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Knowledge of Foodborne Illnesses: A Prerequisite for Improving Food Safety in University Catering in Senegal

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Abstract

This study focuses on the problem of collective foodborne illness (CFI) in public universities in Senegal, including UGB, UCAD, UIT, UADB and UASZ. These institutions are often affected by CFI, and the level of ignorance of the actors makes their prevention difficult. The objective of this study is to improve the understanding of CFI among the actors and to analyze various aspects, such as the socio-demographic composition and the level of education of the actors, their ignorance of CFI, the stages of preparation of risky meals, as well as the level of bacterial contamination of food, surfaces and juices. The survey was conducted from 2012 to 2017 through sampling, analysis, and the HAZOPS method. The survey questionnaire, the team of investigators, and the bacteriological samples made it possible to collect detailed data. The results show that the majority of men (76.92%) and a student population with a low level of education have the staff mostly holding a baccalaureate or less (75.88%). A high rate of ignorance of CFI was observed, with 13.88% to 71.52% of respondents, respectively, not knowing about CFI, their risks, and the first aid to be provided. Regarding food risks, all preparation steps (meals, juices and sandwiches) are identified as potentially critical. Bacteriological analyses show insufficient compliance with hygiene rules, with contamination results varying between 46% and 100% depending on the type of food. The study concludes that lack of knowledge of CFI and poor hygiene practices in university restaurants are prevalent. It recommends ongoing training of staff in good hygiene practices and regular awareness-raising to reduce risks.

Keywords

CFI, HAZOPS, Health, Safety, HACCP

1. Introduction

In recent years, university catering, which covers tens of thousands of students, has been shaken by the appearance of numerous collective foodborne illness (CFI) within the social campuses of public universities in Senegal: UGB, UCAD, UIT, UADB and UASZ [1]. A collective foodborne illness (CFI) is an infectious disease that occurs when there are at least two similar cases of symptomatology, usually gastrointestinal, which can be attributed to the same food source [2] [3]. In these university campuses, neglecting hygiene rules regularly creates serious situations of food safety insecurity characterized by public health issues with the emergence of CFI.

The management of food poisoning risks has a prerequisite which is knowledge of these diseases [4] [5] [6]. These foodborne diseases and their risks remain unknown to the stakeholders, and this constitutes a real problem for their control and the improvement of food safety in university catering [6] [7] [8]. In these conditions of meal manufacturing by actors who ignore food hygiene standards, there are real risks of CFI due to the speed of uncontrolled or poorly controlled actions of control of supply, storage, cutting, preparation, conservation, service and cleaning-disinfection operations [4] [8] [9]. It is with the aim of raising awareness for better knowledge and perfect control of CFI on these university campuses that this contribution is made. It focuses on knowledge of the risks of food poisoning to better improve the health safety of foods prepared in university restaurants and their surroundings. This will specifically involve determining: the socio-demographic composition, the level of knowledge or lack of knowledge of CFI by the stakeholders, then the stages with potential or critical risks, and finally, the level of contamination of the trays, the dishwashers, the waitresses, the prepared fish, the cooked meals served hot to students in this FASTEF restaurant at UCAD, the unpasteurized juices and the sandwiches sold in the surrounding area.

2. Materials and Methods

2.1. Materials

2.1.1. Survey Material on the Socio-Demographic Composition and Level of Knowledge of CFI

The survey material used in this study consists of:

- Questionnaire sheets (physical format) made up of seven (6) parts, each of which includes several sections relating to variable parameters;

- A team of trained investigators made up of students;

- An Excel spreadsheet and XLstat software for data processing and exploitation.

2.1.2. Material for Identifying Potentially Risky and Critical Steps

The identification of potential and critical risk steps was made through the systematic analysis of the entire food chain (HAZOPS), the representation of manufacturing diagrams (of ready-to-eat meals, sandwiches and unpasteurized fruit

juices) and the application of the decision tree as a standard tool (Figure 1 and Figure 2).

2.1.3. Material for Bacteriological Analysis of Contamination at FASTEF and Surrounding Areas

Bacteriological analyses were carried out at the restaurant on surfaces, prepared fish and meals and in the surrounding area on unpasteurized fruit juices and sandwiches.

The technical equipment consists of a device for collecting, storing and transporting samples. Thus, the samples to be analyzed consist of:

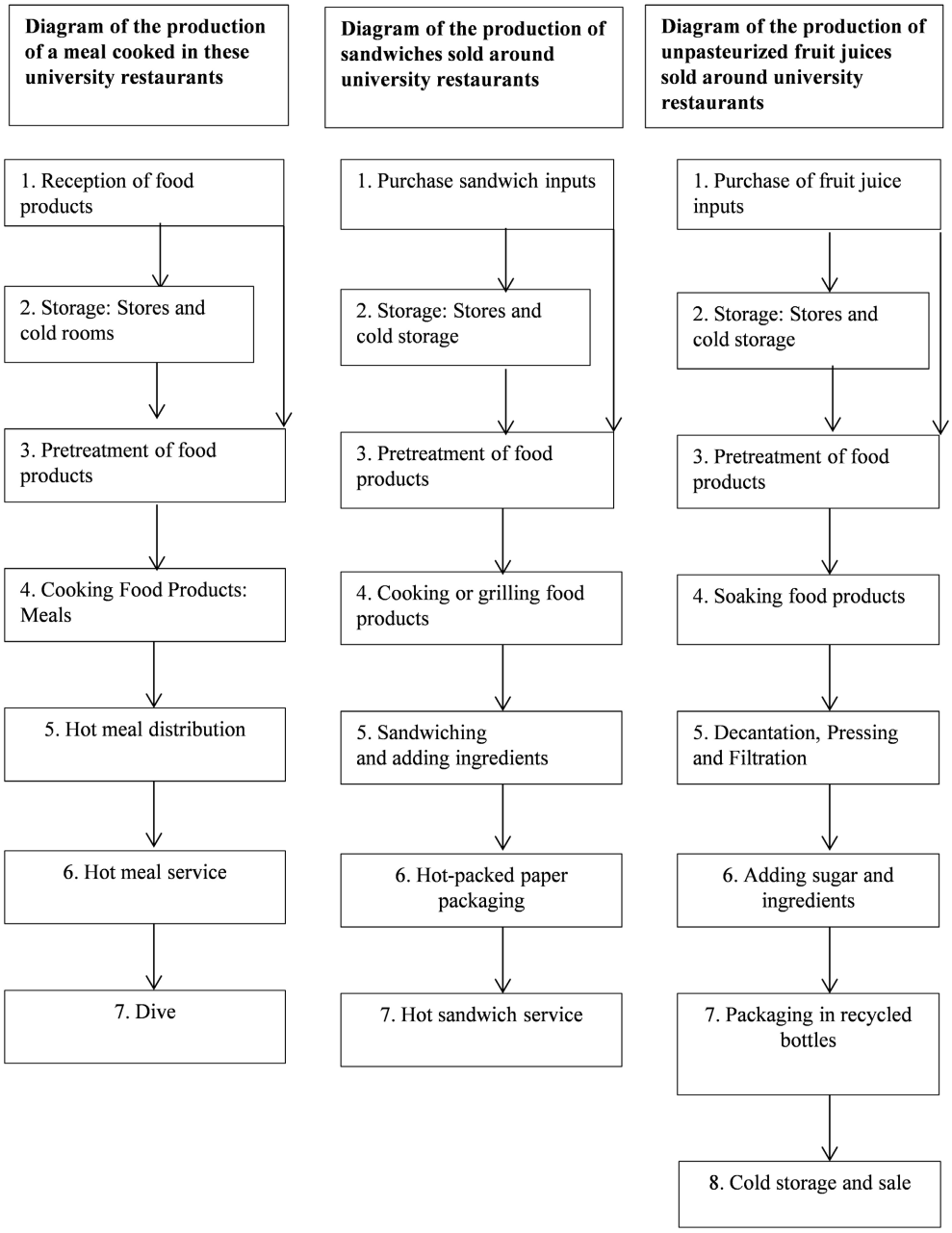

Figure 1. Diagrams of the production of a cooked meal, unpasteurized fruit juices and sandwiches.

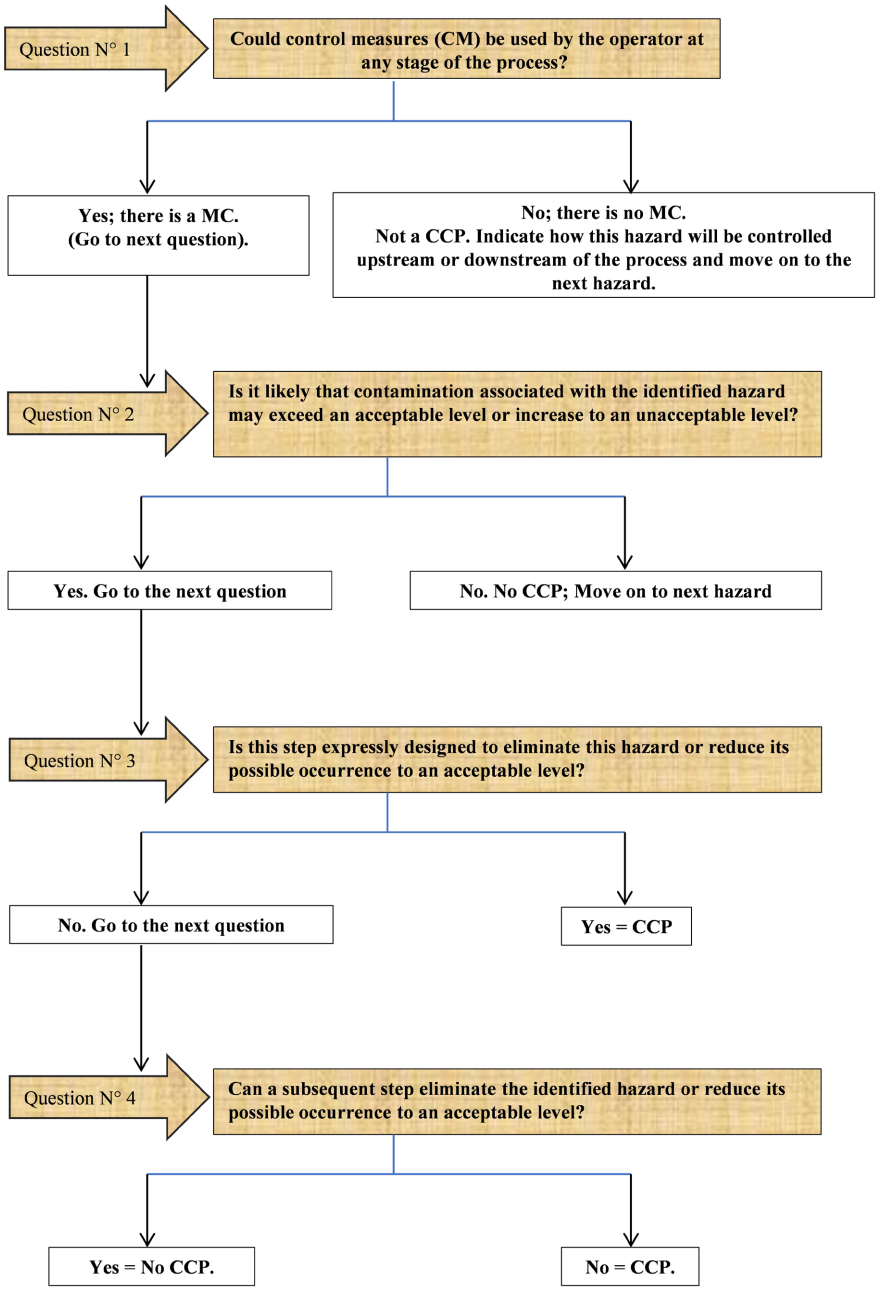

Figure 2. Decision tree.

o Surfaces of the plates;

o Surfaces of the hands of the washers;

o Surfaces of the hands of the servers;

o Raw products (processed fish);

o Cooked products (hot meals);

o Five categories of unpasteurized fruit juices sold around the FASTEF restaurant (Bouye, Bissap, Gingembre, Ditakh and Tamarin);

o Five categories of Sandwiches are sold around the FASTEF restaurant (Meat, Cowpea, Peas, Fatayas and Hamburgers).

2.2. Methods

2.2.1. Survey Methods on the Socio-Demographic Composition and Level of Knowledge of TIACs

As for the survey, we carried out a retrospective survey from 2012 to 2017 targeting students, restaurateurs, food vendors, heads of residence and medical facility agents in the five (5) social campuses of the universities of UGB, UCAD, UIT, UADB and UASZ represented by red stars on the geographical map of Senegal in Figure 3. The application of the sampling method from the sample size estimation table (95% ± 5% confidence level) of Krejcie and Morgan Ref. [10] made it possible to find the sample size of 384 people to be surveyed in these five (5) universities. The distribution was made pro rata in the universities according to the target given for each. Thus, the samples are established in Table 1 below. This part of the survey aims to determine the socio-demographic composition of the staff on these campuses and their level of knowledge of CFI. Likewise, the processes established for manufacturing meals in these university restaurants and other foods sold around these restaurants and the associated risks were determined.

2.2.2. Methods for Identifying Potentially Risky and Critical Steps

As for the identification of potentially risky and critical steps, the following procedure was adopted:

- The HAZOPS method (Hazard and Operability Studies) on the entire chain of restaurants and surrounding areas;
- The application of the decision tree to the manufacturing diagrams of unpasteurized meals, sandwiches, and juices.

Table 1. Sampling method from the Krejcie and Morgan sample size estimation table (95% confidence level ± 5%).

	Targets	UGB	UCAD	UIT	UADB	UASZ	TOTAL
POPULATION	Number of students	11.441	75.111	4.173	3.500	3.525	97.750
	Number of residences	15	47	10	9	5	86
	Number of restaurants	2	8	4	5	1	20
	Number of canteens	22	46	7	7	6	88
	Number of doctors	1	15	1	1	1	19
	Total in VA	11.481	75.227	4.195	3.522	3.538	97.963
	Total in VR (%)	11.72	76.79	4.28	3.60	3.61	100
	Total sheets	**45**	**295**	**16**	**14**	**14**	**384**
	Samples	**UGB**	**UCAD**	**UIT**	**UADB**	**UASZ**	**TOTAL**
SAMPLES	Number of students	23	211	5	3	3	245
	Number of residences	8	21	3	3	3	38
	Number of restaurants	4	28	3	3	3	41
	Number of canteens	8	20	3	3	3	37
	Number of doctors	2	15	2	2	2	23
	Total sheets	**45**	**295**	**16**	**14**	**14**	**384**

Figure 3. Map of Senegal: the red stars designate from top to bottom: UGB, UCAD, ITU, UADB and UASZ.

2.2.3. Methods of Bacteriological Analysis of Contamination at FASTEF and Surrounding Areas

For these bacteriological analyses, only one restaurant located on an external campus is chosen at UCAD; it is FASTEF. During the five (05) series of official analyses, four (4) germs on surfaces (Total Aerobic Mesophilic Flora, *Staphylococcus aureus*, Thermotolerant or fecal Coliforms and *Escherichia coli*) and five (5) germs in food products (Total Aerobic Mesophilic Flora, *Staphylococcus aureus*, Thermotolerant or fecal Coliforms, Sulfite-Reducing Anaerobes and Salmonella) were sought. The total number of samples analyzed was obtained according to the nature of the environment or the type of product; thus:

For surfaces located at the restaurant level:

- plates: 3 samples per series, which gives 15 samples per restaurant or 15 samples;
- washers: 3 samples per series, which gives 15 samples per restaurant or 15 samples;
- servers: 3 samples per series, which gives 15 samples per restaurant or 15 samples;

For food products located at the restaurant level:

- processed fish: 1 sample per series, which gives 5 samples per restaurant, *i.e.*, 5 samples;
- hot meals: 3 samples per series (the first at the start of the service, the second in the middle of the service and the third towards the end of the service), which gives 15 samples per restaurant, *i.e.*, 15 samples.

For the food products sold around this restaurant, two were chosen:

On the one hand, sandwiches:

- 5 categories of sandwiches sold on these campuses: (meat, cowpea, pea, Fataya

and Hamburger) among which two categories are concerned by this part of the study: sandwich with meat and with cowpea;

- 2 samples per series, which gives 10 samples per restaurant area or 10 samples.

On the other hand, unpasteurized fruit juices:

- 5 categories of fruit juices sold on these campuses: (Bouye, Bissap, Ginger, Ditah and Tamarin) among which two categories are concerned by this part of the study: Bouye and Bissap juice;

- 2 samples per series, which gives 10 samples per restaurant area or 10 samples.

The normative references, culture conditions and horizontal two- or three-class counting methods in Table 2 were used.

Table 2. Standards, culture media and incubation temperature used for the analysis of different microbiological flora.

Flores wanted on surfaces, food, meals and fruit juices	Normative References						
	Standards used	Environments of culture	Temperatures (in ˚C), incubation times (in h) and atmosphere	Criteria: (m) (Number of standard germs/g of food or surfaces tested)			
				Surfaces used	Fish costs elaborate	Meal and Sandwiches	Fruit juice
Total Aerobic Mesophilic Flora (TAMF) at 30˚C	NF EN ISO 4833	Standard agar (PCA: Plate Count Agar)	30˚C for 24 hours in aerobiosis	10^2	10^5	3. 10^5	3. 10^3
Staphylococcus aureus	NFV08-057-1	(BP: Rabbit Plasma Brain Heart Broth)	37˚C for 48 h in aerobiosis	10	10^2	10^2	$<10^2$
Coliforms thermotolerant or "faecal" 44˚C	NFV08-060	Bile Sodium Azide Aesculin Agar (BEA)	44˚C for 48 h in aerobiosis	10	10	10	$<10^2$
Sulfo-Reducing Anaerobes (ASR) at 37˚C	XPV 08-61	Tryptose Sulphite Cycloserine Agar (TSC) Liquid Thioglycolate	37˚C for24 h in anaerobiosis	30	10	30	30
Escherichia coli	ISO16649-2	TBX Agar	44˚C for24 h in anaerobiosis	10	10	10	10^2
Salmonella	NFV08-6579	Rappaport Vassiliadis (RV) Selenite-cystine (BSC) broth Brilliant Green Agar (GBA)	44˚C for 24 h in anaerobiosis 37˚C for 24 to 48 hours under aerobiosis	Absence/ 25 g	Absence /25 g	Absence /25 g	Absence/ 25 g

3. Results and Discussions

3.1. Results on the Sociodemographic Composition in These University Campuses

The study on the socio-demographic composition of these university campuses made it possible to obtain the results shown in Table 3.

These results show that in these universities, the number of men (76.92%) is higher than that of women (23.08%) and the staff is aging at 91.92%, so the level of study at 75.88% does not exceed the first cycle. Nevertheless, there are graduates of the second cycle at 13.68% and of the third cycle at 10.44% generally in the medical services. The results of the work are different from those of Julie Leport *et al.* (2017) [11], in which 8.4% of the targets were not educated, 26.5% stopped at primary school, 31.3% continued to secondary school and 19.2% to higher education.

Table 3. Socio-demographic composition of university campus staff.

Socio-demographic parameters	Sex (%)		Seniority (%)		Level of education (%)		
	M	F	New	Old	1˚ Cycle	2˚ Cycle	3˚ Cycle
Results	76.92	23.08	8.08	91.92	75.88	13.68	10.44

3.2. Results of the Survey on the Level of Knowledge of CFI

The results of the study on the level of knowledge of CFI on these university campuses are recorded in Table 4 below.

Table 4. Level of knowledge of TIAC by staff.

Parameters knowledge of CFI		Concept of CFI	Nature of MADO	Types of CFI	First Care
Results	Knowledge (%)	86.12	50.52	28.48	31.56
	Ignorance (%)	13.88	49.48	71.52	68.44

The survey results reveal that 13.88%, 49.48%, 71.52% and 68.44% are respectively unaware of the concept of CFI, their nature of notifiable diseases, the different types and first aid. However, the values obtained on the level of knowledge of CFI are different from those found by Diallo M. L. *et al.* (2010) [12], who are almost 100% satisfied with well-trained staff.

3.3. Results of the Identification of Potentially Risky and Critical Steps

The identification of potentially risky and critical steps gave the results, which are recorded in Table 5.

All the steps mentioned in these diagrams are potentially at risk and critical in number of 4, 3 and 1 respectively for meals cooked in university restaurants, unpasteurized fruit juices and sandwiches sold around restaurants. For each type of product, the critical steps are:

- For meals cooked in university restaurants: pre-treatment of raw vegetables, cooking, storage in a hot cupboard, service and washing up;

- For unpasteurized fruit juices sold around restaurants: pre-treatment, soaking and packaging in recycled bottles;

- For sandwiches sold around restaurants: cooking or grilling.

For meals cooked in university restaurants, our results confirm the rates obtained by Diop *et al.* (2010) [13] and that in reality, all stages constitute potential sources of CFI. The critical stages found are not very close to those obtained by d'Ergonul *et al.* (2002) [14] and Diop *et al.* (2010) [13].

3.4. Bacteriological Results of Contamination in the Restaurant and Surrounding Areas

Bacteriological analyses, in order to determine the level of contamination at the restaurant level (surfaces, processed fish and meals) and outside the restaurant

(unpasteurized juices and sandwiches) gave the results which are recorded in Table 6.

Table 5. Potential and critical stages identified on the three respective charts of meals, unpasteurized fruit juices and sandwiches.

Serial number of the step (of the three manufacturing processes) concerned	Potential and critical stages of the process of manufacturing cooked meals in these restaurants	Potential and critical steps in the sandwich making process	Potential and critical risk steps in the unpasteurized fruit juice manufacturing process	Preventive measures to be applied in the three manufacturing processes
Step Number 1	The reception of raw materials is a step with a potential risk of contamination or alteration.	Buying food for sandwiches at the market is a step with a potential risk of contamination, or non-compliant DLC.	Purchasing food for unpasteurized fruit juice at the market is a step with a potential risk of contamination or spoilage by mold and others.	Respect food hygiene standards with strict control of freshness and shelf life at purchase and receipt.
Step Number 2	Store or cold storage is a step with a potential risk of alteration by heating or contamination.	Store or cold storage for sandwiches is a potentially risky step of contamination.	Store or cold storage during fruit juice making is a potentially risky step of mold alteration or contamination.	Comply with storage standards with strict control of cold temperatures and aeration of products stored in the store.
Step Number 3	Pre-treatment is a risky step for cross-contamination and a critical step for raw vegetables.	Pre-treatment of food for sandwiches is a step with a potential risk of cross-contamination	The pre-treatment of unpasteurized fruit juice foods is a critical step with a high rate of initial contamination reinforced by handling.	Respect the hygiene standards of cleaning disinfection by avoiding cross-contamination.
Step Number 4	Cooking is a critical step.	Cooking or grilling is a critical step	Soaking is a critical step.	Ensure sanitizing cooking and proper soaking.
Step Number 5	Distribution or reassembly is a potentially risky step related to handling.	Sandwiching is a potentially risky step related to handling and contamination.	Decantation, pressing and filtration are a potentially risky step related to contamination and handling.	Respect hygiene standards by covering food, controlling the environment and the equipment used.
Etape Number 6	Hot service is a critical step.	Packaging is a potentially risky handling step.	Adding sugar and ingredients is a potentially risky handling step.	Serve above 63 ˚C and avoid cross-contamination when adding elements.
Step Number 7	Diving is a critical step.	Hot serving is a potentially risky handling step.	Packaging in recycled bottles is a critical step.	Respect the standards of cleaning, disinfection and packaging.
Step Number 8	-	-	Cold service is a potentially risky step related to handling and alteration following a cold break.	Respect the standards of conservation and sale of unpasteurized juice. Put in quantity of quality ice.

Table 6. Level of bacteriological contamination of surfaces and food in the restaurant and unpasteurized fruit juices and sandwiches sold nearby.

Origin Samples	Types of samples (in restaurants and surroundings)			Appreciation some results	Level of satisfaction in (%)
					Restaurant FASTEF
Interior of the restaurant	Surface	Material	Surfaces of plates	Satisfactory	46
				Acceptable	2
				Not satisfactory	52
		Biological	Hand surfaces washers	Satisfactory	45
				Acceptable	4
				Not satisfactory	51
			Hand surfaces servers	Satisfactory	54
				Acceptable	11
				Not satisfactory	35
			Biological surfaces	Satisfactory	49,5
				Acceptable	7,5
				Not satisfactory	43
			Total surfaces	Satisfactory	47,75
				Acceptable	4,75
				Not satisfactory	47,5
	Food	Fish	Elaborated fish	Satisfactory	60
				Acceptable	20
				Not satisfactory	20
		Meal	Hot meals	Satisfactory	100
				Acceptable	0
				Not satisfactory	0
Surroundings restaurant	Other foods	Juice	Unpasteurized fruit juices	Satisfactory	95
				Acceptable	0
				Not satisfactory	5
		Sandwiches	Sandwiches	Satisfactory	90
				Acceptable	4
				Not satisfactory	6

The bacteriological survey carried out on samples from this university restaurant (FASTEF) of UCAD is 46%, 45%, 54%, 60%, and 100% satisfactory respectively for the plates, the hands of the washers, the servers, the prepared fish and the cooked meals served hot to the students. These results on the bacteriological survey of the material and biological surfaces are less satisfactory than those of Njueya *et al.* (2006) [15], which are between 60 and 80% satisfaction. The values found in this study on the prepared fish (60% satisfactory) are different from those

found by Seydi *et al.* (1992) [16] (68.7% non-compliance). Concerning the hot meals, the results of the study are identical to those of Sylla *et al.* (2003) [17].

The bacteriological survey carried out on samples of unpasteurized fruit juice sold around this university restaurant (FASTEF) of UCAD is 95% satisfactory. These bacteriological results revealed a total absence of pathogenic bacteria; this finding is identical to that of Ndiaye *et al.* (2015) [18], unlike the finding of Ouattara *et al.* (2018) [19] which notes the presence of pathogens in these juices produced in an artisanal way. Concerning the bacteriological survey carried out on samples of sandwiches sold around this university restaurant (FASTEF) of UCAD, it is 90% satisfactory and 4% acceptable; this result remains better than that found by Ndione A. *et al.* (2000) [20] which is 70% satisfactory and 30% acceptable.

4. Conclusion

The results of this study reveal that on these campuses, the TIAC is really unknown by the actors located in the university canteens as well as those in the surrounding area. The level of non-compliance with the rules of good hygiene and manufacturing practices is very high and constitutes a real threat to the health and safety of food intended for students. This threat and the risks of CFI are reinforced by the fact that some foods are prepared at home in the absence of any control and then displayed and sold on these university campuses. To ensure good knowledge of CFI and control of their risks, it is necessary to recruit qualified staff, and train them in the rules of good practice with very sustained periodic awareness-raising.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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