Evaluation of Hygienic Practices and Microbiological Quality of Spaghetti Dishes Sold in Stalls in the Yopougon Municipality, Ivory Coast

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**ABSTRACT**

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| --- |
| **Aims:** Kiosks are informal restaurants that are rapidly growing in Côte d'Ivoire, offering a variety of meals. This study focuses on the food safety practices of vendors and customers at these kiosks, as well as the microbiological load of the most sold dish, "spaghetti." The aim is to contribute to the healthiness of dishes prepared and sold at these kiosks.  **Methodology:** Surveys were conducted to identify the main causes of health risks among 62 vendors and 78 consumers of these kiosks. The questionnaires focused on practices, attitudes and hygiene regarding food safety. Additionally, microbiological analysis of 36 samples of "spaghetti" dishes prepared in these kiosks and 24 of utensils was performed. Approximately 50g of already cooked spaghetti dishes were collected using a sterile spoon and placed in sterile bags. The analysis were carried out under international standards. Surface sampling of the utensils was performed according to ISO 18593 (2004).  **Results:** The surveys revealed a significant representation of men (85%) in this sector. The activity was primarily conducted by uneducated individuals (73%), and the prices set are affordable for everyone. The clientele was mainly young (64%) and single (86%). Meat spaghetti represented the most sold dish. Hygiene and food safety regulations were not adhered to by kiosk operators and customers. The microbiological analysis indicated high contamination of spaghetti samples and utensils. *Aspergillus flavus*, *A. niger*, and *Penicillium* sp. were isolated from the utensils, while only *Penicillium* sp. was found in the spaghetti dish. The average loads were 6.6 ± 0.3 x 104 to 2.2 ± 0.2 x 105 CFU/g for total aerobic mesophilic bacteria, 6.8 ± 0.6 x 102 to 7.3 ± 0.5 x 104 for staphylococci, 2.8 ± 0.3 x 104 to 6.0 ± 0.1 x 104 for total coliforms, and 1.3 ± 0.1 x 104 to 1.9 ± 0.7 x 104 for thermotolerant coliforms. Furthermore, potentially pathogenic microbes (*E. coli, S. aureus*) were isolated, which could pose a health risk to customers.  **Conclusion** : Thus, there remains a need for improvements in hygiene and training in good hygiene practices for kiosk operators and consumers. we plan to conduct a similar study in formal restaurants |

***Keywords*:** knowledge, practice, hygiene, food, kiosk

1. INTRODUCTION

The rapid urbanization of cities and the socio-economic difficulties faced by urban populations have facilitated the emergence of new modes of food sales and consumption venues (Aviles et al., 2020). These are foods sold in street corners known as "street food." This term refers to ready-to-eat foods sold primarily by street vendors along streets and in public places (bus stations, factories, schools, universities, etc.) (Koumassa *et al*., 2025). This activity is organized and developed mainly in cities. It thus fills the gap left by the lack of canteens in public and private enterprises, schools, as well as in markets or bus stations. This mode of food provision often remains the only alternative for those who live far from their workplace or for those with time constraints. It is expanding in Ivory Coast and in several other countries in Africa (Neffati et al., 2004; Yaou et al., 2024). Depending on the country, it is referred to as street food, popular restaurants, small eateries, open-air stalls, kiosks, etc. (FAO, 2007).

In Ivory Coast, sale of street food represents an employment opportunity and an important source of income for many people. Monthly earnings often exceed the guaranteed minimum wage (GMW) (Rakha et al., 2022). This activity is predominantly carried out by individuals with little or no education (Lues et al., 2006). Despite its economic and social significance, sale of street food remains an informal and poorly organized activity. The foods sold are often not subject to official health inspections (Canet, 1997). This lack of oversight from the authority responsible for food safety and the unhygienic practices expose customers of these food outlets to health risks such as foodborne illnesses and food poisoning (Omemu and Aderoju, 2008). The most common diseases include gastroenteritis, typhoid fever, salmonellosis, etc. (Aluko et al., 2014; Tingbe et al., 2018). In recent years, several cases of collective food poisoning (CFP) have been reported in Ivory Coast, resulting in fatalities. In 2023, five TIAC outbreaks were detected, leading to 131 cases, including 32 deaths, with a case fatality rate of 24.4%. On August 20, 2024, in the town of Affery in the Akoupé department, a food poisoning incident claimed the lives of five people, including four members of the same family, after consuming a corn meal (MSHPCMU, 2024). Despite these numerous CFP cases, foods sold on the streets, particularly in kiosks, largely escape health inspections in Côte d'Ivoire.

Kiosks are fixed eateries that are popular for offering a variety of meals (local dishes and others) ready to be consumed at any time of the day. The prices they charge are very competitive compared to formal restaurants. They are very flexible and easily adapt according to opportunities (Aluko et al., 2014; da Silva et al., 2014). Setting up a kiosk does not require a large capital investment. The necessary equipment is mainly limited to kitchen utensils that most households already possess (Donkor et al., 2009). They are ty Cancerally located in bus stations, markets and popular neighborhoods, *etc*. (Ngoc et al., 2020). This adaptability and the low costs associated with starting this type of activity make this sector particularly dynamic. However, it is a very poorly organized sector, and good food hygiene practices are not always followed. Therefore, it is important to assess the food safety practices of kiosk operators and customers, as well as the microbiological quality of the foods prepared and sold. This study aims to contribute to the health safety of meals prepared and sold in kiosks in three neighborhoods of the Yopougon municipality (Abidjan).

# MATERIALS AND METHODS

# 2.1 Materials

## **2.1.1 Study Site**

The study was conducted in the municipality of Yopougon (Latitude: 5.31667; Longitude: -4.06667; 5° 19′ 0″ North, 4° 4′ 0″ West), located in the southwest of the Abidjan District. We opted for a purposive sampling technique based on the researcher’s judgment. Among the 10 municipalities of the Abidjan District, Yopougon is the largest (164.2 km²) and the most populated (1,571,065 inhabitants) (INS, 2021). These reasons are responsible for the selection of using this site for study. Regarding the choice of neighborhoods (Siporex, Sicogi, and Niangon), factors such as types of housing, population density and the number of kiosks were taken into account.

**2.1.2 Survey Materials**

The surveys were conducted using questionnaires from the Kobo toolbox digital data collection system via the Kobo collect application installed on mobile phone.

**2.1.3 Analysed Samples**

Samples of cooked spaghetti dishes and the utensils (plates, spoons and drinking glasses) used to serve the meals were subjected to microbiological analyses (Fig. 1). The survey data motivated the choice of spaghetti as the food matrix.



**a :** Plate of sphaghetti **b :** Utensils

## **Fig. 1. Photographs of a cooked spaghetti dish and utensils**

**2.2 Methods**

The study was conducted in two phases. The first phase focused on surveys, which assessed the main causes of health risks. The second phase involved the collection of samples and their microbiological analyses.

**2.2.1 Surveys**

A pre-survey phase was conducted for one week. This allowed for the establishment of a trusting relationship with the kiosk owners and made it possible to adjust the questionnaires. The results from this pilot phase were not included in the final results. Survey data was collected through direct observation on-site, interviews and by administering questionnaires to vendors and customers of the "kiosks." The questionnaires focused on practices, attitudes and hygiene regarding food safety. For the development of the questionnaires, we drew inspiration from several previous studies that addressed the issue of street food (FAO, 2007; Chukuezi, 2010; Ansari-Lari et al*.,* 2010; Samapundo et al., 2015; Auad et al., 2019).

***2.2.1.1 Survey among kiosk owners***

kiosks located near homes, schools and markets are selected. The consent of the vendors was required. Questions focused on the sociodemographic characteristics of the respondents, sales conditions, the average cooking time of prepared dishes, knowledge of and adherence to basic hygiene rules, *etc*. A total of 62 kiosk vendors (21 in Niangon, 20 in Siporex, and 21 in Sicogi) were interviewed.

***2.2.1.2 Survey among consumers***

Consumers were selected from those present at the time of our visit. Only customers who had given their consent were interviewed. Questions centered on the sociodemographic characteristics of the respondents, frequency and reasons for consumption at the kiosks, knowledge of and adherence to basic hygiene rules, prices of dishes, *etc*. A total of 78 consumers (26 per neighborhood) encountered at the kiosks were interviewed.

***2.2.1.3 Observation survey***

Observation survey focused on the hygiene of the kiosks and their environment. Parameters taken into account were primarily related to the hygiene of the sites and their immediate environment (proximity to drains, garbage, presence of flies, rodents, toilets, *etc*.).

**2.2.2 Sampling**

Among the 62 surveyed kiosks, 12 were randomly selected from each neighborhood (Siporex, Sicogi and Niangon) for sampling. Approximately 50g of already cooked spaghetti dishes were collected using a sterile spoon and placed in sterile bags. The collected and labeled samples were placed in a cooler with ice and then transported to the laboratory for analysis.

Surface sampling of the utensils was performed according to ISO 18593 (2004). We delimited a surface of 20 cm2. With sterile water, we moistened the swab as recommended by the NF EN ISO 14698-1 (2004) standard. After collection, the swab was aseptically replaced in its labeled tube and stored at a temperature of approximately 5°C in a cooler during transport to the laboratory (maximum 4 hours).

**2.2.3 Microbiological Analysis of Spaghetti Samples**

All operations were conducted under aseptic conditions established around the flame of a Bunsen burner. The targeted microorganisms included total aerobic mesophilic flora (TAMF), total and thermotolerant coliforms, possibly including *Escherichia* *coli*, presumed pathogenic *staphylococci* (*S. aureus*), and molds. These microorganisms are indicators of fecal contamination or poor general hygiene, which could lead to foodborne illness outbreaks (FBIs).

***2.2.3.1 Preparation of Stock Suspensions and Dilutions***

10 grams of each prepared spaghetti sample were placed in 90 ml of buffered peptone water. The resulting homogenized mixture constituted the stock suspension. This was used to prepare decimal dilutions according to the ISO 6887:2017 standard.

***2.2.3.2 Seeding with Swabs***

The seeding was performed directly by streaking the swab onto the selected media. Practically, we made close parallel streaks with the swab on the surface to be sampled. Then, the same operation was repeated in the same area, but this time with streaks perpendicular to the first. The seeded Petri dishes were incubated at 30±2°C for 5 to 7 days (ISO 18593 (2004)).

***2.2.3.3 Counting***

## **Total Aerobic Mesophilic Flora (TAMF)**. The counting of the Total Aerobic Mesophilic Flora (TAMF) was performed according to the NF ISO 4833:2003 method. The principle of the TAMF detection involves culturing the sample to be analyzed using the double-layer incorporation technique on Plate Count Agar (PCA) (Biokar, France). The reading was done by counting the colonies that have grown on the agar after 72 hours of incubation at 30°C.

## **Staphylococci.** The counting of *Staphylococcus* was conducted on Baird Parker medium (BP OXOID CM0275) following the NF EN ISO 6888-1:1999 standard. The Baird Parker agar, supplemented with egg yolk emulsion and cooled potassium tellurite, was poured into Petri dishes. After solidification, the agar was inoculated and incubated at 37°C for 24 to 48 hours. Black, shiny, whole, convex colonies surrounded by clear zones were counted.

From the characteristic colonies, a deoxyribonuclease (DNase) test was performed to identify *S. aureus*. Petri dishes containing DNase were inoculated with isolated *Staphylococcus* colonies and incubated at 37°C for 24 hours. After incubation, the dish was flooded with a 1N hydrochloric acid solution. After a few minutes, the solution became opaque. It remained clear under the streaks of the DNase-positive strains (*S. aureus*).

## **Coliforms.** The counting was carried out according to the NF ISO 4832 (2006)standard on Lactose Violet Crystal and Neutral Red Agar (VRBL) (Bio-Rad, France). After 24 hours of incubation at 30°C (for the detection of total coliforms) and 44°C (for the detection of thermotolerant coliforms), characteristic colonies with a pink-violet color were counted. The identification of E. *coli* was conducted on chromogenic agar. After inoculating from characteristic colonies of thermotolerant coliforms, the Petri dishes were incubated at 37°C for 24 hours. All *E. coli* strains possess β-galactosidase, and 94 to 97% of them also possess β-glucuronidase (GUD). The presence of this enzyme was revealed by the presence of a blue-colored compound. The simultaneous action of both enzymes caused *E. coli* colonies to appear dark blue to violet.

## **Yeasts and Moulds**. The counting of yeasts was performed according to the ISO 21527-1:2008 standard. The medium used was Sabouraud Agar with Chloramphenicol (Biokar, France). After inoculation and incubation of the Petri dishes at 30°C for 24 to 48 hours, an identification key was used to name the observed molds (Gacem et al*.,* 2012).

**2.2.4 Expression of the results of the analyzed bacterial loads**

The microbial load of the samples was calculated using equation **1**.

(1)

***ΣC*** *: The sum of colonies on all plates from the two successive dilutions. ;* ***V*** *: Volume of the inoculum applied to each plate, in milliliters ;* ***n1*** *and* ***n2*** *: respective number of boxes for the first and second dilution retained ; d : dilution rate of the first dish having produced countable colonies (weak dilution).*

For the enumeration of *S. aureus* and *E*. *coli* loads, equation **2** was used.

**N = (number of confirmed colonies / number of tested colonies) X number of presumed colonies.**

(2)

## 

## **2.2.5 Statistical Analysis**

Various calculations and graphical representations were performed using Excel 2019. The data analysis from surveys and microbiological analyses were carried out using IBM Statistics 20 software. Multiple analysis of variance (ANOVA) was used to calculate the means and standard deviations and to determine if there were differences observed in the average loads of the different germs.

1. **RESULTS AND DISCUSSION**
   1. **Results**

**3.1.1 Sociodemographic characteristics of the cooks and consumers surveyed**

The survey conducted among the cooks at the "kiosks" and the consumers allowed for the determination of certain socio-demographic parameters. The cooks were 85% male and 15% female. Regarding their level of education, 73% were not educated; 10% had completed primary education; 13% had completed secondary education; and 5% had higher education. Among the consumers surveyed, 73% were male and 27% were female. The results also show that the majority (64%) of the customers were aged between 18 and 25 years. More than 86% of them were single, and 14% were married couples. They were 40% uneducated. About 3% had a higher level of education, and 57.5% only reported being educated (primary and secondary) (Table 1).

**Table 1. Sociodemographic characteristics of the cooks and consumers surveyed**

|  |  |  |  |
| --- | --- | --- | --- |
| **Evaluated Parameters** | **Modalities** | **Frequency (N)** | **(%)** |
|  | **Salesperson** |  |  |
| Sex | Male | 53 | 85.5 |
| Female | 09 | 14.5 |
| Level of Education | Not educated | 45 | 72.6 |
| Primary | 06 | 9.7 |
| Secondary | 08 | 12.9 |
| Higher | 03 | 4.8 |
|  | **Customer** |  |  |
| Sex | Male | 57 | 73 |
| Female | 21 | 27 |
| Age group | 18-25 | 50 | 64 |
| 25-30 | 15 | 19 |
| 30-35 | 08 | 10 |
| 35 and above | 05 | 6 |
| Level of Education | Not educated | 31 | 39.7 |
| Primary | 30 | 38.5 |
| Secondary | 15 | 19.2 |
| Higher | 02 | 2.5 |
| Marital status | Single | 67 | 86 |
| Married | 11 | 14 |

**3.1.2 Evaluation of practices and knowledge regarding food hygiene**

The data obtained from questionnaires and direct observations on hygiene practices during meal preparation and consumption in the 'kiosks' were recorded in Table **2**. For meal preparation, a little over half of the cooks (51.6%) regularly washed their hands. More than three-quarters (75.8%) wore jewelry on their fingers or wrists, and 8.1% had wounds on their hands. The vast majority of cooks (95.2% and 80.7%) did not wear gloves and face masks, respectively, during preparations. Just under half (43.5%) wore an apron of questionable cleanliness. Despite more than 83.9% of the kiosks having access to tap water, 80.6% did not regularly change the water used for washing dishes. Cleaning and disinfection techniques for kitchen utensils were inadequate in 70.9% of cases. For the preservation of raw materials and precooked foods, 27.4% of the 'kiosks' had at least one freezer and one refrigerator, while 30.6% had only a refrigerator. As for kitchen facilities, all the 'kiosks' (100%) had a stove, and about 45.2% also had an oven. The cooking time required was insufficient in 59.7% of the observed cases. In 46.8% of cases, the shelf life of raw materials exceeded two weeks, and 16.1% mixed precooked foods with unsold prepared foods during storage.

For meal consumption, about 45% of the surveyed consumers washed their hands, and 61.5% wore jewelry on their fingers and wrists. In 84.6% of the "kiosks," there was no designated space for handwashing, and more than three-quarters (75.6%) did not have a toilet. However, a large number of customers (70.5%) could have access to wash their hands if they wished.

**Table 2. Evaluation of food hygiene practices and knowledge among vendors and consumers**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Vendors N=62** |  |  |
| **Evaluated Parameters** | **Methods** | **Yes**  **N (%)** | **No**  **N (%)** |
| Hand Hygiene | Handwashing | 32 (51.6) | 30 (48.4) |
| Wearing jewellry on fingers and wrist | 47 (75.8) | 15 (24.2) |
| Presence of wounds on hands | 5 (8.1) | 57 (91.93) |
| Wearing kitchen gloves | 3 (4.8) | 59 (95.2) |
| Work equipment hygiene | Wearing an apron | 27 (43.5) | 35 (56.5) |
| Wearing a facemask | 12 (19.4) | 50 (80.7) |
| Access to tap water | 52 (83.9) | 10 (16.1) |
| Regular renewal of dishwashing water | 12 (19.4) | 50 (80.7) |
| Proper cleaning and disinfection of utensils | 18 (29.03) | 44 (70.9) |
| Mixing precooked and prepared foods during storage | 10 (16.1) | 52 (83.8) |
| Shelf life exceeding two weeks | 29 (46.8) | 33 (53.2) |
| Sufficient cooking time | 25 (40.3) | 37 (59.7) |
| Kitchen facilities | Freezer and Refrigerator | 17 (27.4) | 45 (72.6) |
| Refrigertor | 19 (30.6) | 43 (69.4) |
| Cooler | 06 (9.6) | 56 (90.3) |
| Stove | 62 (100) | 00 (00) |
| Oven | 28 (45.2) | 34 (54.8) |
|  | **Consumers N=78** |  |  |
| Hand Hygiene | Washing of hands | 35 (44.8) | 43 (55.1) |
| Wearing jewellry on fingers and wrist | 48 (61.5) | 30 (38.5) |
| Presence of wounds on hands | 2 (2.6) | 76 (97.4) |
| Hygiene | Access to water for washing hands on demand | 55 (70.5) | 23 (29.5) |
| Handwashing area | 12 (15.4) | 66 (84.6) |
| Presence of toilet | 19 (24.4) | 59 (75.6) |

**3.1.3 Frequency and reasons for visiting kiosks**

Table **3** provides information on the frequency and reasons given by customers for visiting kiosks. More than 56.4% of customers ate at kiosks at least once a week, with daily customers representing 28%. Additionally, 10% of customers dined at least once a month, while 5% frequented kiosks occasionally.

The motivations for visiting kiosks varied among customers. Some chose to eat at kiosks due to easy access (23%), while 58% were driven by low prices. Finally, 19% stated they dined at kiosks because of the quality of the dishes offered.

**Table 3. Distribution of Customers Based on Frequency and Reasons for Visiting Kiosks**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters studied** | **Studied methods** | **N=78** | **(%)** |
| Frequency of visit to kiosks | Occasional | 4 | 5.1 |
| Daily | 22 | 28.2 |
| Weekly | 44 | 56.4 |
| Monthly | 8 | 10.2 |
| Reasons for visiting kiosks | Accessibility | 18 | 23.1 |
| Quality of dishes | 15 | 19.2 |
| Applied prices | 45 | 57.7 |

**3.1.4 Cleanliness and immediate environment of the kiosks**

Approximately 35.5% of the kiosks had solid or liquid waste on the kitchen floor. More than half (56.5%) were located along the roadsides. Mice were visible in more than 62.9% of the cases and cats were present in 45.2% of the cases. The majority of the kiosks (85.5%) had trash bins (Table 4).

**Table 4. Cleanliness and immediate environment of the Kiosks**

|  |  |  |
| --- | --- | --- |
| **Parameters evaluated** | **Yes (%)** | **No (%)** |
| Presence of instects, mice… | 39 (62.9) | 23 (37.1) |
| Presence of cats | 28 (45.2) | 34 (54.84) |
| Presence of solid or liquid waste on the kitchen floor | 22 (35.5) | 40 (64.5) |
| Presence of trash bins | 53 (85.5) | 9 (14.5) |
| Kiosk located along the roads | 35 (56.45) | 27 (43.5) |

**3.1.5 Dishes offered in the visited kiosks and their prices**

Several types of dishes were available in the kiosks. For the majority (57%) of kiosk operators, the best-selling dishes were spaghetti dishes, followed by kidney dishes or meat (29%). Dishes based on green peas, curdled milk and omelets represented 8%, 3%, and 3%, respectively (Fig. 2).   
The prices charged in the kiosks ranged from 200 to 1500 CFA francs. Over 64% of the dishes had a price between 500 and 800 CFA francs. The price ranged from 200 to 350 CFA francs; 350 to 500 CFA francs; and 800 to 1500 CFA francs per dish accounted for 8%, 11% and 16%, respectively (Fig. 3).

## **Fig. 2. Distribution of Meals Served in the Kiosks Based on Sales Frequency**

## **Fig. 3. Selling Prices of Meals Offered in the Kiosks**

**3.1.6 Level of Contamination of the Spaghetti Samples**

The results of the microbiological analyses of the spaghetti samples are presented in Table **5**. The data indicates contamination of the samples by mesophilic aerobic microorganisms (MAM), *Staphylococcus*, coliforms (total and thermo-tolerant), and molds. The average counts of MAM varied from 1.6 ± 0.3x104 to 2.2 ± 0.2x105 at Niangon, from 1.1 ± 0.9x104 to 4.2 ± 0.2x105 at Sicogi, and from 3.6 ± 0.2x102 to 6.6 ± 0.3x104 at Siporex. For *Staphylococcus*, the average counts ranged from 1.7 ± 0.6x103 to 1.7 ± 0.2x104 at Niangon, from 1.4 ± 0.3x104 to 7.3 ± 0.5x104 at Sicogi, and from 6.8 ± 0.6x102 to 7±2.4x103 at Siporex. Regarding the contamination level of coliforms, the average counts varied between 1.7 ± 0.9x104 and 6.0 ± 0.1x104 for fecal coliforms and between 1.4 ± 0.6x104 and 1.7 ± 0.4x104 for thermo-tolerant coliforms in the Niangon neighborhood. At Sicogi, the average counts of fecal coliforms ranged from 8.5 ± 3.6x103 to 5.0 ± 0.3x104, and those of thermo-tolerant coliforms ranged from 1 ± 0.7x103 to 1.9 ± 0.7x104. At Siporex, the counts varied between 6.8 ± 3.2x103 and 2.8 ± 0.3x104 and between 3.4 ± 1.1x103 and 1.3 ± 0.1x104, respectively for fecal coliforms and thermo-tolerant coliforms. The highest counts of *E. coli* and *S. aureus* were observed in the samples from Siporex. The results of the statistical analyses indicated a significant difference between the microbial loads of MAM, Staphylococcus, and total coliforms in the samples collected from the three neighborhoods. However, no significant difference (p= 0.05) was observed for the average counts of thermo-tolerant coliforms between the samples from the three neighborhoods.

## **Table 5. Bacterial Loads in Colony-Forming Units per Gram (CFU/g) of Analyzed Spaghetti Samples**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Neighbourhoods of the Municipality** | | | | | |
|  | **Niangon** | | **Sicogi** | | **Siporex** | |
| **Germes** | **Min** | **Max** | **Min** | **Max** | **Min** | **Max** |
| MAM | 1.6±0.3x104a | 2.2 ± 0,2.105 a | 1.1±0.9x104 | 4,2 ± 0,2.105 b | 3.6±0.2x102c | 6.6 ± 0,3.104 c |
| STAPH | 1.7±0.6x103a | 1.7 ± 0,2.104 a | 1.4±0.3x104a | 7.3 ± 0,5.104 b | 6.8 ± 0.6x102 c | 7±2.4x103 c |
| *S. aureus* | 15±3a | 10±0.5x102c | 76±8b | 7,5±0.9x102c | 24±4 b | 1,2±1.3x103 c |
| CF | 1.7±0.9x104a | 6.0 ± 0.1x104 a | 8.5±3.6x103b | 5.0 ± 0,3x104 c | 6.8±3.2x103b | 2.8 ± 0,3x104 c |
| CTH | 1.4±0.6x104a | 1.7 ± 0.4x104 a | 1±0.7x103a | 1.9 ± 0,7x104 a | 3.4±1.1x103b | 1,3 ± 0,1x104 a |
| *E. coli* | 8±2a | 81±7b | 5±2 a | 19±6b | 7±2 a | 1.3±1.2x102c |

## 

## *STAPH: Staphylococcus, CF: fecal coliforms, CTh: thermo-tolerant coliforms*

## **3.1.7 Level of Contamination of Cutlery**

The qualitative results of the microbiological analyses of the cutlery are provided in Table **6**. They indicate the presence of mesophilic aerobic microorganisms (MAM), *Staphylococcus* (*S*. *aureus*), and coliforms (*E*. *coli*) on the analyzed cutlery.

## **Table 6. Microorganisms Present on Plates, Glasses and Utensils used in the Kiosks**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Microorganisms Searched For** | | | |  |
| **Neighborhoods** | MAM | STAPH | *S. aureus* | CF | CT | *E. coli* |
| **Niango** (n=8) | +++ | +++ | + | +++ | ++ | + |
| **Sicogi** (n=8) | +++ | +++ | + | +++ | ++ | + |
| **Siporex** (n=8) | +++ | +++ | + | +++ | ++ | + |

*+++ : Very numerous, ++ : Numerous, + : Few*

## **3.1.8 Frequency of Contamination of the Spaghetti samples and Cutlery**

MAM (Mesophilic Aerobic Microorganisms) were present in all the spaghetti samples and cutlery analyzed, resulting in an isolation frequency of 100%. In the spaghetti samples and on the cutlery, the contamination frequencies were 66.7% and 83.3% for *Staphylococcus*, respectively. For total and thermo-tolerant coliforms, the frequencies were 50% and 33.3% for the spaghetti samples and 75% and 58.3% for the cutlery. The isolation frequencies of *E*. *coli* were 22.2% and 50% in the spaghetti samples and on the cutlery, respectively. As for *S*. *aureus*, it was 33.3% of the spaghetti samples and 58.3% of the cutlery (Table 7).

## **Table 7. Frequency of contamination of analysed spaghetti samples and cutlery**

|  |  |  |
| --- | --- | --- |
|  | **Frequency of contamination (%)** | |
|  | **Samples analysed** | |
| **Target pathogens** | **Spaghetti** (n = 36) | **Cutlery** (n = 24) |
| MAM | 36 (100) | 24 (100) |
| *Staphylococcus* | 24 (66,7) | 20 (83,3) |
| Total Coliform | 18 (50) | 18 (75) |
| Thermotolerant Coliform | 12 (33,3) | 14 (58.3) |
| *E. coli* | 8 (22.2 %) | 12 (50 %) |
| *S. aureus* | 12 (33.3 %) | 14 (58.3 %) |

## **3.1.9 Molds isolated from analysed samples**

Table **8** presents the species of molds isolated from the studied matrices. *Aspergillus flavus*, *A. niger*, and *Penicillium sp.* were found on the cutlery. Only *Penicillium sp.* was found in the spaghetti samples.

|  |  |  |
| --- | --- | --- |
| Mold species | Types of samples analysed | |
| Cooked Spaghetti | Cutlery |
| *Aspergillus flavus* | - | + |
| *Aspergillus niger* | - | + |
| *Penicilium* sp. | + | + |

## **Table 8. Mold species found in the analysed samples**

*+ : present ; - : absent*

**3.2 Discussion**

The survey conducted among sixty-two (62) "kiosk" cooks showed that there were 85% male and that 73% of them had no formal education. As a result of the distrust of these vendors, the age parameter could not be determined. Our results differ from those obtained by Adam et al. (2024) in their study on practices and food safety in Vietnam. In their study, 61.6% of the vendors were women and 38.4% were men. The ages of the vendors ranged from 17 to 55 years, with an average age of 33 years. This difference can be explained by the fact that in Ivory Coast, food selling in kiosks is generally a family activity. Men typically provide service in the afternoons and evenings, while women are mainly present in the mornings. The surveys been conducted more in the afternoons and evenings might explain the predominance of men in our study. According to Canet (1997), the informal food sector is a significant source of employment in urban areas, especially for individuals with lower levels of education who may not find other employment opportunities.

The prices of dishes offered in the kiosks varied between 200 and 1500 F CFA. More than 64% of the dishes offered to customers cost between 500 and 800 F CFA. The spaghetti dish was the best-selling meal, with a percentage of 57%. Da silva, (2014) had already highlighted that the foods sold in kiosks had accessible prices. This type of commerce greatly contributes to the sustenance of many people with modest incomes in the cities. It also represents a real opportunity for many individuals and helps combat precariousness. For example, in the city of Ibadan, Nigeria, the average income of more than 65% of vendors exceeds 3 to 6 times the minimum wage of a worker (Barro, 2004). Baba et al. (2006), on their part, showed that fixed street food vendors in Republic of Benin have the highest earnings.

Raw materials and precooked foods were primarily stored in refrigerators, coolers, but also in freezers. Cold storage is important for certain raw materials (meat, kidney, etc.) and certain types of foods (curdled milk, butter, etc.). The use of coolers as a means of food preservation could be explained by the desire to reduce electricity costs.

Out of a total of 78 kiosk customers surveyed, 57% were men, and they were mostly young. Indeed, over 64% of the customers were aged between 18 and 25 years. Forty percent were uneducated. About 3% had a higher education level, and 57.5% reported being enrolled in school (primary and secondary). Our results are similar to those of Kamara (2009) in his study on the financial impact of food-related illnesses. He showed that the age group (18 to 34 years) of consumers was the most significant. In the study conducted in Vietnam on hygienic practices, the average age of consumers was 26.4 years. However, in that study, 63.8% of consumers were women, and 36.2% were men. Regarding education level in the same study, 84.1% of consumers had a secondary education diploma or higher (Adam et al., 2024). The fact that the clientele of kiosks is predominantly young could be explained by the fact that young people generally prefer eating out. Additionally, young people, most of whom are single, tend to prefer eating outside the family home. Besides being places for dining, the kiosks also serve as meeting spots for these youth.

Regarding the frequency and reasons for visiting kiosks, more than half, or 57% of the surveyed individuals, stated that they eat there at least once a week, and 58% of them justified this choice as a result of the prices charged. The results of the survey among the cooks confirm the attractiveness of the prices charged in the kiosks. Moreover, kiosks are almost present in every neighborhood and street corner in the city of Abidjan. This mode of dining often remains the only alternative for those who live far from their workplace (Badrie et al., 2004; Anoman et al., 2019).

With regards to hygiene practices during food preparation and consumption in the kiosks, hygiene rules are not generally respected. For instance, more than half (51.6%) of the vendors do not wash their hands regularly, and more than three-quarters (75.8%) wear jewelry on their fingers or wrists. The water meant for washing dishes is not regularly renewed (80.65%).

For meal consumption, less than half of the customers (45%) washed their hands, and 62% wore jewelry on their fingers and wrists. In 84.6% of the kiosks, there was no designated area for customers to wash their hands, and more than three-quarters (75.64%) did not have access to toilets. Mice were present in more than 62.9% of the kiosks, and cats were visible in 45.2% of the cases. In these aspects, our data is similar to those of Adam et al. (2024). These authors showed in their work that 65.9% of vendors had no knowledge of food safety. They also mention the wearing of jewelry, the presence of flies, cockroaches, mice and pets on site. The lack of handwashing facilities, hygiene and cleanliness of the sites can lead to cases of poisoning. According to Lues et al., (2006), street food poses problems regarding the safety or nutritional quality of the products offered, the hygiene of the vendors, and the environment in which they are distributed. Samapundo et al. (2016) stated that one of the main issues with street food is its unsatisfactory microbiological quality. Customers at these food sites are exposed to illnesses such as diarrhea, vomiting, nausea, *etc*. (Joyce et al., 2020).

All the spaghetti samples analyzed were contaminated by MAM (Mesophilic Aerobic Microorganisms), *staphylococci*, and *coliforms*. The presence of these microorganisms indicated a low level of hygiene (Badrie et al., 2004; Anoman et al., 2019). The results of the microbiological analyses obtained in this study corroborate those of Anoman et al., (2019) regarding the hygienic quality of *attiéké* *Garba*. The presence of *E*. *coli* and *S*. *aureus* in the analyzed samples could pose a health problem. Indeed, certain strains of *E. coli* are often involved in cases of foodborne illnesses in humans (Argudín et al., 2010; Kashima et al., 2021). The fungal flora isolated during this study consists of three species (*Penicillium sp., Aspergillus niger*, and *A. flavus*). The presence of these fungal species indicated poor conditions for food preservation and questionable hygiene. Some of the isolated fungal species are potentially dangerous to humans. *A. flavus* is recognized as a germ that produces aflatoxin, a highly hazardous mycotoxin in humans (Awuchi et al., 2020).

1. **CONCLUSION**

The objective of this study was to contribute to improving the quality of the dishes prepared and sold in the kiosks. Surveys conducted with cooks and customers at these sites indicated unhygienic practices. Spaghetti was the best-selling dish. Microbiological analyses performed on samples of spaghetti and the utensils confirmed this lack of good hygiene. In fact, the analysis of the samples of spaghetti and serving utensils revealed contamination by numerous germs. These germs include MAM (Mesophilic Aerobic Microorganisms), coliforms (total and thermotolerant), *E*. *coli*, and S. *aureus*. In addition to these germs, molds (*Penicillium, Aspergillus niger, and A. flavus*) were isolated. The presence of these germs could pose a risk to the health of customers. Therefore, efforts need to be made regarding awareness of hygiene and good food safety practices. It is important to raise awareness and organize training in hygiene and food safety for consumers and street food vendors. It is also necessary to step up hygiene inspections to reinforce the safety of street food.

**Consent:**

As per international standards or university standards, Participants’ written consent has been collected and preserved by the author(s).

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

References

Adam, S., Algumassa, J. T., Thanh Nguyen, T. T., Van Pham, H., Dang Xuan, S., & Bui, D. T. (2024). Assessing Food Safety Knowledge, Attitudes and Practices (KAP) of Street Food Vendors and Sanitary Conditions of Vendor Stalls in Gia Lam, Ha Noi, Vietnam. International Journal of BioLife Sciences (IJBLS), 3(1), 70-84. https://doi.org/10.22034/ijbls.2024.188042

Aluko, O. O., Ojeremi, T. T., Olaleke, D. A., & Ajidagba, E. B. (2014). Evaluation of food safety and sanitary practices among food vendors at car parks in Ile Ife, southwestern Nigeria. Food Control, 40, 165-171.. <https://doi.org/10.1016/j.foodcont.2013.11.049>

Anoman, A. T., Koussemon, M., Kouassi, K. I., & Ake Assi, Y. (2019). Qualité microbiologique du garba, un aliment de rue de Côte d’Ivoire. International Journal of Biological and Chemical Sciences, 12(5), 2258. <https://doi.org/10.4314/ijbcs.v12i5.26>

Ansari-Lari, M., Soodbakhsh, S. and Lakzadeh, L. (2010). Knowledge, attitude and practice of workers on food hygienic practice in meat processing plants in Fars, Iran. Food Control, 21(3), 260-263. https:// doi.org/10.1016/j.foodcont.2009.06.003

Argudín, M. Á., Mendoza, M. C., & Rodicio, M. R. (2010). Food Poisoning and Staphylococcus aureus Enterotoxins. Toxins, 2(7), 1751–1773. <https://doi.org/10.3390/toxins2071751>

Auad, L.I., Ginani, V.C., Stedefeldt, E., Nakano, E.Y., Nunes, A.C.S. Zandonadi, R.P. (2019). Food safety knowledge, attitude, and practice of Brazilian food truck food handlers. Nutrients, 11(8), 1784. https:// doi.org/10.3390/nu11081784

Aviles, M. V., Naef, E. F., Abalos, R. A., Lound, L. H., Olivera, D. F., & García-Segovia, P. (2020). Effect of familiarity of ready-to-eat animal-based meals on consumers’ perception and consumption motivation. International Journal of Gastronomy and Food Science, 21, 100225. https://doi.org/10.1016/j.ijgfs.2020.100225.

Awuchi, C. G., Amagwula, I. O., Priya, P., Kumar, R., Yezdani, U., & Khan, M. G. (2020). Aflatoxins in foods and feeds: A review on health implications, detection, and control. Bull. Environ. Pharmacol. Life Sci, 9, 149-155.

Baba-Moussa L, Baba-Moussa F, Bokossa I, Sanni A. 2006. Etude des possibilités de contamination des aliments des rues au Bénin : cas de la ville de Cotonou. Journal de la Recherche Scientifique de l'Université de Lomé, 8(2) : 149-156. DOI: 4314/JRSUL.V812.52102

Badrie, N., Joseph, A., & Chen, A. (2004). An observational study of food safety practices by street vendors and microbiological quality of street-purchased hamburger beef patties in Trinidad, West Indies. Internet Journal of Food Safety, 3, 25-31.

Barro, N., Ouattara, C. A., Nikiema, P. A., Ouattara, A. S., & Traoré, A. S. (2003). Evaluation de la qualité microbiologique de quelques aliments de rue dans la ville de Ouagadougou au Burkina Faso. Cahiers d'études et de recherches francophones/Santé, 12(4), 369-74.

Canet C. (1997). Programme FAO « Approvisionnement et distribution alimentaires des villes » Revue « Aliments dans les Villes » L’alimentation de rue en Afrique, pp :1-11*.* 45

Chukuezi, C. O. (2010). Food safety and hyienic practices of street food vendors in Owerri, Nigeria. Studies in sociology of science, 1(1), 50. DOI: http://dx.doi.org/10.3968/j.sss.1923018420100101.005

Da Silva, S.A., Cardoso, R.d.C.V., Góes, J.Â.W., Santos, J.N., Ramos, F.P., de Jesus, R.B., do Vale, R.S. and da Silva, P.S.T. (2014). Street food on the coast of Salvador, Bahia, Brazil: A study from the socioeconomic and food safety perspectives. Food Control, 40, 78-84. https://doi.org/10.1016/ j.foodcont.2013.11.022

Donkor, E. S., Kayang, B. B., Quaye, J., & Akyeh, M. L. (2009). Application of the WHO Keys of Safer Food to Improve Food Handling Practices of Food Vendors in a Poor Resource Community in Ghana. International Journal of Environmental Research and Public Health, 6(11), 2833–2842. https://doi.org/10.3390/ijerph6112833

FAO. (2007). Les bonnes pratiques d'hygiène dans la préparation et la vente des aliments de rue en Afrique: Outils pour la formation. Ed. Food & Agriculture Org, Italie. 175p.

Institut National de la Statistique (2021). Recensement général de la population et de l’habitat de Cote d’Ivoire. <https://plan.gouv.ci/assets/fichier/RGPH2021-RESULTATS-GLOBAUX-VF.pdf>

Joyce, H., Kofi Osei, A., Peter, D., Amoako, M. K., Boulard, F. J., Benedicta, N. F., Bright Owusu, A., & Lydia, B. (2020). Consumer Perceptions of Street-Vended Local Foods in Urban Ghana. Food Science &amp; Nutrition Research, 3(1). https://doi.org/10.33425/2641-4295.1031

Kamara, F. (2014). Impact financier des maladies liées à la restauration hors foyer. Cas des consommateurs Anosibe Antananarivo. Diplôme d’Etudes Approfondies en Economie Publique et Sociale. Université d’Antananarivo. Faculté de Droit des Sciences Economiques de Gestion et de Sociologie. Département Economie.

Kashima, K., Sato, M., Osaka, Y., Sakakida, N., Kando, S., Ohtsuka, K., Doi, R., Chiba, Y., Takase, S., Fujiwara, A., Shimada, S., Ishii, R., Mizokoshi, A., Takano, M., Lee, K., Iyoda, S., & Honda, A. (2021). An outbreak of food poisoning due toEscherichia coliserotype O7:H4 carryingastAfor enteroaggregativeE. coliheat-stable enterotoxin1 (EAST1). Epidemiology and Infection, 149. <https://doi.org/10.1017/s0950268821002338>

Koumassa, O. A., Ouétchéhou, R., Hounsou, M., Zannou, O., & Dabadé, D. S. (2025). Factors influencing street-vended foods quality and safety in developing countries: a review. Discover Food, 5(1), 1-33. <https://doi.org/10.1007/s44187-025-00286-w>

Lues, J. F., Rasephei, M. R., Venter, P., & Theron, M. M. (2006). Assessing food safety and associated food handling practices in street food vending. International journal of environmental health research, 16(5), 319-328. https:// doi.org/10.1080/09603120600869141

M S H P C M U (2024). Site officiel du Ministère de la Santé, de l’Hygiène Publique et de Couverture Maladie Universelle de Cote d’Ivoire https://www.gouv.ci/\_actualite-article.php?d=3&recordID=9024&p=9

Neffati, L., Ridha, H., Kolsteren, P., & Hilderbrand, K. (2004). L’alimentation de rue chez l’écolier dans une région du nord de la Tunisie. Cahiers d'études et de recherches francophones/Santé, 14(1), 43-48.

Ngoc, T. T. A., Hang, N. T. M., Thanh, D. K., & Hoa, L. V. (2020). Evaluation of microbial safety knowledge, attitude and practice of street food vendors and consumers in Can Tho City, Vietnam. Food Research, 4(5), 1802–1814. https://doi.org/10.26656/fr.2017.4(5).153.

Omemu, A. M., & Aderoju, S. T. (2008). Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria. *Food control*, *19*(4), 396-402. <https://doi.org/10.1016/j.foodcont.2007.04.021>

Rakha, A., Fatima, M., Bano, Y., Khan, M. A., Chaudhary, N., & Aadil, R. M. (2022). Safety and quality perspective of street vended foods in developing countries. Food Control, 138, 109001. https://doi.org/10.1016/j.foodcont.2022.109001.

Samapundo, S., Thanh, T.C., Xhaferi, R. and Devlieghere, F. (2016). Food safety knowledge, attitude and practice of street food vendors and consumers in Ho Chi Minh City, Vietnam. Food Control, 70, 79-89. https://doi.org/10.1016/ j.foodcont.2016.05.037

Tingbe, V. B. F. A., Azonhe, T. H., Yemadje, A., & Vido, A. A. (2018). Consommation De Boissons Desalterantes Et Risques Sanitaires Dans Les Colleges De La Ville D’abomey (Republique Du Benin). European Scientific Journal, ESJ, 14(33), 251. https://doi.org/10.19044/esj.2018.v14n33p251

Yaou, C., Ali, M. A., Lewamy, M., & Sadou, H. (2024). Contrôle de la qualité microbiologique des aliments de la rue vendus dans le milieu scolaire à Niamey (Niger). International Journal of Biological and Chemical Sciences, 18(3), 938–949. <https://doi.org/10.4314/ijbcs.v18i3.17>