basic state can cause migration of sand waves; the stabilisation mechanism which causes sand waves to saturate is based on the balance between the shear stress at the seabed and the fact that sediment is transported easier downhill than uphill; the magnitude of the resistance at the seabed and the eddy viscosity influence both the timescale and the height of the fully-developed sand wave among others.

Wavelength of sand waves increases with increasing water depth, tidal ellipticity and grain size (coarse sand), while it decreases with increasing tidal current amplitude and grain size (fine sand) [102]. The speeds of different shapes of sand waves are different and their shapes have an influence on their migration [120].

According to Tonnon et al [102], sand waves grow in the case of dominant bed-load transport (weak tidal currents, relatively coarse sediment, small roughness height, low waves) and decays in the case of dominant suspended transport (strong currents, relatively fine sediment, large roughness height, storm waves).

Komarova and Newell [50] noted that there are at least two mechanisms responsible for the growth of sand banks and sand waves. One is linear instability, and the other is nonlinear coupling between long

sand banks and short sand waves. One novel feature of their work was the suggestion that the latter is more important for the generation of sand banks.

Several authors [8][21][97][42][55][67][68][100][101][102] developed numerical simulation models which has been proven to be able to describe sand wave excitation and select the initially most unstable mode assuming sand waves are free instabilities of the water-seabed system. As a result, several mechanisms and characteristics of sand waves were revealed.

UNDERWATER LANDSLIDES

The action of an underwater landslide can result in the creation of pipeline free spans [41][124]. Submarine Landslides are characterised by outward and downward movement of sediments and rocks sometimes from shallower to deeper regions of the ocean floor. The travel distance of deposits is called the run-out distance and can be several kilometres from the original location. They can be referred to as all types of gravity-induced submarine mass movements such as avalanches, slump and flows [102].

Slope instability is the movement of seabed mass [29]. Submarine landslides/ slumps and submarine flows are classified as types of slope instability. Submarine flows according to the type of sediment can involve grain, debris, liquefaction, and turbidity and these are more liquid than other types of slope instabilities. Debris flows usually involve a combination of fine and granular soils while liquefaction flows involve sands. Unlike liquefaction flows grain flows can only occur on very steep slopes and are usually made up of granular soils.

Slides can either be translational or rotational of which translational slides are the most frequent [20]. Inclination is one of several crucial factors which dictate slope instability. Examples of types of translational submarine landslides include elongate slides and slumps, mudflow gullies, block slides, shallow slab slides, successive slides, collapse depressions, and bottlenecks slides [20; 29].

According to Liu and Rourke [59], one of the causes of damage to offshore pipelines in the Gulf of Mexico during past Hurricanes is Landslides. Deepwater pipelines are at greater risk from landslide impact than other subsea structures because of the increased length of installed pipelines which results in increased exposure to landslide hazards; and due to the small structural resistance of pipelines compared to landslides. Large hurricane waves can trigger mudslides on the seafloor offshore and pipelines can span over failed zones caused by mudslides [72].

According to several authors [37; 54], the triggering mechanisms for landslides include earthquakes and faulting [52], rapid sedimentation, gas and disassociation of gas hydrates [20], ocean storm waves [20; 72], tidal events, human activity, erosion, mud volcanoes, magma volcanoes, salt diapirism, flood events, creep, tsunamis and sea-level fluctuations. An extensive description of each of these mechanisms can be found in Hance [37].

According to Martel [61], landslide scars will tend to have elliptical shapes in map view and width-to-length values ranging from 0.5-1. As the shear fracture spreads, the stress concentration at its perimeter enhances its propagation up towards the surface. Sliding at depth causes and precedes fracturing at the surface. For a shear fracture less than twice as long as its width, surficial fracturing should start in the head and from there 'unzip' down along the slide flanks. Depending on the ambient stress state and whether there is loss in shear strength at the slide base or not, it may be necessary for a shear fracture to be several times wider and longer than its depth to develop a significantly intense stress concentration to propagate out of plane to the surface. This is why many natural slides are characterised by large length-to-thickness ratios. Landslide characteristics include an echelon pattern of opening-mode fractures along the flanks and subparallel to the head scarp trace; a steep, arcuate, concave-downhill head scarp; subsidence and normal faulting near the head of a slide; and uplift with thrust faulting near the slide toe.

Hitchcock et al. [38], developed a geomorphology-based approach to map mudflow susceptibility on the sea floor bottom. Their research was designed to provide regionally-consistent hazard information for the siting and design of pipelines using readily available datasets.

Fernandez-Nieto et al [30] presented a two-layer model of Savage-Hutter type to study submarine avalanches. It was assumed that a layer composed of fluidized granular material flows within an upper layer composed of an inviscid fluid. The model was derived in a system of local coordinates following a non-erodible bottom and takes into account its curvature.

LIQUEFACTION

According to Sumer and Fredsoe [94], liquefaction can be described as the state of the soil where the effective stresses between the individual grains in the bed vanish, and thus the water-sediment mixtures as a whole acts like a fluid. As a result of this, the soil fails resulting in instability of a subsea pipeline. Liquefaction could be induced by either build-up of pore pressure / residual liquefaction or by upward-directed pressure gradient/ transient liquefaction.

The process of liquefaction depends on the wave induced shear stresses in the soil, the pore process and the ground-water flow which are basically governed by the Biot consolidation equations [115].

Inadequate trenching such as in situations whereby the supporting materials under the pipeline are not completely moved away, laying a pipeline on the edge of the groove but not in the groove completely and in cases where the anchor holes expand under piping effect can lead to pipeline spanning [110].

The number and complexity of free spans for pipelines in deepwater can increase substantially depending on the seabed roughness along the pipeline route from the continental shelf break to the deepwater fields [Pereira, 2008].

Spans can be classified into isolated or interacting depending on the soil type and span/span support lengths. For spans with horizontal supports the interaction between spans increases as the soil becomes softer under certain conditions. Again, for a given seabed profile, softer soils tend to have shorter and fewer spans and perhaps less interacting spans than harder soils [104].

STRUDEL SCOUR

Strudel scour can be described as a localized seasonal phenomenon [18] that occurs during spring when melting fresh water in rivers and streams, flow into the sea (such as Beaufort sea and Arctic coast of Alaska which will still be frozen during this period) in such a way that if the frozen river cover encounters a crack, it pours downward through the crack, forming a powerful rotating vortex ('strudel') and a jet directed downwards with high velocities, scouring a hole in the seabed [1;74]. See Error! Reference source not found..

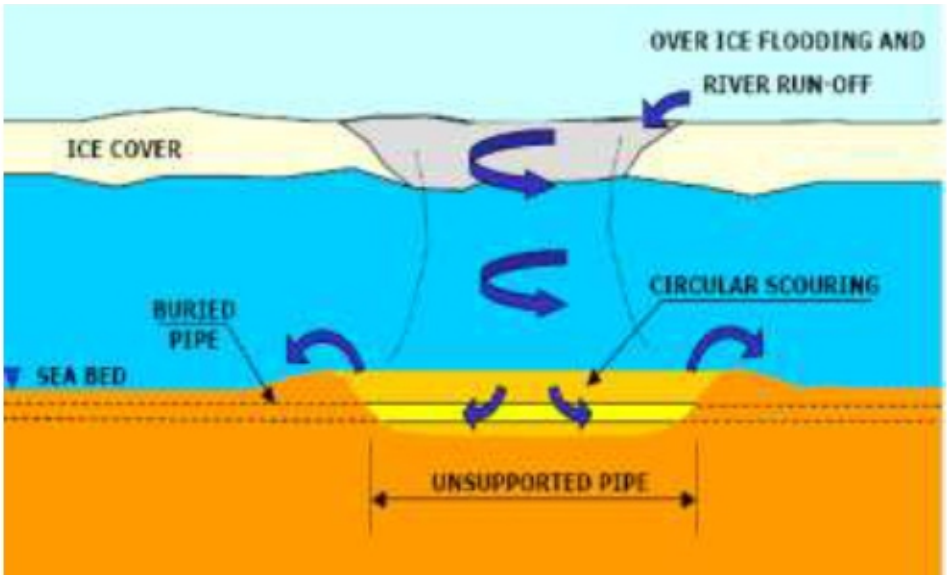

Figure 0-2: A schematic of strudel scour. Source: Abdallah et al [1].

According to Palmer [74], a seabed pipeline, which the scour happened to coincide with may be damaged, due to the high velocity in the jet which could induce so much drag that the pipeline deforms, or might induce vortex-excited oscillations. Given that ice and water above are in isostatic equilibrium, and the water then breaks through a crack, then the driving pressure difference is $(\rho_w - \rho_I)gh$, where $(\rho_w - \rho_I)gh$, where are the densities of ice and fresh water, *g* is the acceleration due to gravity, and *h* is the ice thickness. The velocity in the jet can be estimated from Eq. (0-5).

$$U = c\sqrt{2gh\left(1 - \frac{\rho_I}{\rho_w}\right)} \qquad (0\text{-}5)$$

Where c is the discharge coefficient.

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APPENDIX

Span creation mechanisms

A low depression in the sea floor for example seafloor gullies can induce a free span if the natural curvature of the pipeline is unable to follow the sea bed contour. This depends on factors such as the seabed profile, the type of soil, the residual tension, the pipe flexural stiffness and its submerged weight. The pipeline sags at the middle of the depression which causes increased static bending stresses at the depression boundaries of a free span and at mid-span. The static failure of a free span induced by a low depression can be due to the dead weight of the pipeline and contents causing severe bending stresses in the pipe. As the pipe sags at the middle of the depression, the pipe may be uplifted on each side of the depression causing additional free spans on each side of the depression.

Natural seabed obstructions or elevated obstructions such as boulders, pipeline crossing, rock beams, etc. can cause free spans [89][44]. In this case, the pipe tension has little effect on the static bending stress. The maximum static bending stress occurs at the crest of the span and is the governing stress in this case. As pipe tension increases, the pipeline touch down points on the sea bed will move further

away from the elevated obstruction that is causing the span. This effectively increases the free span length. The stresses however increase only marginally. Therefore an increase in pipe tension will cause an increase in the maximum allowable span length [80].

The residual lay tension depends on the type of installation method used. The effect of the residual lay tension on span creation depends on the pipe weight. A large residual lay tension tends to generate more spans, and increase span length, whereas a heavy pipe will normally rest on seabed, thus reducing the number and length of spans. However, greater tension is necessary during installation to prevent overstress, if the pipe is heavy [44].

The residual tension in the pipe in contact with the sea bed is also dependent on the soil friction. If the anchor point is reached the full residual lay tension remains effective in the rest of the pipe. A pipe which is relatively stiff will tend to develop more and longer spans than a less stiff pipe on the same seabed.

A particular challenge in free span analysis is non-stationary spans. Examples are scour and erosion which have been identified by Mouselli [64]. It is claimed that erosion depends on factors such as bottom currents and soil properties. Due to the cohesion between clay particles it will require a high current velocity to initiate its movement with respect to that of sand, silt or gravel. According to the same author, the movement consists of random rolling and sliding of individual grains. It was claimed that as flow increases, at certain velocities the following occurs: (a) First, more particles roll and slide near the seabed, this motion being referred to as threshold of particle movement (b) Second, with increase in velocity, more particles move with some lifted off the seabed for a short trajectory before falling back on the seabed whereby the particle transportation can be referred as siltation of sediment. (c) An increase in turbulence will result in some of the particles being lifted increasingly higher above the seabed until they are in suspension and can be transported with flow. (d) At extremely high flow rates, the flow will cause ripples whereby the suspended particles are free to travel in the mixed flow until the velocity decreases to a level such that the particles cannot remain in suspension any longer. This velocity can be referred to as the settling velocity.

Submarine mudslides have been identified as being associated with pipeline spanning. It was claimed that a development sequence for mudslide evolution and elongation include three major stages. An extensive work on this subject can be found in Prior and Suhayda [79].

Other mechanisms which have been reported to cause soil movements at the seabed include turbidity, rapid soil deposition on steep slopes and passage of large surface waves. Factors such as gravity forces,

waves, etc. are associated with sediment instability. Also, finite element analyses (FEA) has been used to calculate wave induced seabottom movements, where the effect of gravity, cyclic and permanent soil movements were considered (Wright (1976) as cited in Mouselli [64]).

An extensive literature on this can be found in Mouselli [64].

The number and complexity of free spans can increase significantly depending on the seabed roughness along the pipeline route. Spans could be classified into interacting or isolated based on the soil type and span/ span support lengths. Table 0-1) shows an overview of the characteristics of free spans.

Table 0-1: Characteristics of free spans. DNV RP F105 [103]

L/D	< 30	30 < L/D < 100	100 < L/D < 200	L/D > 200
Desctiption	Short free span caused by local unevenness in or at the start of erosion of the seabed.	Free spans in form of fully developed scour holes created as a result of erosion	Long free spans formed due to uneven seabed.	
Response	Very little dynamic amplification	Resp onse dominated by beam behaviour	Resp onse dominated by combined beam and cable behaviour.	Response dominated by cable behaviour.

According to Alam and Cheng [3], for live bed conditions, the net effect of superimposing a current on waves is to make the downstream width of the scour hole larger and the upstream width slightly smaller, probably due to the effect of the lee-wake the critical regime of the 2-D scour process is up to one pipe diameter away in both directions from the middle of unsupported length of pipelines (See Figure 0-1).

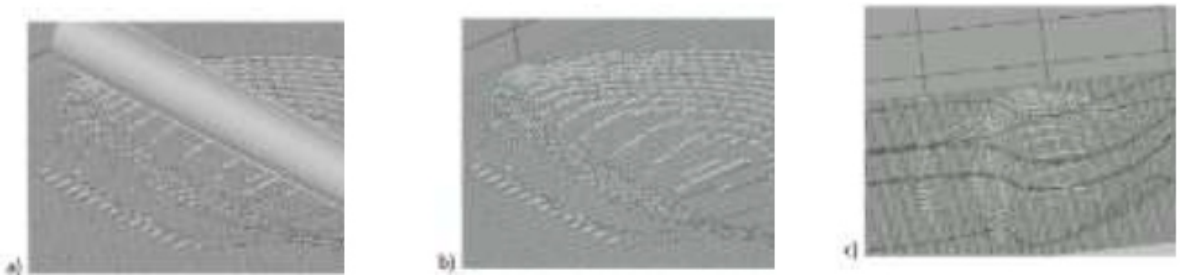

Figure 0-1: Equilibrium scour bed profiles presented with or without cylinder and selected streamlines. Source: Alam and Cheng [3].

It was claimed that for a pipeline laid on the seabed, for every 35 feet installed 1 foot was spanned initially and after five years of operation, for every 15 feet installed, 1 foot was spanned. The freespan length is governed by the following effects:

(1) Changing flow conditions: When the flow velocity is below the threshold value for the onset of scour, a developing free span may stop growing.

(2) Changing soil conditions: When the support reaches a non-erodible bed area, further development of the free span will be hindered.

(3) Sinking of the pipeline at the span shoulder: This will stop the development of a free span as the 3-D scour process will be terminated. This may be as a result of shear failure or liquefaction. Liquefaction potential is a function of the relative density of the soil, the permeability, the presence of the pipe, influence of stress history, etc.

(4) Sagging of the pipeline in the scour hole: As the pipe sag and reaches the bed, the free span length will be cut into half.

The span length can be calculated using Eq. (0-1).

$$L = 3.35 D^{\frac{1}{4}} L_s^{\frac{3}{4}} \qquad (0\text{-}1)$$

Where L_s is the stiffness length and is defined as

$$L_s = \left(\frac{EI}{p}\right)^{1/3}$$

The scour model developed by Alam and Cheng [3] was able to predict stream-wise and span-wise propagations of scour with respect to lattice unit of time and the shape of the stream-wise equilibrium scour hole. The speed of propagation of scour along the pipeline length maintains an almost constant rate. The scour slope at the shoulder region remains fairly constant throughout the whole scour process. The scour process along the stream-wise direction is stronger than that of the span-wise direction [3].

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Study on Information Retrieval Through Opinion Mining

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A B S T R A C T

Modern opinion mining techniques are divided into "property driven strategies" and "sentiment-driven techniques". The essential thought is to utilize credit or sentiment catchphrase to find opinion candidates by applying certain opinion examples to extricate sentiment articulations, accordingly filtering the false opinion candidates. The technique's downside is that it yields higher precision at the cost of a large review loss as generalization ability isn't implied. The issue is expected to "Out-Of-Vocabulary (OOV)" qualities

Keywords: Opinion, mining, techniques, sentiment, etc.

1. INTRODUCTION

Opinion Mining is the combination of information retrieval and computational linguistic techniques dealing with opinions in a document. It plans to take care of issues related to opinions of items, politics in newsgroup posts and survey sites. Before the World Wide Web clients solicited opinions from family and companions to buy items so also, when associations expected to take choices on items they directed overviews of centered gatherings or enlisted outer consultants. Opinion mining facilitates clients to take choices by reviewing clients remarks posted on web communities, web journals, twitter, and item's sites.

Opinion Mining or Sentiment Analysis separates opinionated content data sets summarizing them in an understandable frame for end clients. It extricates "positive", "negative" or "nonpartisan opinions" from unstructured data. It involves computational management of opinion and content subjectivity. Natural Language Processing (NLP) handles content element processing which is changed to machine arrange by NLP.

Artificial Intelligence (AI) utilizes NLP provided information applying maths to determine whether an opinion is certain or negative. Different techniques exist to determine a client's view on subjects from natural language literary information. Machine learning is utilized with varying viability in classifying of opinions.

Numerous approaches are utilized in opinion mining, the most widely recognized being "dictionary based and machine learning". In vocabulary, straightforward content representation is a "sack of-words"

approach where documents are considered as a collection of words without considering relations between individual words. Opinion vocabularies are resources associating sentiment orientation and words. The strategy's downside is that a word considered positive in a situation can be considered negative in another. In machine learning approach, classifiers classify documents as positive or negative. Standard machine learning strategies perform well, however require a commented on corpus to train a classifier.

2. DIFFERENT TYPES OF OPINIONS

Different opinion types are portrayed (Liu 2012):

- Regular opinion: It has two main sub-types: Direct opinion and indirect opinion. Opinions communicated directly on an element or substance angle is direct opinion, e.g., "The photo quality is extraordinary." Whereas an opinion communicated indirectly on an element based on its impact on different elements is indirect opinion.
- Comparative opinion: This communicates a relation of likenesses or differences between at least two elements and/or a preference of opinion holder based on elements shared perspectives. It is communicated using comparative or superlative type of an adjective or adverb
- Explicit opinion: An emotional proclamation that gives a regular and comparative opinion, e.g., "Coke tastes extraordinary," and "Coke tastes superior to Pepsi."
- Implicit (implied) opinion: An objective proclamation implying a regular or comparative opinion. Objective articulations express an attractive or unwanted certainty, e.g., "I purchased the sleeping cushion seven days back, and a valley has shaped," and "The battery life of Nokia telephones is longer than Samsung telephones."

3. TOOLS USED IN OPINION MINING

A portion of the tools used to track opinion or extremity from client generated substance are:

- "Review Seer Tool": Used to robotize crafted by aggregation sites. Credulous Bayes classifier approach gathers positive or negative opinions to relegate a score to the extricated include terms.
- "Web Fountain": It utilizes the "Beginning definite Base Noun Phrase (bBNP) heuristic approach" to separate item features. It can develop a basic web interface.
- "Red Opal": It is a device which empowers clients to determine the items opinion orientations based on their features. Results are appeared with an electronic interface.
- "Opinion Observer": An opinion mining system to examine or analyze opinions on the Internet using client generated substance. It utilizes "WordNet Exploring strategy" to appoint earlier extremity.

4. APPLICATIONS OF OPINION MINING

Opinion mining applications help distinguish issues by reviewing, ensuring an accurate reflection of reality. Opinion mining technology has enormous scope for down to earth applications like:

- Individual Consumers: When an individual needs to buy an item, it is valuable to see an opinions rundown of current clients with the goal that he or she can settle on an informed choice.
- Organizations and Businesses: Opinion mining is critical for an item maker to know how consumers see its items and that of the contenders which shapes the reason for marketing and item bench marking and for item design and item developments.
- Argument mapping software sorts out logically such policy articulations, by explicating their logical links. In Online Deliberation, tools like "Summary, Debatepedia, Cohere, Debate diagram" were developed to guarantee a logical structure to numerous policy proclamations, and link arguments with proof to back it up.
- Voting Advise: Help voters understand which political gathering (or voters) has nearer positions to the policy proclamations with theirs.
- Automated Content Analysis: Processes voluminous qualitative data using numerous tools to recognize relevant remarks and appoint positive or negative sentiment to it.

5. DOCUMENT SENTIMENT CLASSIFICATION BASED ON MACHINE LEARNING METHODS

Machine learning applicable to sentiment analysis belongs to directed classification. In machine learning classification, two documents sets: training and test set are required. A training set is used by a programmed classifier to differentiate document characteristics and a test set validates the programmed classifier performance. Many machine learning techniques were adopted to classify reviews (Vinodhini and Chandrasekaran 2012). Machine learning techniques like "Naive Bayes, maximum entropy, and SVM made progress in content arrangement". The other well-known machine learning methods in NLP are "K-Nearest Neighborhood (KNN), C5, ID3, winnow classifier, centroid classifier, and N-gram model".

Sentiment classification builds a content classifier by extracting affiliation decides that partner a document's terms and its classifications, by modeling content documents as an exchanges collection where an exchange represents a content document and things in the exchange being terms selected from a document and classifications a document is allocated to. Numerous words used as features are considered while classifying a document, however just couple of words in a corpus express sentiment. The additional features must be eliminated as they slow down document classification because of the nearness of a greater number of words than required. Likewise, it reduces accuracy as a classifier

considers such words when a document is being grouped. Using less features is advantageous and so selection is depended on evacuate the pointless features. Feature selection as the name recommends, is a procedure wherein a corpus is gone through before a classifier is trained to evacuate pointless features enabling a classifier to fit a model to an issue set speedily as there is less information to consider resulting in enhanced accuracy.

6. INVESTIGATION OF EXISTING TECHNIQUES FOR OPINION MINING

The prominent IMDb dataset is investigated for identifying opinion as positive or negative using machine learning techniques. Additionally medical queries obtained from different blogs are likewise investigated. Computational investigation of opinions, sentiments and feelings in content is called sentiment analysis or opinion mining. Opinion holders are people or organizations expressing opinions. Opinion holders are the post's writers in item reviews and blogs and they are vital in news articles as they plainly express that a man or association has a particular opinion. An opinion on a feature f (or object o) is a positive or negative view or examination on f (or o) from an opinion holder's viewpoint. Positive or negative represents opinion orientations.Opinions have a major role in decision-making. At the point when individuals need to choose, they hear others' opinions and when it is regarding consuming significant resources like time and cash, individuals rely especially on companions past understanding. A paradigm move from a read-just to read-compose Web gave individuals tools to make and offer their substance, thoughts and opinions with others on the World Wide Web cost-efficiently. The ability to look for public opinions on item preference, political developments, social occasions, marketing campaign, and friends strategies made interest in the logical and business communities. It made interest on upcoming difficulties and in the last for fall outs in marketing and financial market prediction.

It is hard to mine opinions or sentiments from natural languages as it requires a profound understanding of those languages explicit and implicit, regular and irregular, syntactical and semantic principles. Current methods rely on content parts where opinions or sentiments are communicated in influence words, extremity terms and co-occurrence frequencies. Opinions or sentiments are passed on through latent semantics ensuring that syntactical approaches are ineffective.

An essential technology in OM and sentiment-analysis applications is of classification including relapse and ranking. Why classification is critical is on the grounds that many interesting issues are defined by applying classification or relapse or ranking to textual units. Binary classification labeling of opinionated documents expressing in general positive or negative opinion is sentiment extremity classification or extremity classification. With increased opinion-rich resources availability like online reviews or individual blogs, opportunities and difficulties are accessible as individuals actively utilize

information technology to search out and understand others opinions. A sudden ejection of OM and sentiment analysis action which manages opinion, sentiment and subjectivity's computational treatment occurred as a result of a direct reaction to interest in new systems handling opinions as five star objects directly.

In this section, the prevalent IMDb dataset is used to classify the review as positive or negative and used as bench check for assessing the medical service dataset. Commotion is evacuated using stop words and stemming. Features are extricated using Inverse Document Frequency and three classifiers Naïve Bayes,AdaBoost and Fuzzy Lattice Reasoning classifiers are trained and tried.

7. CONCLUSION

This examination work proposes a semantic based component selection for OM where the sentiment passed on in a survey is centered around. Sentiment is delegated positive or negative by extracting and classifying features from audits. Motion picture audits opinion is examined and delegated positive or negative. Features are removed from surveys using Inverse document recurrence and audits characterized using Naïve Bayes, AdaBoost and FLRC classifier. Results demonstrate that Naïve Bayes achieves the best order. Advance investigation based on directed learning ought to be attempted to enhance order.

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