Assessment of the Microbial Quality of Braised Products from Bangangte City and Antibiotic Susceptibility of Selected Pathogens Isolated Therein

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MMP and CN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors HTM, TNN and ICD managed the analyses of the study. Author MNT managed the literature searches. Authors FT, LNT and NYN oversaw the research and writing of the article. All authors read and approved the final manuscript.

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ABSTRACT

The present study had as objective to assess the microbiological quality and profile of some braised products and their accompanying soups sold in the city of Bangangte (Cameroon) and evaluate the antibiotic susceptibility of selected pathogens isolated in these products. An investigation was conducted in three locations in city of Bangangte in order to assess the environment and working conditions as well as the respect of good hygiene practices. Then, samples of braised fish (05) and its soups (05), and braised chicken (05) and its soups (05) were collected from six vendors in each location. The samples (360) were submitted to microbiological analyses and the isolates were identified at species level using API gallery. The susceptibility of the isolates to 14 antibiotics were tested. The 72 participants involved in this study declared having knowledge on hygiene despite the fact that, most of them had no formal education and do not apply good hygiene practices. Microbiological analyses revealed the poor quality of all the samples of braised products. Fecal coliforms and staphylococci counts higher than the values recommended by norms demonstrated the non-respect of good hygiene and manufacturing practices during the braising activity. The 169 strains isolated from these products belonged to 12 different species: *Enterobacter gergoviae*, *Enterobacter* spp., *Morganella morganiae*, *Yersinia enterolitica*, *Yersinia frederiksenii*, *Staphylococcus aureus*, *Staphylococcus epidermitidis*, *Staphylococcus* spp., *Clostridium* spp., *Klebsiella pneumoniae*, *Enterobacter aerogene*, and *Proteus mirabilis*. Strains which could be considered as marker of braised fish sold in the city of Bangangte were *Yersinia enterolitica*, *Staphylococcus aureus* and *Klebsiella pneumonia* while for braised chicken, they were *Yersinia enterolitica*, *Staphylococcus aureus* and *Proteus mirabilis*. The antibiotic susceptibility test performed on these pathogens revealed that they were resistant with 93.75% having multiple antibiotic resistance index values greater than 0.2. We conclude that the microbiological quality of braised products is poor and we suggest to producers to applicate the good hygiene practices. For breeders, we suggest respecting withdrawal periods and the better use of antibiotics.

1. INTRODUCTION

The phenomenon of street food in African cities is not recent. In these cities, street food is nowadays becoming a growing sector of activity as it is consumed by more than 2.5 billion of people every day [1]. Reasons behind are the low incomes of the great majority of the population, the migration from rural to urban cities, the demographic growth, the high cost of meals sold close to the workplace, and the long distances between the workplace and home [2-3]. Besides, street foods are available, inexpensive and nutritious and sold closed to workplace [4]. In Cameroonian cities, there are several street vended foods including bread accompanied with beans, fried eggs, spaghetti or sardine, meals, fritters, fermented milk, chips, fruit juices, peanut products, boiled, roasted and braised meat and fish [5]. Amongst these products, a particular attention is paid to braised products because the braising process improves the color, aroma and taste of the products [6]. Braised products such fish, chicken, beef, goat, sheep, pork are highly consumed and solicited by urban population [7]. Among the different forms of cooked fishes sold in the city of Yaounde (Cameroon), the braised form was reported as the most accepted one [8] and braised mackerel and carp as the most appreciated fish species [9]. However, the braising conditions of these products might lead to a microbial contamination. In fact, the braised products are air-exposed during the selling period and could get contaminated with dust and insects. Besides, water as well as utensils of uncertain microbiological quality are used with associated failure to comply with basic principles of hygiene rule during the braising activity, the poor storage of unsold products [10]. In these conditions, the braised products are getting contaminated independently of the heat treatment applied during the braising process. The consequences might be the rapid spoilage of the products as a result of microbial activity, the modification of the nutritional value of the products and the outbreak of foodborne diseases [11].

Nowadays, the production of fish and chicken in Cameroon it is still insufficient to meet the market demand due to the growing population (2.8

annually) and rapid urbanization which has consequently led to a significant increase in their prices [12]. In order to satisfy the increasing demand of braised products by consumers, antibiotics are used abusively in farming activities, and this could result in the presence of antibiotics residues in final products. The exposition of microflora to these residues might have as consequence the development of resistances [13-14].

In this context, the present study was designed and has as objective to assess the microbiological quality and profile of some braised products and their accompanying soups sold in the city of Bangangte (Cameroon) and evaluate the antibiotic susceptibility of selected pathogens isolated in these products.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the City of Bangangte (5° 15'N and 10° 50' E). Bangangte is located in the Department of Nde, Western Region of Cameroon. Braised products such as fish and chicken were daily available. The study was carried out from September to October 2020.

2.2 Study Population

The study which involved vendors of braised products in the City of Bangangte, was approved. Only volunteer vendors were included in the study and they were randomly selected in 3 locations (Bangangte I, Bangangte II and Bangangte III) in the city of Bangangte.

2.3 Study Design

A cross-sectional study was performed in the city of Bangangte from. Thirty-six (36) vendors of braised products were randomly chosen from different retail outlets spread over 3 locations in the city of Bangangte.

2.4. Questionnaire Design

Information's on the braising activity were collected by the means of a questionnaire. The semi structured questionnaire has three sections: the socio-demographic characteristics, the environment and working conditions, and the respect of good hygiene practices. The questionnaire was designed and pretested through a pilot study. Thereafter, the questionnaire which contained open-ended and closed questions was adjusted. It was then administrated through a direct interview to the different actors of braised products (fish and chicken). The questionnaire sought information on the socio demographic characteristics of the population investigated, their working environment as well as the working conditions, and finally, the respect of good hygiene practices during the braising activity.

2.5 Samples Collection

A convenience sampling design was used to collect samples of braised fish and chickens as well as the spicy soup accompanying the braised products during its consumption. In each location, six vendors of braised fish and 6 vendors of braised chicken were randomly chosen. Five samples (400 g each) of braised fish and five samples (50 g each) of its spicy soup as well as five samples (400 g each) of braised chicken and five samples (50 g each) of its spicy soup were collected from each vendor. A total of 360 samples were collected, transferred into sterile bags, labeled and transported to the laboratory in an icebox cooler.

2.6 Microbiological Analyses

Microbiological analyses performed in this study aimed at assessing the total mesophilic aerobic flora, fecal coliforms, yeast and moulds, *Staphylococcus* spp. and enterococci.

2.6.1 Samples processing

Samples were processed at the laboratory following the method ISO 6887-2 [15]. In the protocol, the five samples were pooled and crushed under aseptic conditions. Then, 25 g were introduced into a sterile flask containing 225 mL of sterile peptone water (LiofilChem, Italy). The mixture was homogenized and kept at room temperature for 30 min in order to allow microbial revivification. The revivificated solution was decimally diluted (10^{-1} to 10^{-7}).

2.6.2 Plates inoculation and culture conditions

Enumeration of total aerobic mesophilic flora (TAMF) was performed following the pour plate method ISO 4833-1 [16]. After introducing 1 mL of the different dilutions into Petri dishes, 15 mL

of sterile Plate Count Agar (PCA, LiofilChem, Italy) added. The mixture was homogenized, left at room temperature for 30 min and then incubated in aerobic condition at 30°C for 48 h. Regarding fecal coliforms, the spread plate method ISO 4832 [17] was used. Petri dishes containing 15 mL of sterile Eosin Methylene Blue agar (EMB, LiofilChem, Italy) were inoculated with 0.1 mL of the different dilutions and incubated at 44°C for 24 h. Yeast and moulds were enumerated following the spread plate method ISO 21527-1 [18]. Petri dishes filled with 15 mL of Sabouraud agar supplemented with chloramphenicol (LiofilChem, Italy) were inoculated with 0.1 mL of the different dilutions and incubated at 25°C for 72 and 120 h respectively for yeast and moulds. For *Staphylococcus* spp., the method ISO 6888-2 [19] was used. Briefly, 0.1 mL of the different dilutions was inoculated into a Petri dish containing 15 mL of sterile Chapman agar (LiofilChem, Italy) followed with incubation at 37°C for 48 h. Enterococci were enumerated after inoculating 0.1 mL of the different dilution onto sterile Bile Esculin Azide agar. The Petri dishes were incubated at 37°C for 48 h [20]. Clostridia were sought in tryptone sulfite neomycin agar (TSN, LiofilChem, Italy) medium incubated at 46 °C for 18 – 24 hours, anaerobically.

2.6.3 Plates reading

Petri dishes were observed after incubation and colonies forming units were counted. Petri dishes considered were those with colony-forming units between 30 and 300. The microbial counts obtained from triplicate experiments were summarized as mean load and the final results expressed as colonies forming unit per gram of braised products.

2.7 Identification of Isolated Pathogens

Individual colonies appearing on each Petri dish were sub-cultured thrice on nutrient agar and identified using standard bacteriological tests such as the macroscopic (colony shape, size and color), microscopic (Gram staining), cultural (growth at different temperatures and NaCl concentrations) and biochemical (catalase, coagulase, oxidase) traits of isolates as well as their fermentative profile through their Analytical Profile Index (API). The different tests were performed according to Bergey's Manual of Determinative Bacteriology [21]. The results obtained from API galleries were analyzed using

the software Apident 2.0 (BioMérieux, France) and the identity of strains was confirmed through comparison with Bergey's Manual of Determinative Bacteriology [21] and online (https://apiweb.biomerieux.com).

2.8 Antibiotics Susceptibility Tests

The disk diffusion method of the American Society for Microbiology [22] with slight modifications was used to determine the susceptibility of the isolates to Ciprofloxacin (CIP, 5 µg), Cotrimoxazole (SXT, 25 µg), Cefuroxime (CXM, 30 µg), Ceftazidime (CAZ, 10 µg), Amoxycillin-clavulanic acid (AMC, 30 µg), Amoxycillin (AX, 30 µg), Norfloxacin (NOR, 10 µg), Nitrofurantoin (F, 300 µg), Gentamicin (GEN, 10 µg), Cefroxadine (FX, 10 µg), Erythromycin (ERY, 10 µg), Nalidixic acid (NA, 30 µg), Ampicillin (AMP 10 µg), and Imipenem (IMP, 10 µg). Inoculum preparation for the antibiotic's susceptibility test was performed as followed. Isolates were sub-cultured in Trypticase Soy Broth (TSB, LiofilChem, Italy) at 37°C for 24 h. The cultures were centrifuged (6000 g, 20 min, 4°C), cells were washed with sterile phosphate saline buffer (PBS, pH 7.2), and suspended in PBS. Their loads were adjusted to 0.5 McFarland standard [22]. For test realization, the culture suspension (0.5 McF) was plated on sterile Mueller Hinton agar (MH, LiofilChem, Italy) using sterile swabs. The Petri dishes were left at room temperature for 30 min in order to allow evaporation of excess of culture. Then, antibiotic disks were placed on the plates (six disks per plate) using sterile pinces. The plates were incubated at 37°C for 24 h and the diameters of the inhibition zone surrounding each antibiotic disk were measured and recorded to the nearest millimeter. Isolates were classified as susceptible, intermediate or resistant according to the zone diameter interpretative standards of the Clinical and Laboratory Standards [23]. Multiple antibiotic resistance (MAR) index was determined for each isolate by dividing the number of antibiotics to which an isolate is resistant with the total number of antibiotics tested [24]. MAR index value > 0.2 indicates that the tested strains were isolated from high-risk sources [25].

2.9 Statistical Analysis of Data

Data from investigation was analyzed using the Statistical Package for the Social Science 20.0 (SPSS) and Sphinx Plus² - Edition Lexica-V5. Using descriptive statistics, data for continuous

variables were summarized as means and standard deviation while the ones for categorical variables were summarized as percentages. Triplicate data obtained from the microbiological analyses and antibiotics susceptibility tests were expressed as means ± standard deviation. One-way ANOVA and Duncan multiple range test were used to compare means at *P*-values lower than .05.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic Characteristics of the Study Population

A total of 72 participants were involved in this study amongst which 50 % were females and the other 50 % were males (Table 1). This result is not in accordance with previously reported studies which confirmed that female was dominant in street vended food in developing countries [2, 26-28]. An explanation to this observation could be the fact that braised chicken activity is mostly performed by men in Cameroon because according to the tradition, slaughter is reserved to male. Most of these participants (56 %) had no formal education. This result is worrisome as it is well known that formal education might promoted a good understanding of good hygiene practices. The highest proportion of participants were aged between 29 and 38 years (39 %). Danikuu et al. [26] also noticed that regarding street food business in the Tamale Metropolis, a high proportion of vendors were aged between 20 and 39 years.

Fifty-eight percent of the population declared that they had received training on the braising activity. Amongst these 58 %, 33 % were self-training and 25 received a formal training in school. In fact, because of their low education level, most of participants started the braising activity by working for another person. After getting sufficient experience, they leave and created their own braising structure. The braised products identified in this study were chicken and fish. This could be ascribed to their lower cost compared to other meat products such as beef, sheep or goat. The animals were mainly collected in two points: fish shops (67%) and farms (86%). This could be justified by the fact that, the climate of the western region of Cameroon where Bangangte is located, offers sufficient conditions to bred fish and chicken.

Water used during the braising activity was from borehole (41%) and tap (41%). However, the storage conditions of water are questionable as they used cans. These cans were not properly cleaned and closed and they were handled by many persons including customers who wanted to drink water. In these conditions, dishes cleaned and rinsed with the water might be contaminated. Besides, outbreaks of toxi-infection associated to braised products might to ascribed not only to the quality of braised products but also to the quality of water drunk by costumers. In a study conducted by Nkah [29] on braised mackerels sold in the city of Douala (Cameroon), it was noticed that water used by braised fish vendors are stored in cans and the same can is used as source of water for preparing fish, wash utensils (during and after service) as well as source of hand washing and drinking water.

It was noticed that 66.67 % of braising structures were close to gutter. This could be justified the street vended nature of the braising activity. In fact, these actors do not have sufficient money to buy a specified place and pay tax. Reason why their used street corner as selling place and most of streets are surrounded by gutters which allow a proper circulation of waste water. The main distance between vendors were 1 to 5 m (58 %). This observation could be explained by the fact that, they are some streets which are highly frequented by almost all the population. In these streets a concentration of street food vendors is always observed.

Although 100% of participants declared to have knowledge on hygiene and to regularly clean their grill, it was noticed that they do no empty gutters and they mainly used cement papers for packaging (61.11 %). Given that, these papers contained residues of cement which are very harmful for human health and knowing that most of participants had no formal education, their knowledge of hygiene became questionable.

It comes from Table 2 that un-sold products are mostly stored at home and resold the next day (83.3 %). This practice is liable to favor the growth and proliferation of some spore forming and toxin-producing bacteria such as *Bacillus cereus* [30]. The consumption of such products might result in foodborne diseases [31].

3.2 Microbiological Quality of Braised Products Sold the City of Bangangte

Table 3 presents the mean microbial loads (Log CFU/g) of the six samples of braised fish and six

samples of its soup, six samples of braised chicken and six samples of its soup collected per locality in the city of Bangangte.

3.2.1 Braised fish and its seasoning soup

With regards to the total aerobic mesophilic count, all analyzed samples were contaminated independently of the nature (soup, fish) at a level which varies significantly ($P < .05$) from one location to another. Amongst braised fish samples, the less contaminated one was those from Bangangte II (5.77 ± 1.30 Log CFU/g) while

samples from Bangangte I and III showed total aerobic mesophilic flora (TAMF) loads which were not significantly different (Table 3). The TAMF loads of braised fish samples obtained in this study is higher than those reported by Maffouo [9] with braised carp samples sold in the city of Yaounde. The authors found a TAMF load ranging from 4.01 to 6.66 Log CFU/g. This difference could result from the variation in the braising fish processes and also from the species of fish which is braised. Carp opposite to mackerel analyzed in the present study generally takes enough time to be braised.

Table 1. Socio-demographic characteristics of the vendors of braised products in the city of Bangangte, Cameroon

Parameters		Frequency	Percentage (%)
Sex	Male	36	50
	Female	36	50
Education level	No formal education	40	56
	Primary	24	33
	Secondary	8	11
	University	0	0
Age	18-28 years	19	26
	29-38 years	28	39
	38 years and more	25	35
Location	Bangangte I	24	33.3
	Bangangte II	24	33.3
	Bangangte III	24	33.3

Table 2. Abbreviated questionnaire of street vended braised products in the city of Bangangte, Cameroon

Parameters		Frequency	Percentage (%)
Training	Yes	42	58
	No	30	42
Nature of training	Self-training	24	57.14
	Formal training	18	42.86
Products	Fish	36	50
	Chicken	36	50
Origin of the products	Fish shop	24	33.33
	Farm	31	40.05
	Others	17	23.61
Origin of water	Borehole	30	41
	Tap	30	41
	Well	12	18
Proximity with gutter	Yes	48	66.67
	No	24	33.33
Knowledge of hygiene	Yes	72	100
	No	0	0
Cleaning of grill	Yes	72	72
	No	0	0
Distance between vendors	1 - 5 m	42	58
	5 – 10 m	18	25
	10-20 m	12	17
Packaging	Plastic	4	5.56
	Journal papers	24	33.33
	Cement papers	44	61.11
Unsold products	Sored and sold the next day	60	83.3
	Family consumption	12	16.7

Table 3. Mean microbial loads (Log CFU/g) of the samples of braised fish and its soup, and braised chicken and its soup collected per locality in the city of Bangangte, Cameroon

Products	Location	Microbial flora (Log CFU/g)				
		TAMF	Fecal coliforms	Fungal flora	*Staphylococcus* spp.	Enterococci
Braised fish (n=90)	Bangangte I	8.40 ± 0.62[b]	6.54 ± 0.67[a]	6.04 ± 0.99[ab]	5.82 ± 1.08[a]	0 ± 0.00
	Bangangte II	5.77 ± 1.30[a]	5.84 ± 1.23[a]	5.47 ± 0.56[a]	5.37 ± 0.90[a]	0 ± 0.00
	Bangangte III	8.58 ± 0.49[b]	5.91 ± 1.12[a]	6.82 ± 1.43[b]	6.24 ± 1.40[a]	0 ± 0.00
Braised fish soup (n=90)	Bangangte I	8.73 ± 0.93[a]	6.60 ± 1.12[a]	6.01 ± 2.03[a]	6.43 ± 1.19[a]	0 ± 0.00
	Bangangte II	7.71 ± 1.50[a]	5.68 ± 1.09[a]	5.59 ± 0.56[a]	5.69 ± 1.60[a]	0 ± 0.00
	Bangangte III	8.76 ± 0.40[a]	6.27 ± 0.90[a]	5.51 ± 0.07[a]	8.62 ± 0.83[b]	0 ± 0.00
Braised chicken (n=90)	Bangangte I	8.72 ± 0.39[a]	4.33 ± 0.01[a]	4.78 ± 0.50[b]	5.33 ± 0.42[a]	0 ± 0.00
	Bangangte II	8.85 ± 0.13[a]	5.82 ± 0.26[b]	3.35 ± 0.55[a]	7.56 ± 0.58[c]	0 ± 0.00
	Bangangte III	9.75 ± 0.23[b]	7.64 ± 0.37[c]	5.61 ± 0.49[c]	6.73 ± 0.33[b]	0 ± 0.00
Braised chicken soup (n=90)	Bangangte I	9.40 ± 0.55[b]	6.28 ± 0.27[b]	6.39 ± 0.48[b]	6.50 ± 0.44[b]	0 ± 0.00
	Bangangte II	9.12 ± 0.46[ab]	6.86 ± 0.06[c]	3.47 ± 0.49[a]	7.34 ± 0.56[c]	0 ± 0.00
	Bangangte III	8.40 ± 0.88[a]	5.59 ± 0.56[a]	5.73 ± 0.64[b]	3.88 ± 0.03[a]	0 ± 0.00
Norms		6	2	4	3	0

Mean values with same superscript letters on a same column are not significantly different at P < .05, Norms=Microbiological Criteria of foods intended to human consumption [32]

Amongst the braising soup samples which accompanied braised fish during its consumption, the TAMF loads although not significantly different from one location to another, were higher than those recorded for braised fish samples. This could be explained by the fact that, during the braising process, raw fish is generally daubed on the grill with spicy soup and refined oil using a brush. However, the same brush without being cleaned is again introduced in the spicy soup to daub the braised fish. In these conditions cross-contamination might occurred leading to a contamination of the spicy soup with pathogens from the raw fish and a contamination of braised fish through the use of a contaminated spicy soup. Similar braising behaviors were reported by Nkah [29] in a survey on braised mackerels sold in the city of Douala (Cameroon), and by Maffouo [9] during his study on braised fish sold in the city of Yaounde (Cameroon). Taking into consideration the Microbiological Criteria for Foods intended to Human consumption [32] which specified that the TAMF loads should not exceeded 6 Log CFU/g of sample, only braised fish samples from Bangangte II can be considered as suitable. The rest of samples including all accompanying soups were out of the threshold value of the norm. This result suggests that important measures regarding the good hygiene and manufacturing practices should be taken by the braised fish vendors in order to protect consumer health.

Fecal coliforms were also analyzed in the braised fish samples and its soup. The results showed that all analyzed samples were contaminated although not significant difference were noticed. However, the loads were far higher than the threshold value recommended by the norm which is 2 Log CFU/g. The presence of fecal coliforms could be attributed to the non-respect of good hygiene practices during the braising process. It could also be the result of a cross-contamination with brush used to daub fish on grill as previously mentioned or knife used to handle fish during the braising process and to cut raw onion. Unhygienic handling conditions associated to the presence of fecal coliforms in foods were highlighted by Adeyeye et al. [33] and Dutta et al. [34]. Moreover, instruments such as knives, saws, cleavers, and vessels used during food processing, were noticed as food contamination sources by Biswas et al. [35].

Microorganisms associated to food handling by humans called staphylococci [36-37] were found in all samples of braised fish as well as its accompanying soup. Globally, braised fish samples were less contaminated than their respective accompanying soup. Although no significant difference was noticed between the braised fish samples independently of the locality, samples from Bangangte II scored the less count of staphylococci (5.37 ± 0.90 Log CFU/g) while samples Bangangte III scored the highest staphylococci count (6.24 ± 1.40 Log CFU/g). The similar observation was noticed with the spicy soups as samples from Bangangte II recorded the less staphylococci count (5.69 ± 1.60 Log CFU/g) and samples from Bangangte III recorded the highest one (8.62 ± 0.83 Log CFU/g). This result suggests that the braised fish vendors of the locality of Bangangte II respected some good hygiene practices such as avoid discussion with customers while braising fish, avoid sneezing with free hand avoid cleaning with free hand sweat coming from perspiration, and avoid coughing while handling fish. It is well known that application of these hygiene practices prevents contamination of foods with staphylococci as that pathogen is normally found in human skins, nose, sweat and saliva [38-39]. As observed in Table 3, all samples were contaminated in staphylococci at a load higher than the value (3 Log CFU/g) specified by the Microbiological Criteria of foods. The presence of *Staphylococcus* spp. at loads higher than the norm (from 3.33 to 6.47 Log cfu/g) was also noticed in braised carp sold in the city of Yaounde by Maffouo [9].

Fungal flora was detected in braised fish and its soup samples. As observed for the other germs, braised fish samples from Bangangte II showed the low fungal load (5.47 ± 0.56 Log CFU/g) while samples from Bangangte III showed the highest fungal load (6.82 ± 1.43 Log CFU/g). Regarding soup samples, no significant difference of fungal load was noticed independently of the locality. However, all analyzed samples showed a fungal load higher than the norm (4 Log CFU/g). The high contamination with fungal flora observed in this study could result from the air exposition of braised fish during its selling. In fact, air might contain fungal spores which can resist to heat treatment [40]. Hence, important measures such as the protection of braised fish with transparent glass and frequently watering the surrounding braising environment should be implemented by vendors. However, enterococci were not found in all samples independent of the locality.

3.2.2 Braised chicken and its seasoning soup

Besides braised fish which is very prized and commonly found in several streets in the city of Bangangte, braised chicken is nowadays available despite its high cost. In this study, braised chicken samples as well as their accompanying soup were collected and analyzed. Table 3 shows that TAMF were detected in all samples at load which significantly (P < .05) ranging from 8.72 ± 0.39 (Bangangte I) to 9.75 ± 0.23 Log CFU/g (Bangangte III) for chicken samples and from 8.40 ± 0.88 (Bangangte III) to 9.40 ± 0.55 Log CFU/g (Bangangte I) for soup samples. The TAMF loads of the samples were higher than the norm (6 Log CFU/g). These results showed that the different samples were of poor microbiological quality and suggests a potential health risks for consumers. TAMF was reported in the literature as a good indicator of the quality of foods intended to human consumption [41]. Moreover, the high level of TAMF indicated a reduced shelf live for these braised products. In fact, according to ICMSF [42], the maximum level of TAMF up to which meat products start to spoil is 7 Log CFU/g. Meat spoilage associated to a total aerobic count higher than 7 Log CFU/g was highlighted by Mouafo et al. [43].

Fecal coliforms count of the different samples ranges significantly (P < .05) from one locality to another. For braised chicken samples, 4.33 ± 0.01, 5.82 ± 0.26 and 7.64 ± 0.37 Log CFU/g were found in Bangangte I, Bangangte II and Bangangte III, respectively. In soup samples, 6.28 ± 0.27, 6.86 ± 0.06 and 5.59 ± 0.56 Log CFU/g were obtained in samples from Bangangte I, Bangangte II and Bangangte III, respectively. The significant variation of fecal coliforms load from one locality to another could be ascribed to the great variability in the application of good hygiene practices as observed during the investigation. A significant variation of the level of contamination of a street food according to the sampling site was also noticed by Ed-Dra et al. [44].

Staphylococci were detected in the different samples at load higher than the norms (3 log CFU/g). Globally, chicken samples (5.33 ± 0.42 Log CFU/g) from Bangangte I were less contaminated than the soup collected in the same locality (6.50 ± 0.44 Log CFU/g). Opposite observations were noticed in Bangangte II and Bangangte III where chicken samples were more contaminated than their accompanying soup.

Yeast and moulds counts of the different samples were significantly (P < .05) different from one locality to another. The fungal flora count ranging from 3.35 ± 0.55 to 5.61 ± 0.49 Log CFU/g were detected in chicken samples while loads ranging from 3.47 ± 0.49 to 6.39 ± 0.48 Log CFU/g were observed in soup samples. The storage conditions of chicken and soup could explain the contamination observed in this study. In fact, braised chicken and soups are air-exposed during the whole selling period. Associated to this, they are handled by customers while performing their choice. Besides, the hygiene conditions of vendors might also justify the high contamination recorded in this study. However, regarding the fungal flora load, braised samples from Bangangte II (3.35 ± 0.55 Log CFU/g) and its soup (3.47 ± 0.49 Log CFU/g) were of good quality as their loads were beyond the threshold value established by the Microbiological Criteria [32] which is 4 Log CFU/g. The rest of samples were not satisfying. As for fish samples, chicken samples and their soup were not contaminated with enterococci.

3.3 Microbial Profile of Braised Products Sold the City of Bangangte

In braised fish samples, the highest proportions of strains were isolated from samples from Bangangte II (17 strains) while for braised fish soup, 17 strains were isolated from samples from Bangangte I and 17 from those from Bangangte II. A total of 44 strains were isolated from braised fish samples and 47 strains from braised fish soups. These strains belonged to 8 different genera (Enterobacter, Morganella, Yersinia, Clostridium, Staphylococcus, Klebsiella, Pasteurella and Proteus) and 12 species (*E. gergoviae, Enterobacter* spp., *M. morganiae,* Y*. enterolitica, Y. frederiksenii, S. aureus, S. epidermitidis, Staphylococcus* spp., *Clostridium* spp., *K. pneumoniae, P. aerogene,* and *P. mirabilis*).

The most abundant genus was Staphylococcus (37.36 %), followed by Yersinia (23.07 %), Klebsiella (12.08 %), Pasteurella (8.79 %), Enterobacter (5.49 %), Morganella (5.49 %), Clostridium (4.39 %) and Proteus (3.29 %). At the species level, the most abundant one was *S. aureus* (25.27 %). Taking into consideration the nature of sample and the collection site, the strains identified were distributed accordingly as shown in Table 4.

Amongst braised fish samples, those from Bangangte I had the highest diversity with 8

different species. Strains specific to Bangangte I were *E. gergoviae*, *Enterobacter* spp., and *M. morganiae* while in Bangangte II, the specific strains *P. aerogene* and *P. mirabilis*. Bangangte III scored the less diversity with only 5 species. In that site, strains belonging to *Clostridium* spp., *P. mirabilis*, *Y. enterolitica*, *P. frederiksenii* and *M. morganiae* were absents. Globally, the results of this study suggest that strains which can be used as marker of braised fish sold in the city of Bangangte were *Y. enterolitica*, *S. aureus* and *K. pneumonia.* These 3 strains were found in braised fish samples independent of their sampling sites. Further identification at genomic level of these strains is required in order to validate this hypothesis.

In regards with braised fish soup, samples from Bangangte I showed the highest diversity with 9 different species (*Y. enterolitica*, *Y. frederiksenii*, *K. pneumoniae*, *S. aureus*, *S. epidermitidis*, *Staphylococcus* spp., *P. mirabilis*, *E. gergoviae* and *M. morganiae*). Amongst these species, the major ones in samples from Bangangte I were *Y. enterolitica* (17.64 %), *S. aureus* (29.41 %) and *M. morganiae* (17.64 %). In Bangangte II, it was *K. pneumoniae* (23.52%), *S. aureus* (17.64 %), and *Staphylococcus* spp. (23.52 %), while in samples from Bangangte III, it was *Y. enterolitica* (30.76 %) and *S. aureus* (30.76 %). Strains specific to samples Bangangte I were *S. epidermitidis*, *E. gergoviae*, *P. mirabilis* and *M. morganiae* while *Enterobacter* spp. was found only in samples from Bangangte III. *P. aerogenes* and *Clostridium* spp. were not found in samples from Bangangte I.

K. pneumoniae, *S. aureus*, *Staphylococcus* spp. and *Y. enterolitica* were found in all samples independently of the sampling sites. In braised fish samples, it was *Y. enterolitica*, *S. aureus* and *K. pneumonia*. Hence, these strains could be considered as markers of braised fish sold and consumed in the city of Bangangte. Their potential implication in foodborne diseases suggests that braised fish vendors in that city should be sensitized on good hygiene and manufacturing practices. The implication of *Staphylococcus aureus* in foodborne toxi-infection were noticed in French by Hennekinne [45] and more recently at Bangangte by Tangwa et al. [11].

While comparing the diversity of braised fish and its soups in a same location, some strains specific to braised fish and others specific to soup samples were identified. This result suggests that there are some strains which could originate from fish microflora and others from spices microflora. In Bangangte I, the difference was the presence of *Clostridium* spp. and *Enterobacter* spp. in braised fish samples, and the presence of *S. epidermitidis*, *Staphylococcus* spp. and *P. mirabilis*. In Bangangte II, *P. mirabilis* was detected in braised fish only, while *Y. frederiksenii* was detected only in braised fish soup. In the site Bangangte III, *Enterobacter* spp. and *Clostridium* spp. were specific to braised fish soup samples. No species specific to braised fish samples was detected.

Table 5 presents the microbial profile of samples braised chicken and their accompanying soups collected in three localities on the city of Bangangte. A total of 38 strains were isolated from braised chicken samples while 40 strains were isolated from their accompanying soup. These strains belonged to five genera: Yersinia (34.61 %), Staphylococcus (37.17 %), Proteus (17.94 %), Enterobacter (2.53 %) and Klebsiella (7.69 %). The predominance of strains belonging to *Staphylococcus genus* justifies the contamination of samples as the results of poor handling conditions and the non-respect of good manufacturing practices. The presence of staphylococci in foods associated to their handling by vendors was also highlighted by Mouafo et al. [46]. The strains belonged to seven species: *Y. enterolitica, Y. frederiksenii, S. aureus, P. mirabilis, K. pneumoniae*, *Staphylococcus* spp. and *Enterobacter* spp. Their repartition according to the location is presented in Table 6. For chicken samples, 5 species were identified in Bangangte I with *Y. enterolitica* being the most abundant (38.46 %). In Bangangte II, 4 species with *S. aureus* and *Y. enterolitica* being the most represented (33.33 % each). In Bangangte III, it was 4 species with *S. aureus* as the most abundant (38.46 %). In regards with braised chicken soup, samples from Bangangte presented the highest diversity with 6 different species identified. The most abundant species were *Y. enterolitica* for Bangangte I (30.76 %) and II (35.71 %) and *S. aureus* for Bangangte III (38.46 %). The predominance of *Y. enterolitica* in foods intended to human consumption as observed in this study is worrisome as it is well known that, that gastrointestinal pathogen is the leading cause of diseases characterized by diarrhea, ileitis, and mesenteric lymphadenitis [47]. Moreover, the survival ability of that pathogen at low temperatures increases its potential to cause foodborne diseases [47]. Hence, important must be taken by Government in order to protect the consumers.

Table 4. Microbial profile of braised fish samples and its seasoning soup sold in the city of Bangangte, Cameroon

Products	Location	Genus	Species	Frequency	Percentage (%)
Braised fish	Bangangte I	Enterobacter	*Enterobacter gergoviae*	1	7.69
			Enterobacter spp.	1	7.69
		Morganella	*Morganella morganiae*	2	15.38
		Yersinia	*Yersinia enterolitica*	2	15.38
			Yersinia frederiksenii	1	7.69
		Clostridium	*Clostridium* spp.	1	7.69
		Staphylococcus	*Staphylococcus aureus*	4	30.76
		Klebsiella	*Klebsiella pneumoniae*	1	7.69
	Bangangte II	Pasteurella	*Pasteurella aerogene*	1	5.88
		Klebsiella	*Klebsiella pneumonia*	3	17.64
		Yersinia	*Yersinia enterolitica*	3	17.64
		Proteus	*Proteus mirabilis*	2	11.76
		Staphylococcus	*Staphylococcus aureus*	3	17.64
			Staphylococcus spp.	3	17.64
		Clostridium	*Clostridium* spp.	1	5.88
	Bangangte III	Yersinia	*Yersinia enterolitica*	4	28.57
		Pasteurella	*Pasteurella aerogenes*	4	28.57
		Klebsiella	*Klebsiella pneumonia*	1	7.14
		Staphylococcus	*Staphylococcus aureus*	4	28.57
			Staphylococcus spp.	1	7.14
Braised fish soup	Bangangte I	Yersinia	*Yersinia enterolitica*	3	17.64
			Yersinia frederiksenii	1	5.88
		Klebsiella	*Klebsiella pneumoniae*	1	5.88
		Staphylococcus	*Staphylococcus aureus*	5	29.41
			Staphylococcus epidermitidis	1	5.88
			Staphylococcus spp.	1	5.88
		Proteus	*Proteus mirabilis*	1	5.88
		Enterobacter	*Enterobacter gergoviae*	1	5.88
		Morganella	*Morganella morganiae*	3	17.64
	Bangangte II	Yersinia	*Yersinia enterolitica*	2	11.76

Products	Location	Genus	Species	Frequency	Percentage (%)
			Yersinia frederiksenii	1	5.88
		Pasteurella	*Pasteurella aerogenes*	2	11.76
		Clostridium	*Clostridium* spp.	1	5.88
		Klebsiella	*Klebsiella pneumoniae*	4	23.52
		Staphylococcus	*Staphylococcus aureus*	3	17.64
			Staphylococcus spp.	4	23.52
	Bangangte III	Yersinia	*Yersinia enterolitica*	4	30.76
		Enterobacter	*Enterobacter* spp.	1	7.69
		Pasteurella	*Pasteurella aerogenes*	1	7.69
		Clostridium	*Clostridium* spp.	1	7.69
		Klebsiella	*Klebsiella pneumoniae*	1	7.69
		Staphylococcus	*Staphylococcus aureus*	4	30.76
			Staphylococcus spp.	1	7.69

Table 5. Microbial profile of braised chicken samples and its seasoning soup sold in the city of Bangangte, Cameroon

Products	Location	Genus	Species	Frequency	Percentage (%)
Braised chicken	Bangangte I	Yersinia	*Yersinia enterolitica*	5	38.46
			Yersinia frederiksenii	1	7.69
		Staphylococcus	*Staphylococcus aureus*	2	15.38
			Staphylococcus spp.	4	30.76
		Proteus	*Proteus mirabilis*	1	7.69
	Bangangte II	Yersinia	*Yersinia enterolitica*	4	33.33
		Klebsiella	*Klebsiella pneumoniae*	1	8.33
		Staphylococcus	*Staphylococcus aureus*	4	33.33
		Proteus	*Proteus mirabilis*	3	0.25
	Bangangte III	Yersinia	*Yersinia enterolitica*	4	30.76
		Proteus	*Proteus mirabilis*	3	23.07
		Staphylococcus	*Staphylococcus aureus*	5	38.46
		Klebsiella	*Klebsiella pneumoniae*	1	7.69
Braised chicken soup	Bangangte I	Staphylococcus	*Staphylococcus* spp.	2	15.38
			Staphylococcus aureus	2	15.38

Products	Location	Genus	Species	Frequency	Percentage (%)
		Proteus	*Proteus mirabilis*	1	7.69
		Klebsiella	*Klebsiella pneumoniae*	3	23.07
		Enterobacter	*Enterobacter* spp.	1	7.69
		Yersinia	*Yersinia enterolitica*	4	30.76
	Bangangte II	Yersinia	*Yersinia enterolitica*	5	35.71
		Enterobacter	*Enterobacter* spp.	1	7.14
		Proteus	*Proteus mirabilis*	3	21.42
		Staphylococcus	*Staphylococcus* spp.	2	14.28
			Staphylococcus aureus	3	21.42
	Bangangte III	Yersinia	*Yersinia enterolitica*	4	30.76
		Proteus	*Proteus mirabilis*	3	23.07
		Staphylococcus	*Staphylococcus aureus*	5	38.46
		Klebsiella	*Klebsiella pneumoniae*	1	7.69

Table 6. Antibiotic susceptibility profiles of the pathogens isolated from braised products sold in the city of Bangangte

Strains	Susceptibility to antibiotics														MAR Index
	CIP	SXT	CXM	CAZ	AX	NOR	F	AMC	GEN	FOX	ERY	NA	AMP	IMP	
P. mirabilis P10B2N2	S	S	S	R	S	I	S	I	S	I	R	S	I	S	0.14
K. pneumoniae P12C2W2	I	S	I	I	I	S	S	I	S	I	R	I	R	S	0.14
E. gergoviae P1A1F1	S	S	R	S	R	S	S	R	S	I	R	S	R	S	0.35
Y. enterolitica P2A1E1	R	S	R	R	R	S	S	R	S	R	R	S	R	S	0.57
K. pneumoniae CP5C1V1	S	S	R	R	I	S	S	I	S	R	R	I	R	S	0.35
P. aerogenes CP4B1N1	S	S	S	R	S	S	S	I	S	S	R	S	R	S	0.21
E. gergoviae CP8A2E2	S	S	I	I	I	S	S	I	S	I	R	S	R	S	0.14
K. pneumoniae CPIA1F1	S	S	S	S	R	S	S	I	S	S	R	S	R	S	0.21
Y. enterolitica P7A2F2	S	S	R	S	S	S	S	I	S	R	R	R	R	S	0.35
Y. enterolitica P11B2N2	S	R	S	S	R	S	S	I	S	I	R	I	R	S	0.28

Strains	Susceptibility to antibiotics														MAR Index
	CIP	SXT	CXM	CAZ	AX	NOR	F	AMC	GEN	FOX	ERY	NA	AMP	IMP	
Y. frederiksenii P12C2W2	S	S	R	S	R	S	I	I	S	S	R	S	I	S	0.21
Y. enterolitica P7A2F2	S	S	S	R	I	S	R	I	S	R	R	S	R	I	0.35
K. pneumoniae CP11B2N2S	S	S	S	R	S	R	R	S	I	R	S	R	S	S	0.35
Y. enterolitica P2A1E1	S	S	R	R	R	R	S	R	S	R	R	S	R	S	0.57
Y. enterolitica CP5C1V1	S	S	I	I	S	S	S	R	S	R	S	S	R	S	0.21
Y. enterolitica CP11B2N2S	S	S	S	R	S	R	R	S	I	R	S	R	S	S	0.35
M. morganiae P1A1F1	S	S	R	S	R	S	S	R	S	R	I	S	R	S	0.35
E. gergoviae P1A1F1	S	S	R	R	R	S	I	R	S	I	I	S	R	S	0.35
P. mirabilis CT5C1K1	S	S	R	R	R	R	R	R	S	I	S	S	R	S	0.50
Y. enterolitica T3B1L1	R	S	R	R	I	I	R	R	S	I	R	I	R	S	0.50
K. pneumoniae T5C1K1	S	R	R	S	I	S	S	S	S	I	R	S	R	S	0.28
Y. enterolitica T1A1S1	S	R	R	R	I	R	R	I	S	I	R	I	I	S	0.42
P. mirabilis T5C1K1	R	S	S	I	I	S	R	S	S	I	S	R	R	S	0.28
K. pneumoniae CT6C1G1	S	S	R	R	R	R	R	R	S	I	R	S	R	S	0.57
P. mirabilis CT5C1K1	I	S	R	S	R	S	S	R	S	R	R	S	S	S	0.35
K. pneumoniae T5C1K1	R	S	R	I	R	I	R	R	S	I	S	S	R	S	0.42
Y. enterolitica T15B3O3	R	R	R	I	R	R	R	R	S	I	R	S	R	S	0.64
P. mirabilis T3B1L1	S	S	R	R	I	R	R	R	R	I	S	S	I	S	0.42
Y. enterolitica T16B3O3	I	S	R	I	S	R	S	S	S	I	R	R	S	S	0.28
Y. enterolitica T1A1S1	S	I	R	R	R	R	R	R	S	S	I	I	R	S	0.50
Y. enterolitica CT4B1O1	I	S	R	R	I	R	R	I	R	S	S	S	R	S	0.42
Y. enterolitica CT18C3G3S	S	R	R	R	S	R	R	R	S	R	S	R	S	S	0.57
Y. enterolitica CT1A1S1	S	S	R	I	S	R	R	I	I	I	S	I	S	S	0.21

Strains	Susceptibility to antibiotics														MAR Index
	CIP	SXT	CXM	CAZ	AX	NOR	F	AMC	GEN	FOX	ERY	NA	AMP	IMP	
Y. enterolitica T6C1G1	R	S	R	R	I	S	S	I	I	I	I	S	R	S	0.28
K. pneumoniae T9B2L2	S	S	I	R	R	S	S	R	S	I	R	S	R	S	0.35
Y. enterolitica T2A1J1	S	R	R	S	I	R	S	I	S	I	S	I	R	S	0.28
Y. enterolitica T6C1G1	R	S	R	R	I	S	S	I	S	S	R	R	R	S	0.42
P. mirabilis P15B3M3	S	S	R	I	R	S	S	R	S	S	R	I	R	S	0.35
Enterobacter sp. P13A3F3	S	R	R	R	R	S	S	I	S	I	R	S	R	S	0.42
Y. enterolitica P16B3N3	S	S	R	I	R	S	S	R	S	I	S	S	R	S	0.28
Y. enterolitica P7A2F2	S	S	R	R	I	S	S	R	S	I	R	S	R	S	0.35
P. aerogenes P17C3V3	S	R	R	R	I	S	S	S	S	I	S	S	R	S	0.28
Y. enterolitica P5C1V1	S	R	R	R	R	S	R	R	S	S	R	S	R	S	0.57
E. gergoviae CP8A2E2	S	S	R	R	R	S	S	S	S	S	I	S	R	S	0.28
E. gergoviae P6C1W1	S	S	R	R	R	S	S	R	S	S	R	S	R	S	0.42
K. pneumoniae CP15B3M3S	S	R	S	R	S	R	R	S	I	R	S	R	S	S	0.42
P. aerogenes CP15B3M3S	R	R	S	R	S	R	R	S	S	R	S	R	S	S	0.42
Y. enterolitica P18C3W3	S	S	S	R	R	S	S	I	S	S	R	S	R	S	0.28
K. pneumoniae CP11B2N2S	S	R	S	R	S	R	R	S	I	R	S	R	S	S	0.42

S=Susceptible, R=Resistant, I=Intermediate, CIP=Ciprofloxacin, SXT=Cotrimoxazole, CXM=Cefuroxime, CAZ=Ceftazidime, AMC=Amoxycillin-clavulanic acid, AX=Amoxycillin, NOR=Norfloxacin, F=Nitrofurantoin, GEN=Gentamicin, FX=Cefroxadine, ERY=Erythromycin, NA=Nalidixic acid, AMP=Ampicillin, IMP=Imipenem. For MAR index calculation, bacteria with intermediate resistance were considered as susceptible

3.4 Antibiotic resistance Profile of Strains Isolated from Braised Products Sold the City of Bangangte

The susceptibility of pathogens isolated from braised products sold in the city of Bangangte was assessed and results are presented in Table 6. The phenotypic antimicrobial sensitivity pattern of pathogens isolated from braised products sold in the city of Bangangte indicates that imipenem, gentamicin, ciprofloxacin and cotrimoxazole were the most efficient antibiotics as they retained antibacterial activity against 97.91, 83.33, 75 and 72.91 % of tested pathogens, respectively. The high sensitivity of the tested pathogens to these antibiotics might arise from their excellent activities against Gram negative and Gram-positive bacteria [48]. Ciprofloxacin acted by inhibiting bacterial DNA gyrase responsible for DNA replication and transportation [49]. Gentamicin binds irreversibly to the 16S rRNA subunit of the 30S ribosome and inhibit bacterial protein synthesis [50]. Independently of the tested pathogens, no resistance was noticed for imipenem only. The sensitivity of pathogens to imipenem could arise from its ability to bind and inactivate penicillin-binding proteins of bacteria and to inhibit the bacterial cell wall synthesis. In fact, penicillin-binding proteins are located on the inner membrane of the bacterial cell wall. Its inactivation will interfere with the cross-linkage of peptidoglycan chains necessary for bacterial cell wall strength and rigidity. Hence, the bacterial cell wall synthesis will be interrupted. The bacterial cell wall will be weakened leading to cell lysis [51]. This result suggests imipenem as the most efficient antibiotics against pathogens isolated from braised products sold in the city of Bangangte.

However, the tested pathogens were resistant to almost antibiotics used in this study. The highest resistances were recorded with ampicillin (72.91 %), cefuroxime (66.66 %), ceftazidime (60.41 %) and erythromycin (56.25 %). The multiple antibiotic resistance of several pathogens observed in this study might result from the abusive use of antibiotics in fish and poultry farming activities in the West region of Cameroon. Ntsama et al. [12] highlighted 75 % of fish farmers in Cameroon used antibiotics without referring to a veterinarian for prescription. Wadoum et al. [52] found that in Cameroon, antibiotics administration to poultry as well as their dosage were often subjective. Associated to this, many farmers do not observe the withdrawal periods. In the study conducted by Fakorede et al. [53], fish pond was reported as a reservoir of multi-drug resistant bacteria. The authors also mentioned that fish pond could serve as environmental source of drug resistance gene transfer. In fact, when antibiotics are used in poultry or fish farming, their residues might bioaccumulate in tissues and thus leading to development of antibiotic-resistant bacteria [54]. There are reports addressing the presence of antibiotic residues in the fish muscles as a result of the use of antibiotics for the prevention and treatment of bacterial infections in aquaculture [55-56]. Wadoum et al. [52] noticed the presence of antibiotics residues in meat and eggs from chicken farmed in the Western Highlands of Cameroon at levels higher than the maximum residual limits set by regulatory authorities.

Table 6 also shows the MAR index of the different pathogens isolated from braised products sold in the city of Bangangte. The MAR index values obtained in this study ranged from 0.14 (*P. mirabilis* P10B2N2 and *K. pneumoniae* P12C2W2) to 0.64 (*Y. enterolitica* T15B3O3). High MAR index of 0.57 was noticed with strains *Y. enterolitica* CT18C3G3S, *Y. enterolitica* P5C1V1, *K. pneumoniae* CT6C1G1, *Y. enterolitica* P2A1E1 and *Y. enterolitica* P2A1E1. It is worrisome to highlight that 93.75 % of pathogens tested in this study were multi-resistant to various antibiotics with MAR index values greater than 0.2. This suggests that all the tested pathogens came from high antibiotic usage area. Osundiya et al. [57] also highlighted that MAR index values greater than 0.2 indicate high risk source of contamination where antibiotics are often used. The multidrug resistance of pathogens isolated from braised fish and chicken products as observed in this study could be ascribed to the presence of antibiotic residues in the products. These residues might have favored the development of resistant microorganisms. The possible gene transfer of resistance between these pathogens could also be one of the reasons behind the multiple antibiotic resistance. In fact, Sandhu et al. [58] reported that the multi-resistance of bacteria is most commonly associated with the presence of plasmids which contain one or more resistance genes each encoding a single antibiotic resistance phenotype. Wadoum et al. [52] reported that after the consumption of food containing antibiotic residues, resistant bacterial strains can spread throughout the human population, which will lead to the transfer of genes coding for resistance. The results of this study suggest that the commonly used antibiotics

in the city of Bangangte will not be effective for the management of diseases associated with consumption of braised fish and chicken products. Microbial multidrug resistance of pathogens isolated from ready-to-eat braised fish and chicken products sold in the city of Bangangte therefore frustrates efforts for disease control resulting in a prolonged hospitalization of patients [53].

Globally, strains belonging to the same species scored different resistance profile to the tested antibiotics. This result means that they could be of different phenotype profile. A similar observation was noticed by Ed-Dra et al. [59]. The authors identified 25 different phenotypic profiles of *S. aureus* based on their resistance to 16 tested antibiotics. Difference between strains belonging to the same species based on their resistance profile to antibiotics was also highlighted by Bouymajane et al. [60].

4. CONCLUSION

This study demonstrated the poor microbiological quality of braised products sold in the city of Bangangte in relation to the non-respect of good hygiene and manufacturing practices. The microbial profile of braised products was dominated by strains which belonged to the genus of Staphylococcus thus highlighting the poor handling practices. Strains belonging to 12 different species colonize braised products sold in the city of Bangangte. *Y. enterolitica*, *S. aureus* and *K. pneumonia* appear as markers of braised fish sold in the city of Bangangte were as for braised chicken, they were *Y. enterolitica*, *S. aureus* and *P. mirabilis*. For that, further characterization of the different isolates at genomic level (16S rRNA gene analysis) is required. Apart imipenem, the strains isolated from braised fish and chicken products sold in the city of Bangangte were resistant to the 13 antibiotics tested and 93.75 % of these pathogens were multi-resistant with MAR index values greater than 0.2. The results of this study suggest that the commonly used antibiotics in the city of Bangangte will not be effective for the management of diseases associated with consumption of braised fish and chicken products. Hence, appropriate measures must be taken by the government in order to sensitize fish and poultry farmers.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s) from Autorisation N° 2019/032/UdM/PR/CIE.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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