FUNGI ASSOCIATED WITH SUYA SOLD IN PORT-HARCOURT METROPOLIS

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Abstract
This study aims at isolating and identifying the fungi associated with suya (meat) sold in Port-Harcourt Metropolis. Samples were collected from different areas in Port-Harcourt Metropolis: Trans-Amadi Diobu, GRA, and Borokiri all in Rivers State, Nigeria. The study shows that the fungi isolated from the samples (Balangu, Kilishi and Tsire) were identified as Aspergillus niger, Aspergillus flavus, Penicillium sp., Rhizopus stolonifer, Candida sp., Fusarium sp., Alternariasp., and Mucor sp. Out of the twelve (12) samples from the four {4} different areas, Rhizopus stolonifer had the highest percentage occurrence (30%) in Trans-Amadi sample, Diobu (30%), GRA (20%) and Borokiri (10%). This is followed by Penicillium sp.: Trans-Amadi (30%), Diobu (20%), GRA (20%), Borokiri (10%). Mucor sp.: Trans-Amadi (20%), Diobu (20%), GRA (20%), Borokiri (20%). Aspergillus flavus: Trans-Amadi (10%), Diobu (10%), GRA (20%), Borokiri (30%). Aspergillus niger: Trans-Amadi (20%), Diobu (20%), Borokiri (30%), GRA no isolate. Fusoriumsp.: Trans-Amadi (20%), Diobu (10%), GRA (10%) and Borokiri (20%). Candida sp.: Trans-Amadi (10%) Diobu (10%) GRA (10%), Borokiri no isolate. Lastly Alternaria sp.: Trans-Amadi (10%), Diobu (10%), GRA no isolate and Borokiri (10%). Trans-Amadi area had the highest percentage occurrence 150%, followed by Diobu 130%, Borokiri 110%, and GRA 100%. This study showed that ready-to-eat meat (suya) sold in Port-Harcourt Metropolis was highly contaminated with different fungi species, this cafl for strict and serious public health regulations regarding the sales of suya by vendors.
Keywords: Borokiri, Diobu, Fungi, GRA, Isolates, Port-Harcourt Metropolis, Trans-Amadi.

Introduction

Suya is a smoked or roasted spicy or barbecued meat made ready-to-eat. It is traceable to the Hausa people of Northern Nigeria, where their primary occupation is rearing of cattle and the growing of crops. Hence it is an important mainstay and major source of livelihood for the people. The occupation has led to the production of different types of beef products such as kundi, kilishi, balangu and suya, [tsire], which are very rich sources of protein food. Interestingly, amongst the identified beef products, suya is now the most popular as it is consumed in other parts of the country (Inyang *et* a/., 2005).Suya mean and include a specially sliced meat delicacy prepared and presented for consumption. Of course the genesis of the consumption of suya delicacy in Port-Harcourt could be traceable to the inception of the Hausa people being that this is their main and primary occupation. Meat of course is one of the main sources of protein to the body; therefore suya which is a delicacy from meat has become a proteineous fast food to the inhabitants of Port-Harcourt metropolis. Although the Hausa communities could be located at the aforementioned places like Slaughter Area, Mile One, Town, etc. Nevertheless, the sale and consumption of suya is not restricted to these communities as they migrate to other areas within or even outside the Port-Harcourt metropolis. Even in GRA's {Government Reserved Areas) and specialized ceremonies in various communities in Rivers state, Suya meat is sold. Knowing therefore that the oil city of Port-Harcourt hosts both indigenes and non-indigenes who all are consumers of the suya delicacy, the preparation, presentation and sale of suya is therefore of concern nolt only to the Government, the multi-national oil companies, non-Governmental organizations, Educational institutions, other religious bodies and of course the various families. This, no doubt needs serious attention because being a fast food already prepared for consumption, it does not require any other preparation before it is consumed. Therefore, its preparation and presentation need thorough sanitary control as to avoid food poisoning and its related infections (Igene and Abulu, 2004). Indeed, it is in view of several indiscriminate infections which are traceable to this proteineous fast food (suya) consumption that necessitated this study as tremendous deaths and several illnesses have been attributed to the consumption of suya.

To Abdullah! *et al.* (2004), suya is prepared basically from boneless meat of animals. The meat is thinly sliced and marinated in various spices which include peanut cake, salt, ginger and other flavorings and barbecued (Egbebi and Seidu, 2011). Usually, suya is served with further helpings of dried pepper mixed with spices and sliced onions. It is worthy of note that there is no standard recipe for the complex mixture of spices and additives which make up the suya marinade (called yaji in Hausa language) and the spice mix and served with it (Ugwuja *et al.,* 2009). The ingredients used in suya spice for taste vary according to personal and regional preferences and include garlic, clove, ginger, chili pepper, negro pepper, salt, peanut cake as well as food additives such as monosodium glutamate and maggi cube in some cases (Ugwuja *et al.,* 2009). One of the most important stages during the production of suya is the addition of spice because it is a critical control point; it is equally added to the suya after processing (Shamsuddeen and Ameh, 2008).

Suya has been a major source of protein; it also has been linked with high microbial load whose major source is from the spice. Spices are potential hazard, especially if they are added to the end of cooking or to foods prepared without further cooking. Nevertheless, they are not the major sources of food-borne diseases (Little *et al.,* 2003). Thus, since all spices are susceptible to a variety of microbial contamination, protection of human health lies in the application of good manufacturing anddistribution practices. Indeed, it has been a source of concern all the years as these microbial contaminations has always been linked to poor handling during the production of the spice and this has led to food poisoning. It is therefore imperative now to research and determine the effect of consuming suya spiced and a more hygienic way of producing and applying this spice to reduce food safety risk. Although spices are used in small quantities, they are recognized as significant carriers of molds and some bacteria (Romagnoli et *al.,* 2007). While molds and yeasts are the most common contaminants, majority of them are probably commensal residents on the plant.Both molds and yeasts devalue the nutritive quality of food and create a potential risk for human health with the production of toxic metabolites known as mycotoxins. To Frazier and Westhoff (2006), spices do not have a marked bacteriostatic effect in the concentrations used in meat products and they even serve as source of contamination of processed product. Occurrence of these microorganisms that are potentially pathogenic in the spices that is used in suya preparation is considered as one of the major gastrointestinal disturbances and food poisoning resulting from the consumption of suya in Nigeria (Ejiekwu and Ogbonna, 2008). Furthermore, no attempt has been made to reduce the microbiological load and food safety risks associated with this popular protein food like suya. This experience is not a welcome one especially in this part of the world where protein consumption in the diet is very low compared with the consumption of Carbohydrate-rich food, hence the consumption of products such as suya should be encouraged. Price and Schweigert (2001), assert that unless spices are treated to decrease their microbial load, they may add high numbers of undesirable organisms to food in which they are used.lt is as a result of these findings that this research was set up with the aim of assessing pathogens (fungi) associated with suya especially the spices used in the preparation of the suya meat, as well as to investigate toxins produced by the isolates and its health implications.

Meat contains an abundance of all nutrients required for the growth of fungi - yeasts and molds. Molds are important in food because they can grow even in conditions in which many bacteria cannot grow such as low pH, low water activity (a_w), and high osmotic pressure. Many types of molds are found in foods. They are important spoilage microorganisms. Examples of common genera of molds found in food are; *Aspergillus* - members of these genera have the ability to cause food spoilage, *Alternaria,* members can cause rot in tomatoes and rancid flavor in dairy products; *Fusarium,* cause rot in citrus fruits, potatoes and grains; *Geotrichum,* causes spoilage of dairy products., *Mucor,* causes spoilage of vegetables; spoilage of meat, breads and grains and *Rhizopus* causes spoilage in many fruits and vegetables. Yeasts are also important in food because of their ability to cause spoilage. Several genera are *Saccharomyces, Pichia, Rhodotorula, Torulopsis, Candida* and *Zygosaccharomyces.* Yeasts and molds are found on meat with respect to fungal spoilage of fresh meats especially beef, the following genera of molds have been recovered from various spoilage conditions of whole beef (Dillon and Board, 2001). The genera of mold most often found on meat are; *Thamnidium, Mucor and Rhizopus,* all of which produce "Whiskers" on beef; *Cladosporium,* a common cause of "blackspot"; *Penidllium,* which produce green patches, and *Sporotrichum* and *Chrysosporium,* which produce "white spot". Molds generally do not grow on meats if the storage temperature is below 5°c. Roasted meat or beef tend to undergo surface spoilage by molds on available moisture.Molds tend to predominate in the spoilage of beef cuts when the surface is too dry for bacterial growth or when beef has been treated with antibiotics such as the tetracycline. Molds virtually never develop on meats when bacteria are allowed to grow freely (Jay *et al.,* 2007). The reasons appear to be that bacteria grow faster than molds, thus consuming available surface oxygen, which molds also requires for their activities.Microbial contamination has been reported to be the cause of food illness and spoilage and many of these microbes are fungi (Nwaimu and Imo, 2006). Fungi are ubiquitous or cosmopolitan (i.e. they are present everywhere), air, water and soil and even on and inside man, as explained by Jonathan *et al.,* (2010). They are a group of organisms known to be good "biodegraders" of waste, many of which have different characteristic mode of converting waste of living and dead tissues of various products such as plant products, agricultural products, wood and paper products, dead animal tissues and chemical wastes. Most fungi are generally more tolerant to high concentrations of many pollutants than bacteria; this explains why fungi have been investigated (Romagnoli *et al.,* 2007). Many groups of fungi, mostly filamentous (Deuteromycota) fungi such as *Penicillium, Aspergillus, Fusarium, Rhizopus* and *mucor* have been successfully isolated from some spices and some street vended foods (Ahmeh *et at.,* 2007). These fungi are involved in food spoilage, an activity which is common among the molds which results in the reduction of food value/nutrient of the particular food.

Suya in Nigeria lack hygienic control and the risk of food-borne infections is high. Some researchers elsewhere had noticed sporadic cases of gastroenteritis and symptoms of infection after consumption of suya which indicated that the product indeed constitute a food safety risk. Suya in Nigeria poses potential hazard particularly the spice that is added to it at the end of preparation (roasting), no further preservative measures are taken, this serves as a public health issue, without the awareness of many Nigerians. Also fungal contamination of suya has not been given much attention or priority, knowing the implication of consuming food contaminated with fungal toxin, it is now imperative to study in order to create the awareness of the effect of consuming suya that is contaminated with fungal. This will make people understand the risks involved in consuming roadside suya.Suya is traditionally processed and is usually not prepared with hygiene condition because they are done locally. It is one of the intermediate moisture products that are easy to prepare and highly relished. Literature has it that microbial organisms isolated from suya are of public health significance. Harris *et at.,* (2005), pointed out that suya is a delicatessen item since it does not receive any treatment that is designed to extend its shelf-life. They said that most sale points hardly exhaust their sales and leftovers are often carried over to the next day or beyond. To this extend, rancidity often occur leading to the contamination and spoilage of suya product - consequently poisoning. Roister *et at.,* (2005), confirmed that the contamination of suya was due to old newspaper that is used to wrap the meat or nylon bags or cellophane. They concluded that materials used in preparation and packaging, the handlers and the surrounding environment can serve as sources of contamination to the food product. In the same vein, Roister *et al.,* (2005), pointed out that the unhygienic condition of meat processing plants, insufficient cleaning of slaughter environment and other equipment are the most important sources of suya contamination by toxicogenic molds. They isolated psychotropic molds such as *Aspergillus* sp., *Cladosporium* sp., *Geotrichum* sp. and *Rhizopus* sp. from suya surface. Lawrie and Ledward, (2006), also found out that molds that commonly infect suya are: *Penicillum* sp., *Mucor, Cladosporium, Atternaria, Sporotrichum* and *Thamnidium.* Edema *et al.,* (2008), evaluated the microbial hazards associated with processing of suya, reported that processing water, meat processing slabs, utensils, spices and inadequate heat cause contamination with potential pathogen such as aflatoxigenic molds with aerobic mesophilic counts in order of 10^5cfu with the highest value (7.17), observed in processing water, and other microbes such as *Bacillus cereus, staphylococcus aureus,* and *Salmonella* species.

According to Price and Schweigert, (2001), unless spices are treated to reduce their microbial content, they may add high number of undesirable kind of organisms to food. Many scholars such as Baxter and Holzaptel, (2002), Garcia et *al.,* (2000), also confirmed that spices may provide an avenue to introduce food spoilage and pathogenic organisms to a wide range of meals. Nevertheless, Little *et al.,* (2003), revealed that spices are potential hazard particularly if they are added at the end of cooking or to food prepared without further cooking. Jonathan et *al.,* (2010), pointed out that microbial contamination of spices has been reported to be the cause of food illness and spoilage. They also found out that many groups of fungi, mostly molds such as *Aspergillus, Penicillium, Fusarium, Mucor, Rhizopus* etc. have been successfully isolated from spices and some street vended foods. As such it becomes imperative that a serious attention is paid to the use of spices in foods; especially the ready to eat foods like suya that are not subject to further treatments before consumption.

Materials and Methods Study Area

Samples were collected from four (4) different locations in Port-Harcourt Metropolis, Rivers state, Nigeria. These locations were chosen because they are well known and famous in Port-Harcourt and include Port-Harcourt Township (Borokiri), Trans-Amadi Industrial Area (Slaughter), Mile one (Diobu) and Government Reserved Area (GRA).

Collection of Sample

A total of 12 samples comprising 4 each of 3 differently prepared ready-to-eat Suya (Balangu, Tsire and Kilishi) were purchased from vendors. The Suya samples were immediately wrapped separately with sterile Aluminium foil and transported to the department of Biology laboratory of Ignatius Ajuru University of Education, Rumuolumeni, Port-Harcourt, Rivers state for Studies.

Media and Sterilization

All the glass wares used for the experiments were properly washed, dried and sterilized in the oven at 160°c for one hour. The entire working surfaces were also disinfected with ethanol to reduce contamination. Potato Dextrose Agar was used for the isolations. Sixteen gram (16g) of the powder was weighed and poured into a conical flask and 400ml of sterile distilled water was added into the conical flask. Further sterilization was performed by autoclaving at 121*0 for ISminutes. The medium was brought out of the autoclave and allowed to cool, after which it was poured into 24 plates, 6 sterile petri dishes each according to the different sample and allowed to solidify.

Sample Preparation

The purchased Suya samples were removed from the aluminum foil and cut into small (tiny) pieces with sterile surgical blade. The different samples were inoculated into the agar plate aseptically using direct plating technique and incubated at 28°c for 3 days.

Isolation of Fungi

After incubation of the plates at 28°c for 3 days, discrete colonies were isolated using inoculating needle which was sterilized by flaming in the Bunsen burner. The isolated colonies were sub-cultured on freshly prepared PDA in plates to obtain pure cultures.

Identification of Isolates

Fungal isolates were identified based on their macroscopic, colony morphology and microscopic characteristics as recommended by Frazier and Westhoff, (2006).

Results

The fungal isolates from different samples of Suya were *Aspergillus niger, Aspergillus flavus, Penicillum* sp., *Rhizopus stolonifer, Candida* sp. (yeast), *Fusarium* sp., *Alternaria* sp. and *Mucor* sp. as shown in tables below: Table 1 shows the morphological characteristic of fungi isolates, table 2 shows the fungi isolated from the different suya types, the result obtained in table 3 shows the fungi associated with suya samples at Trans-Amadi area, that of table 4, shows the fungi associated with suya samples from Diobu axis, table 5 shows the fungi associated with the suya samples of GRA, and table 6 shows the fungi associated with suya samples of Borokiri area. The result obtained in table 7 shows the percentage occurrence of fungi in the suya samples.

Table 1: CHARACTERIZATION AND IDENTIFICATION OF THE ISOLATES

Isolate	Characteristics & morphology	Microscopic Features
Aspergillus niger	colonies appear black with fast growing mycelium with spores.	smooth conidiophores, hyaline has spherical spore heads, double sterigmata, Conidia head uniseriate.
Aspergillus flavus	light yellow mycelium	has spherical spore heads, conidiophores are heavy walled, hyaline coarsely roughened.
Penicillium sp.	conidiophores are borne from subsurface or surface, hyphae colonies appear grayish green and later turns white.	have spherical conidia, long septate, hyaline sporangiophore bears terminal sporangium.
Rhizopus stolonifer	spherical sporangia initially white but later black with numerousspores, stolon hyaline becoming brown towardsnodes, light brown mycelium.	sporangia resembles black pin heads and are widely interspersed in cotton wood-like mycelium. Non-septate hyphae, dark-spherical sporangia at terminal.
Candida sp.	colonies appear yellowish-green	hyphae are septate with conidiophores arrangedat the top hyphae.
Fusarium sp.	produces abundant micro-conidia, fluffyspread creating white mycelium	they are hyaline, abundantly uniform micro-conidia are formed in long chains.
Alternaria sp.	colonies appear pink	chains of conidia are produced at the beak of a spore
Mucor sp.	appears white with numerous fluffy spores, hyaline septate	sporangia bear black heads, conidia heads are in chains and dispersed

Table 2: Fungi isolated from different suya samples

Fungi	Balangu	Tsire	Kilishi
Aspergillus niger	+	+	-
Aspergillus flavus	-	+	+
Penicillium sp	+	+	-
Rhizopus stolonifer	+	+	+
Candida sp.	-	+	-
Fusarium sp.	-	+	-
Alternaria sp.	-	+	+
Mucor sp.	-	+	+

(+): Isolated (-): Not isolated

Table 3: FUNGI ASSOCIATED WITH SUVA SAMPLES AT TRANS-AMADI

Xerophilic fungi isolated	BST	TST	KST
Aspergillus niger	+	+	-
Aspergillus flavus	-	+	-
Penicillium sp.	+	+	+
Rhizopus stolonifer	+	+	+
Candida sp.	-	+	-
*Fusarium*sp.	+	+	-
*Alternaria*sp.	-	-	+
Mucor sp.	-	+	+

(+): isolated (-): not isolated, (BST): Balangu Sample at Trans-Amadi, (TST): Tsire sample at Trans-Amadi, (KST): Kilishi Sample at Trans-Amadi.

Table 4: FUNGI ASSOCIATED WITH SUVA SAMPLE AT DIOBU

Xerophilic Fungi Isolated	BSD	TSD	KSD
Aspergillus niger	+	+	-
Aspergillus flavus	+	-	-
Penicillium sp.	-	+	+
Rhizopus stolonifer	+	+	+
Candida sp.	-	+	-
*Fusarium*sp.	-	+	-
*Alternaria*sp.	-	+	-
Mucor sp.	+	-	+

(+): isolated, (-): not isolated, (BSD): Balangu sample at Diobu, (TSD): Tsire sample at Diobu, (KSD): Kilishi sample at Diobu.

Table 5: FUNGI ASSOCIATED WITH SUVA SAMPLE AT GRA

Fungi isolated	BSG	TSG	KSG
Aspergillus niger	-	-	-
Aspergillus flavus	+	+	-
Penicillium sp.	+	-	+
Rhizopus stolonifer	+	+	-
Candida sp.	-	+	-
*Fusarium*sp.	+	-	-
*Alternaria*sp.	-	-	-
Mucor sp.	-	+	+

(+): isolated, (-): not isolated, (BSG): Balangu sample at GRA, (TSG): Tsire sample at GRA, (KSG): Kilishi sample at GRA.

Table 6: FUNGI ASSOCIATED WITH SUVA SAMPLES AT BORIKIRI

Xerophilic fungi Isolated	BSB	TSB	KSB
Aspergillus niger	-	+	-
Aspergillus flavus	+	+	+
Penicillium sp.	-	-	+
Rhizopus stolonifer	-	+	-
Candida sp.	-	-	-
*Fusarium*sp.	+	+	-
*Alternaria*sp.	-	+	-
Mucor sp.	+	-	+

(+): isolated, (-): not isolated, (BSB): Balangu sample at Borokiri, (TSB): Tsire sample at Borokiri, (KSB): Kilishi sample at Borokiri.

Table 7: PERCENTAGE OCCURENCE OF FUNGI IN THE SUYA SAMPLES.

S/N	Organisms identified	Number of plates	% Identification
1.	*Aspergillus niger*	5	50%
2.	*Aspergillus flavus*	7	70%
3.	*Penicillium* sp.	8	80%
4.	*Rhizopus stolonifer*	9	90%
5.	*Candida* sp.	3	30%
6.	*Fusarium*sp.	6	60%
7.	*Alternaria*sp.	3	30%
8.	*Mucor* sp.	8	80%

Key: each sample plate represent 10%

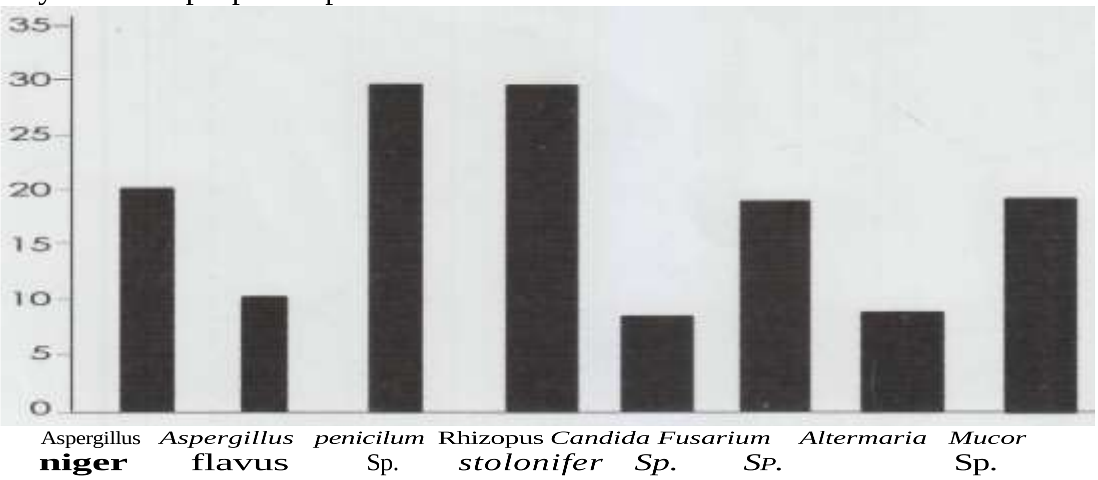

Figure 1: GRAPH OF PERCENTAGE OCCURRENCE OF FUNGI ISOLATES AT TRAS-AMADI SAMPLE.

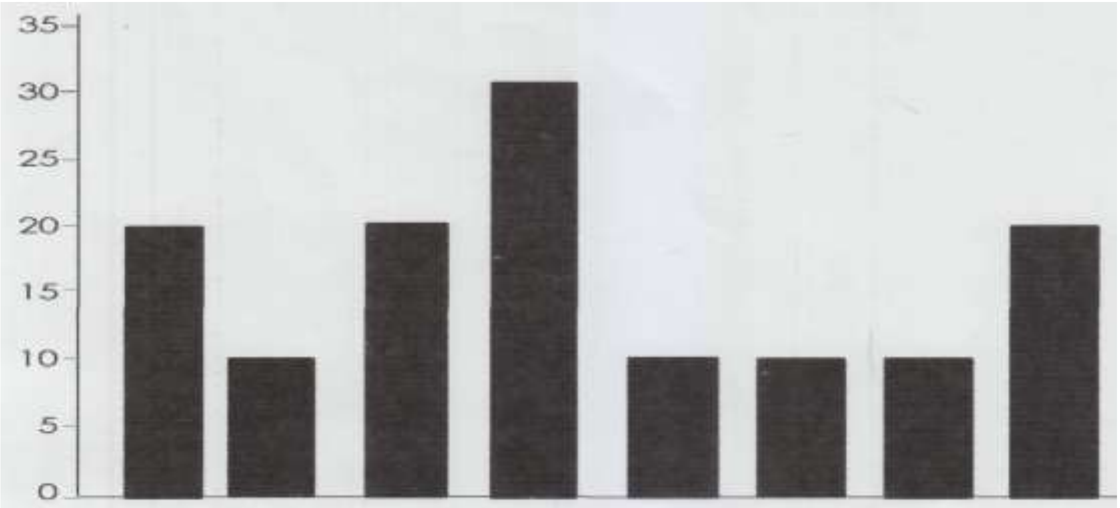

FIGURE 2: GRAPH OF PERCENTAGE OCCURRENCE OF FUNGI ISOLATES AT DIOBU SAMPLE

Figure 3 : GRAPH OF PERCENTAGE OCCURRENCE OF FUNGI ISOLATES AT GRA Sample.

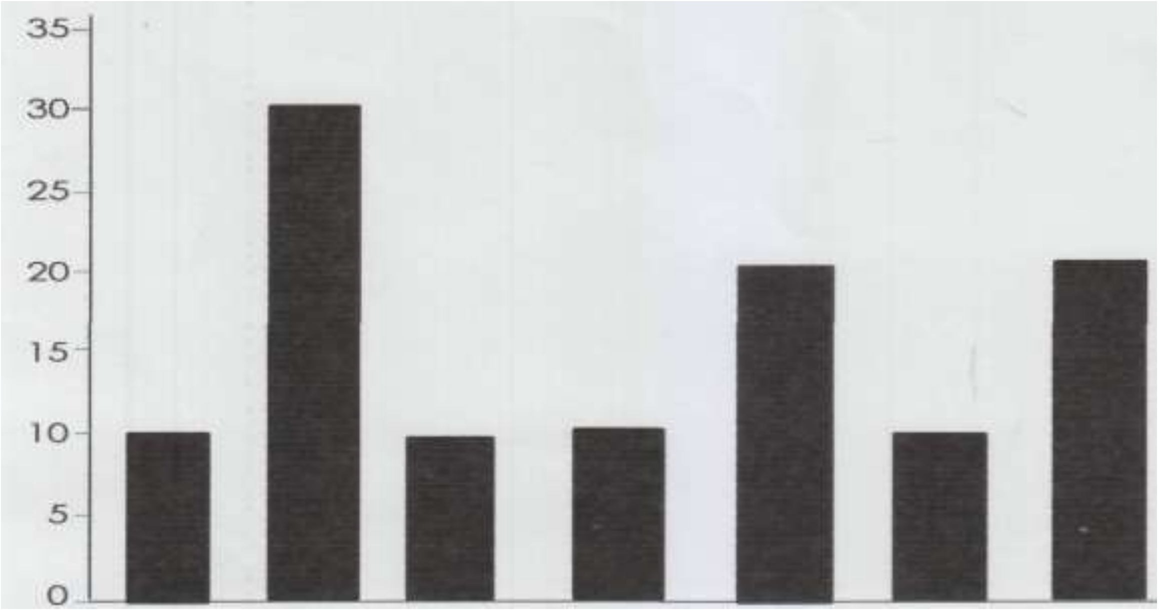

Figure 4: GRAPH OF PERCENTAGE OCCURRENCE OF FUNGI ISOLATES AT Borokiri sample

DISCUSSION

In this study, samples were collected from different areas of Port-Harcourt Metropolis such as Trans-Amadi, Diobu, GRA and Borokiri. In these areas, three (3) types of suya samples were used for the study, they are Balangu, Tsire and Kilishi. Eight (8) organisms were isolated from these samples; they are *Aspergillus niger, Aspergillus flavus, Penicillium* sp, *Rhizopus stolonifer, Candida* sp., *Fusarium* sp, *Alternariasp.,* and *Mucor* sp. The study revealed that amongst the types of suya, tsire contained all the eight (8) identified fungi followed by Kilishi (4), while Balangu had only three (3) organisms. This implies that tsire type of suya is more prone to fungal contamination than the others. This is because, it is always exposed to the air by vendors, the product attracts moisture from the air and dust from the atmosphere which introduces microbes to the product and even when the product over stays, till the next day, it is not always subjected to heat treatment before consumption. In addition, the preparation of tsire requires various spices like groundnut, garlic, pepper, etc, which of course can be the sources of contamination to this product.

Furthermore, the study revealed that amongst the identified fungi, *Rhizopus stolonifer* has the highest percentage occurrence (90%) in the entire suya sample, followed by *Penicilliuim* and *Mucor* (80%) each, *Aspergillus flavus* (70%) *Fusarium* (60%), *Aspergillus niger* (450%), *Candida* and *Alternaria* (30%) each. In addition, samples collected from the various study area reveals that the highest occurrence is in Trans-Amadi (150%), followed by Diobu (130%), Borokiri (110%) and GRA (100%). This difference may be due to the unhygienic environment of the area added with the high population density of the area and the poor socio-cultural attitude of the inhabitants. The possible causes of the heavy contamination of the suya sold in Port-Harcourt may be due to washing the meat with dirty water, use of unwashed hands by vendors, exposure of the products to air and dust, processing close to sewage or refuse dumps, use of spices, transportation, use of old newspaper to wrap the meat and the use of contaminated equipment such as knife and other utensils.

Notwithstanding, all the fungi isolated are xerophilic species. The growth of xerophilic fungi on roasted meat is known to increase the water activity (a_w) of the meat. It was noticed that the after weeks of storage, the meat became softer; this allowed other organisms previously prevented by the low available water to now grow and contaminate the sample. Taniwaki *et* a/., (2001), reported that fungi are capable of growing at a very low moisture content or low water activity (a_w) of less than 0.83 as well adapted to dry and partially dry food. *Aspergillus, Penidllium* and *Fusarium* among the Fungi isolates have been associated with disease conditions (Steinhouser, 2005). Results from this study are in agreement with other findings revealing that *Aspergillus niger, Aspergillus flavus, Penidllium* sp., and *Fusarium* sp. are some of the Fungi isolates of dried meat. The potential health hazard of suya (meat) can be predicted on the basics of the normal water activity to which indigenous xerophilic fungi proliferate. Microbial spoilage, food poisoning and fermentation occur if the water activity of the substrate is favourable for the multiplication of the organism involved (Olaoye and Onilude, (2010). The effect of reduced water activity in a substrate creates a competition for water between dry solutes and organism nuclear enzymatic components as well as shrinkage effect like the case of Kilishi - an intermediate moisture meat that has a suitable concentration of dissolved solids that binds the moisture in it sufficiently to inhibit the growth of spoilage organism. This cannot be said of Tsire and Balangu, these can easily absorb moisture from the atmosphere that will permit the growth of yeast and molds

CONCLUSION

This study shows that ready-to-eat meat (suya) sold in Port-Harcourt Metropolis is highly contaminated with different fungi and these fungi are known to possess the ability to produce mycotoxins, hence the situation calls for strict and serious public health regulations regarding the sales of suya by vendors using unwashed hands, wrapping with old newspaper, exposing the meat to the atmosphere, under heat processing, using dirty, utensils for preparation, selling and preparing the product at an unhygienic environment and the use of contaminated spices. Routine inspection by health inspectors is needed for microbiological safety and quality of this product (suya). The ultimate solution remains with the provision of portable water, teaching of good hygiene practices, including proper hand washing, creating awareness to the public and environmental sanitation may help to improve the situation.

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